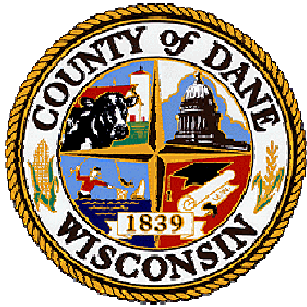


**RFB NO. 313086.**



## **CONSTRUCTION DOCUMENTS PROJECT MANUAL**

DANE COUNTY DEPARTMENT OF PUBLIC WORKS,  
HIGHWAY AND TRANSPORTATION

PUBLIC WORKS ENGINEERING DIVISION  
1919 ALLIANT ENERGY CENTER WAY  
MADISON, WISCONSIN 53713

### **REQUEST FOR BIDS NO. 313086**

## **CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS HENRY VILAS ZOO 702 SOUTH RANDALL AVE. MADISON, WISCONSIN**

**VOLUME II of II  
Division 21 through Division 33**

Due Date / Time: **THURSDAY, DECEMBER, 12, 2013/ 2:00 P.M.**

Location: **PUBLIC WORKS OFFICE**

Performance / Payment Bond: **100% OF CONTRACT AMOUNT**

Bid Deposit: **5% OF BID AMOUNT**

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FOR INFORMATION ON THIS REQUEST FOR BIDS, PLEASE CONTACT:  
ROB NEBEL, ASSISTANT DIRECTOR OF PUBLIC WORKS  
TELEPHONE NO.: 608/266-0119  
FAX NO.: 608/267-1533  
E-MAIL: [NEBEL@COUNTYOFDANE.COM](mailto:NEBEL@COUNTYOFDANE.COM)

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## SECTION 21 05 00 - BASIC FIRE SUPPRESSION REQUIREMENTS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 21 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced in the specification section.

## 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make his portion of the Mechanical Work a finished and working system.
- C. Fire protection shall be provided for the Restaurant building only. No fire protection for Bear or Seal buildings.

## 1.3 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL &amp; CONTROL CONTRACTORS

## A. Definitions:

- 1. "Mechanical Contractors" refers to the following:
  - a. Plumbing Contractor.
  - b. Heating Contractor.
  - c. Air Conditioning and Ventilating Contractor.
  - d. Fire Protection Contractor.
  - e. Testing, Adjusting, and Balancing Contractor.

## B. General:

- 1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as mechanical equipment, and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
- 2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
  - a. Light fixtures.
  - b. Gravity flow piping, including steam and condensate.
  - c. Electrical busduct.
  - d. Sheet metal.
  - e. Electrical cable trays, including access space.
  - f. Sprinkler piping and other piping.
  - g. Electrical conduits and wireway.

## C. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.4 QUALITY ASSURANCE

## A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.
- B. Qualifications:
1. Only products of reputable manufacturers are acceptable.
  2. All Contractors and subcontractors shall employ only workers skilled in their trades.
- C. Compliance with Codes, Laws, Ordinances:
1. Conform to all requirements of the City of Madison, Wisconsin Codes, Laws, Ordinances and other regulations having jurisdiction.
  2. Conform to all State Codes.
  3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
  4. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
  5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
  6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
- D. Permits, Fees, Taxes, Inspections:
1. Procure all applicable permits and licenses.
  2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
  3. Pay all charges for permits or licenses.
  4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
  5. Pay all charges arising out of required inspections by an authorized body.
  6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

## E. Examination of Drawings:

1. The drawings for the fire protection work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in fire protection documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
  - a. Any item listed as furnished shall also be installed, unless otherwise noted.
  - b. Any item listed as installed shall also be furnished, unless otherwise noted.

## F. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

## G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit MEP.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

## 1.5 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

<u>Referenced Specification Section</u>	<u>Submittal Item</u>
21 13 00	Sprinkler Systems
21 13 00	Fire Protection Equipment

- B. In addition to the provisions of Division 1, the following provisions are required:

1. Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
2. The Contractor shall submit one electronic copy of each shop drawing for review by the Architect/Engineer BEFORE releasing any equipment for manufacture or shipment.
3. Shop drawings which are larger than 11"x 17" or are plan size layout or erection drawings such as sprinkler system drawings shall be submitted on reproducible



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

media. Submit one reproducible and one print of each drawing or plan. All Contractor approval stamps shall be made on the reproducible.

4. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. CONTRACTOR'S APPROVAL STAMP IS REQUIRED ON ALL SUBMITTALS. APPROVAL WILL INDICATE THE CONTRACTOR'S REVIEW of all material and a COMPLETE UNDERSTANDING OF EXACTLY WHAT IS TO BE FURNISHED. Contractor shall clearly mark all deviations from the contract documents on all submittals. IF DEVIATIONS ARE NOT MARKED BY THE CONTRACTOR, THEN THE ITEM SHALL BE REQUIRED TO MEET ALL DRAWING AND SPECIFICATION REQUIREMENTS.
5. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
6. The Contractor shall clearly indicate the size, finish, material, etc.
7. Assemble and submit by specification section numbers for all submittals. All sets shall be identical and contain an index of the items enclosed with a general topic description on the cover.
8. Each set shall be bound in a manufacturer's folder or inside of a manila file folder.
9. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is relevant to the work.
10. Failure to comply with the above shall be reason to resubmit all shop drawing submittals.
11. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

## 1.6 PRODUCT DELIVERY, STORAGE, HANDLING &amp; MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

allow movement of equipment. Contractor shall coordinate his/her work with other trades.

## 1.7 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

## 1.8 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

## 1.9 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

## PART 2 - PRODUCTS

NOT APPLICABLE

## PART 3 - EXECUTION

## 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employee and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

## 3.2 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:
1. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    - a. Pipe wall penetrations are sealed.
    - b. Pipe identification is installed.
    - c. Branch piping in the location of sprinklers shall be dropped to the ceiling.
  2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

## 3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  - 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
  - 2. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, This Contractor must submit the following:
  - 1. Operation and maintenance manuals with copies of approved shop drawings.
  - 2. Record documents including marked-up or reproducible drawings and specifications.
  - 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
  - 4. Inspection report by the State Fire Marshal of the fire protection system.
  - 5. Start-up reports on all equipment requiring a factory installation inspection or start-up.
  - 6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

## 3.4 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Submit three properly indexed and bound copies, in 'D' Ring style notebooks, of the Operations and Maintenance Instructions to the Architect/Engineer. Make all corrections or additions required.
- B. Manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.
- C. Operation and maintenance data shall consist of written instructions for the care, maintenance, and operation of all equipment and systems. Include all instruction books, cards, and manuals furnished with the equipment.

## 3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The instructions shall include:
  - 1. Explanation of all system flow diagrams.
  - 2. Maintenance of equipment.
  - 3. Start-up procedures for all major equipment.
  - 4. Explanation of seasonal system changes.
  - 5. Description of emergency system operation.
- D. The Architect/Engineer shall be notified of the time and place instructions will be given to the Owner's representatives so he or his representative can attend if desired.
- E. Minimum hours of instruction for each item shall be:
  - 1. Sprinkler System(s) - 2 hours.
- F. The Contractor shall prepare a detailed, written training agenda. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
- G. Operating Instructions:
  - 1. Contractor is responsible for all instructions to the Owner's representatives for the fire protection and control systems.
  - 2. If the Contractor does not have staff that can adequately provide the required instructions he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

## 3.6 SYSTEM COMMISSIONING

- A. The fire protection systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- C. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

## 3.7 RECORD DOCUMENTS

- A. The following paragraph supplements Division 1 requirements:

Contractor shall maintain at the job site a separate and complete set of fire protection drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the fire protection systems.

- B. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations of other control devices, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.
- C. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

## 3.8 PAINTING

- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor.
- C. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer his color preference and furnish this color.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.

## 3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

## 3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

END OF SECTION 21 05 00

## SECTION 21 05 29 - FIRE SUPPRESSION SUPPORTS AND ANCHORS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Sleeves and Seals.
- C. Flashing and Sealing of Equipment and Pipe Stacks.
- D. Cutting of Openings.
- E. Escutcheon Plates and Trim.

## 1.2 QUALITY ASSURANCE

- A. Support Sprinkler Piping in conformance with NFPA 13.

## 1.3 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

## PART 2 - PRODUCTS

## 2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter Column #1
2" and smaller	3/8"
2-1/2" through 3-1/2"	1/2"
4" and 5"	5/8"

Column #1: Steel pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:
  - 1. Kitchens.

## 2.2 PIPE HANGERS AND SUPPORTS

- A. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58, 69, 89, and 127 (where applicable).



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

B. Unless otherwise indicated, hangers shall be as follows:

1. Clevis Type:

Service: Bare Metal Pipe

Acceptable Products:	Bare Steel Pipe
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Anvil	Fig. 260
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Cooper/B-Line	Fig. 3100
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Erico	Model 400
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Nibco/Tolco	Fig. 1
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2. Adjustable Swivel Ring Type:

Service: Bare Metal Pipe - 4 inches and Smaller

Acceptable Products:	Bare Steel Pipe
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Anvil	Fig. 69
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Cooper/B-Line	Fig. B3170NF
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Erico	Model FCN
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Nibco/Tolco	Fig. 200
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C. Support may be fabricated from U-Channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.

1. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

D. Unless otherwise indicated, pipe supports for use with struts shall be as follows:

1. Clamp Type:

Service: Bare Metal Pipe

a. Pipes subject to expansion and contraction shall have clamps slightly oversized to allow limited pipe movement.

Acceptable Products:	Bare Steel Pipe
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Unistrut	Fig. P1100 or P2500
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Cooper/B-Line	Fig. B2000 or B2400
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Nibco/Tolco	Fig. A-14 or 2STR
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## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
1. Beam Clamps:

<u>Acceptable Products:</u>	
Anvil	Fig. 228, 292
Cooper/B-Line	Fig. B3054
Erico	Model 360
Nibco/Tolco	Fig. 329
- F. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs.
- G. Welding:
1. Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and for protecting walls and ceilings from being damaged by smoke.

## 2.3 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at his expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

## 2.4 PIPE SLEEVES AND LINTELS

- A. Each Contractor shall provide pipe sleeves and lintels for all openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Engineer's design.
- E. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

## 2.5 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

## 2.6 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

## 2.7 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

## 2.8 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

## PART 3 - EXECUTION

## 3.1 FIRE SUPPRESSION SUPPORTS AND ANCHORS

- A. General Installation Requirements:
  - 1. Install all items per manufacturer's instructions.
  - 2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
  - 3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
3. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
4. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

## C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

## D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
  - a. The hanger is attached within 6" from a web/chord joint.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- F. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- G. Spacing of Hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

	<u>Pipe Material</u>	<u>Maximum Spacing</u>
1.	Steel (Std. Weight or Heavier – Liquid Service):	
	1-1/4" & under	7'-0"
	1-1/2"	9'-0"
	2"	10'-0"
	2-1/2"	11'-0"
	3"	12'-0"
	4" & larger	12'-0"
2.	Installation of hangers shall conform to MSS SP-69, MSS SP-89 and applicable NFPA standards.	

END OF SECTION 21 05 29

## SECTION 21 05 53 - FIRE SUPPRESSION IDENTIFICATION

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Identification of products installed under Division 21.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. 3M, Bunting, Calpico, Craftmark, Emedco, Kolbi Industries, Seton, W.H. Brady, Marking Services.

## 2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

<u>O.D. of Pipe or insulation</u>	<u>Marker Length</u>	<u>Size of Letters</u>
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"

Plastic tags may be used for outside diameters under 3/4".

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- D. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- E. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- F. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.
- G. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## C. Valves:

1. All valves (except shut-off valves at equipment) shall have numbered tags.
2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
3. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
4. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
5. Number all tags and show the service of the pipe.
6. Provide two sets of laminated 8-1/2" x 11" copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

## D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
3. Stencil Painted Pipe Markers:
  - a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
  - b. Apply primer on non-insulated pipes before painting.
  - c. Use background and letter colors as scheduled later in this section.
4. Apply markers and arrows in the following locations where clearly visible:
  - a. At each valve.
  - b. On both sides of walls that pipes penetrate.
  - c. At least every 20 feet along all pipes.
  - d. On each riser and each leg of each "T" joint.
  - e. At least once in every room.

## E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of Standard 90.1.

## 3.2 SCHEDULE

## A. Pipes to be marked:

Pipe Service	Lettering Color	Background Color
Fire Protection Water	White	Red

END OF SECTION 21 05 53





## SECTION 21 13 00 - FIRE PROTECTION SYSTEMS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Pipe, Fittings, Valves, and Connections for Fire Protection System.
- B. Wet-Pipe Sprinkler System.

## 1.2 QUALITY ASSURANCE

- A. Welding Materials and Procedures: Conform to ASME Code.
- B. Equipment and Components: Bear UL label or marking.
- C. Valves: Bear UL label or marking. Provide manufacturer's name and pressure rating marked on valve body. Pressure rating shall match specified pipe system pressure rating. Remanufactured valves are not acceptable.
- D. Specialist Firm: Company specializing in sprinkler systems with minimum three years' experience.
- E. Sprinkler design drawings submitted by the contractor shall be designed, certified, and shall include the NICET certification block or the Professional Engineer seal of the fire protection designer. Fire protection designer shall be NICET Level III or Level IV certified or be a licensed Professional Engineer.

## 1.3 SUBMITTALS

- A. Submit shop drawings per Section 21 05 00. Indicate pipe materials, joining methods, supports, floor and wall penetration seals, sprinklers, equipment data and ratings, and hydraulic calculations.
- B. Submit detailed pipe and sprinkler layout and other calculations and forms as described in NFPA 13.
- C. Submit detailed working drawings and obtain review of them in the following order:
  - 1. Engineer/Architect
  - 2. Local Fire Department
  - 3. Owner's Insurance Company
  - 4. Architect/Engineer

Begin construction after all approvals are received.

- D. Working drawings shall include piping and sprinkler layout, sprinkler types and ratings, sections and elevations at critical points. Show coordination with lighting, ductwork, and diffusers, and indicate basic flow and hydraulic design information, including main location and date that the test was taken.
- E. Provide the Owner with one copy of NFPA 25. *Standard for the Inspection Testing and Maintenance of Water-based Fire Protection Systems.*

## 1.4 EXTRA STOCK

- A. Provide metal storage cabinet, wrenches for each sprinkler type, and extra sprinklers per NFPA 13 and applicable building code.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store valves and sprinklers in shipping containers, with labels in place.
- B. Provide temporary protective coating on iron and steel valves.
- C. Maintain temporary end caps and closures in place until installation.

## 1.6 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves to General Contractor for placement in walls. Sleeve location to be determined by the Fire Protection Contractor prior to construction. If additional sleeves are required, they shall be core drilled by the Fire Protection Contractor.

## 1.7 SYSTEM DESCRIPTION

- A. System shall cover building areas noted.
- B. System shall interface with building fire alarm system. Provide all required wiring.
- C. Provide wet pipe sprinkler system to NFPA 13 and building code requirements as required by Owner's insurance company and as shown on the drawings.
- D. Provide a Fire Department connection.

## 1.8 REGULATORY REQUIREMENTS

- A. All material, equipment, and installation shall be approved by the Authorities Having Jurisdiction and the Owner's Insurance Company.
- B. The Authorities Having Jurisdiction and the Owner's Insurance Company shall have precedence over the drawings and specifications in case of discrepancies.
- C. The entire installation shall comply with all applicable codes.

## 1.9 SYSTEM DESIGN

- A. Design and install a complete, hydraulically calculated wet-pipe sprinkler system for the entire building.
- B. Provide all required equipment and accessories.
- C. System shall include a 5 psi allowance for future decrease in available pressure and an allowance for inside and outside hose streams.
- D. Provide monitor switches on all shut-off valves.
- E. Install sprinkler riser in location shown on drawings or as approved by the Architect/Engineer.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- F. Provide pressure gauge with valve in the main riser.
- G. Provide main drain valve piped to outside the building. Locate so discharge does not damage lawn or other surfaces.
- H. Provide flow switch in the main riser and as indicated on drawings.
- I. Provide horn and strobe.

## 1.10 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturers' operation and maintenance data. Include written maintenance data on components of system, servicing requirements, and record drawings.

## 1.11 JOB CONDITIONS

- A. Fire Protection Contractor shall determine the flow and pressure available at the service connection. The Fire Protection Contractor is responsible to verify this information and make all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 18 months.
- B. Pipe sizing shown on drawings for service entrance and main risers is preliminary for coordination purposes only. Contractor is responsible for final sizing from hydraulic calculations.

## PART 2 - PRODUCTS

## 2.1 PIPE AND FITTINGS

- A. Steel Pipe (Inside Building-Above Grade):
  - 1. Pipe: 2" and Under - Schedule 40, black steel, ASTM A53. Threaded and coupled or flanged.
  - 2. Joints: 2" and under - screwed or flanged.
  - 3. Fittings: Screwed - cast iron, 125 lb., black, ANSI/ASME B16.4 or malleable iron, 150 lb., black, ANSI/ASME B16.3. Flanged-cast iron, 125 lb., ANSI/ASME B16.1.
- B. Steel Pipe (Inside Building-Above Grade):
  - 1. Pipe: 2-1/2" and Over - Schedule 10, black steel, grooved, ASTM A135.
  - 2. Joints: Mechanically coupled grooved.
  - 3. Fittings: 500 lb. WOG, black, malleable iron, ASTM A47.
  - 4. Plain end fittings and couplings are not acceptable.
- C. Fire Protection Service to Building (by others):
  - 1. Refer to Section 22 10 00.

## 2.2 FLEXIBLE SPRINKLER HOSE WITH THREADED END FITTINGS

- A. UL listed per UL 2443.
- B. Construction:
  - 1. Hose:
    - a. Type 304 stainless steel.
    - b. Straight or elbow hose - maximum six (6)-foot hose length.
    - c. 1/2" or 3/4" outlet.
    - d. 175 psi rated pressure.
    - e. Leak-tested minimum 7/8".
    - f. Minimum 7/8" hose Braided hose.
    - g. O-ring sealed joints are not acceptable.
  - 2. Ceiling Bracket:
    - a. Zinc plated or galvanized steel – 24" and 48" sizes.
    - b. Flexible hose attachment: Open hub or set screw.
  - 3. Unit may be prepackaged with sprinkler head.
- C. Acceptable Manufacturers: FlexHead Industries, Victaulic Aquaflex.

## 2.3 UNIONS AND COUPLINGS

- A. Unions: 175 psi malleable iron for threaded ferrous piping.
- B. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular and longitudinal deflection; "C" shaped composition sealing gasket, steel bolts, nuts, and washers. 175 psi, ASTM A47. Plain end fittings and couplings are not acceptable. Rolled groove couplings for Schedule 10 pipe. Cut groove couplings for Schedule 40 pipe. Couplings shall be enamel coated for wet systems. Acceptable Manufacturers: Victaulic, ITT, Grinnell, Central, Anvil GruvLok, Star Fittings.
- C. Coupling gaskets for wet systems shall be Grade "E" EDPM Type A.

## 2.4 VALVE OPERATORS

- A. Provide handwheels for gate valves. Provide gear operators for butterfly valves.

## 2.5 VALVE CONNECTIONS

- A. Provide all connections to match pipe joints. Valves shall be same size as pipe.

## 2.6 BACKFLOW PREVENTERS

- A. Provide backflow preventers as required by code and as specified on the drawings.

## 2.7 EQUIPMENT

- A. Equipment shall be as scheduled on the drawings.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION - PIPING

A. General Installation Requirements:

1. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over sprinkler piping and sprinklers.
2. Ream pipe and tube ends to full inside diameter. Remove burrs. Remove scale and foreign material, inside and outside, before assembly.
3. Die cut screw joints with full cut standard taper pipe threads.
4. Coat threads with pipe joint compound or wrap with Teflon tape.
5. Locate piping to minimize obstruction of other work.
6. Route piping in concealed spaces above finished ceiling.
7. Use full and double lengths of pipe wherever possible.
8. Slope all piping for complete drainage. Install auxiliary drains for all trapped piping per NFPA 13.
9. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
10. Comply with manufacturer's installation instructions.

B. Steel Piping:

1. In steel piping, main sized saddle branch connections or direct connection of branches to main is permitted if main is one pipe size larger than the branch for up to 6" mains and if main is two pipe sizes larger than branch for 8" and larger mains. Do not project branch pipes into main pipes.

C. Wall Penetration:

1. Provide sleeves when penetrating walls.

D. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment. Fire protection equipment dedicated to the electrical equipment room or space may be installed above equipment if other alternatives are not available.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Hangers and Supports:
  - 1. Provide hangers and supports as required by NFPA 13 and UL, with the following exceptions:
    - a. Do not use powder driven devices, explosive devices, wooden plugs, or plastic inserts.
    - b. Do not install fasteners to carry the load in tension, unless absolutely necessary.
- F. Exposed Piping:
  - 1. Install chrome plated steel escutcheons where exposed pipes penetrate walls or floors.

## 3.2 INSTALLATION - VALVES

- A. Install gate valves with stems upright or horizontal, not inverted.
- B. Backflow Preventer:
  - 1. Units shall be field tested and tagged in accordance with manufacturer's instructions by a certified tester before initial operation.
  - 2. Install unit between 12" and 60" above finish floor.
- C. Shutoff Valve:
  - 1. Provide drain valves at main shutoff valves, low points of piping and apparatus.

## 3.3 INSTALLATION - EQUIPMENT

- A. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over system equipment and sprinklers.
- B. Fire Department Connection:
  - 1. Locate fire department connection in an accessible location as approved by the local fire department with sufficient clearance from walls and obstructions, to allow full swing of fire department wrench handle.
- C. Horn and Strobe:
  - 1. Locate outside horn and strobe on building wall as shown on drawings.
  - 2. Wire all horn and strobes, flow switches and supervisory switches to fire alarm system. All wiring shall be in conduit and meet the requirements of the electrical specifications.
- D. Test Valves:
  - 1. Install test valves where required. Pipe to outdoors or drain. Test connection shall have flow equivalent to the smallest K-factor sprinkler.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## E. Sprinklers:

1. Locate sprinklers to clear lights, ducts and diffusers. Do not run sprinkler pipes through ducts. Ductwork has priority over sprinkler pipes. Offset pipes as needed.
2. Center sprinklers in two directions in ceiling tiles and provide offsets as required.
3. Do not allow concealed sprinkler cover plates to be painted. Sprinkler cover plates are to be factory painted only. Do not field paint.
4. Apply strippable or paper covers so concealed sprinkler cover plates do not receive field paint finish.

## 3.4 SYSTEMS CLEANING AND TESTING

## A. General Requirement:

1. All water used for testing and remaining in the piping system shall be obtained from a potable water source.

## B. Interior Piping:

1. Verify adequate water flow at the inspector's test connection.
2. Flush all interior piping to remove scale and other foreign material before placing system into service.
3. Hydrostatically test the entire interior piping system at a minimum of 200 psig or 50 psig in excess of the normal system working pressure for systems subjected to pressures in excess of 150 psig. Maintain test pressure for 2 hours without loss of pressure.

## C. Fire Alarm System:

1. Test the alarm system by operating the inspector's test connection or the alarm test valves. Verify that the building fire alarm system activates.
2. Adjust all monitor switches for proper operation.

END OF SECTION 21 13 00





## SECTION 22 05 00 - BASIC PLUMBING REQUIREMENTS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced in the specification section.

## 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make his portion of the Mechanical Work a finished and working system.

## 1.3 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL &amp; CONTROL CONTRACTORS

- A. Definitions:
  - 1. "Mechanical Contractors" refers to the following:
    - a. Plumbing Contractor.
    - b. Air Conditioning and Ventilating Contractor.
    - c. Fire Protection Contractor.
    - d. Testing, Adjusting, and Balancing Contractor.
- B. General:
  - 1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
  - 2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
  - a. Light fixtures.
  - b. Gravity flow piping, including steam and condensate.
  - c. Electrical busduct.
  - d. Sheet metal.
  - e. Electrical cable trays, including access space.
  - f. Sprinkler piping and other piping.
  - g. Electrical conduits and wireway.

## C. Mechanical Contractor's Responsibility:

1. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.4 QUALITY ASSURANCE

## A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Madison, Wisconsin Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
  3. Pay all charges for permits or licenses.
  4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
  5. Pay all charges arising out of required inspections by an authorized body.
  6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
  7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.
- E. Utility Company Requirements:
1. Secure from the appropriate private or public utility company all applicable requirements.
  2. Comply with all utility company requirements.
  3. Make application for and pay for service connections, such as sewer, water, and gas.
  4. Make application for and pay for all meters and metering systems required by the utility company.
- F. Examination of Drawings:
1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
  2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
  3. Scaling of the drawings is not sufficient or accurate for determining these locations.
  4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
  5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
  6. If an item is either on the drawings or in the specifications, it shall be included in this contract.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
  8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
    - a. Any item listed as furnished shall also be installed, unless otherwise noted.
    - b. Any item listed as installed shall also be furnished, unless otherwise noted.
- G. Field Measurements:
1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.
- H. Electronic Media/Files:
1. Construction drawings for this project have been prepared utilizing Revit MEP.
  2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
  3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.
  4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
  5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
  6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
  7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
  8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 1.5 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals List:

<u>Referenced Specification Section</u>	<u>Submittal Item</u>
22 11 23	Domestic Water Pumps
22 30 00	Water Softeners
Refer to drawings	Plumbing Material List Items

- B. In addition to the provisions of Division 1, the following provisions are required:

1. Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
2. The Contractor shall submit one electronic copy of each shop drawing for review by the Architect/Engineer BEFORE releasing any equipment for manufacture or shipment.
3. Shop drawings which are larger than 11"x 17" or are plan size layout or erection drawings shall be submitted on reproducible media. Submit one reproducible and one print of each drawing or plan. All Contractor approval stamps shall be made on the reproducible.
4. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. CONTRACTOR'S APPROVAL STAMP IS REQUIRED ON ALL SUBMITTALS. APPROVAL WILL INDICATE THE CONTRACTOR'S REVIEW of all material and a COMPLETE UNDERSTANDING OF EXACTLY WHAT IS TO BE FURNISHED. Contractor shall clearly mark all deviations from the contract documents on all submittals. IF DEVIATIONS ARE NOT MARKED BY THE CONTRACTOR, THEN THE ITEM SHALL BE REQUIRED TO MEET ALL DRAWING AND SPECIFICATION REQUIREMENTS.
5. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
6. The Contractor shall clearly indicate the size, finish, material, etc.
7. Assemble and submit by specification section numbers for all submittals. All sets shall be identical and contain an index of the items enclosed with a general topic description on the cover.
8. Each set shall be bound in a manufacturer's folder or inside of a manila file folder.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

9. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is relevant to the work.
10. Failure to comply with the above shall be reason to resubmit all shop drawing submittals.
11. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

## 1.6 PRODUCT DELIVERY, STORAGE, HANDLING &amp; MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

## 1.7 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.



## 1.8 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

## 1.9 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

## PART 2 - PRODUCTS

NOT APPLICABLE

## PART 3 - EXECUTION

## 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employee and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

## A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with his work.

## B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

## C. Dewatering:

1. Contractor shall furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

## D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## E. Fill and Backfilling:

1. No rubbish or waste material is permitted for fill or backfill.
2. Provide all necessary sand for backfilling.
3. Dispose of the excess excavated earth as directed.
4. Backfill materials shall be suitable for required compaction, clean and free of perishable materials and stones greater than 4 inches in diameter. Water shall not be permitted to rise in unbackfilled trenches. No material shall be used for backfilling that contains frozen earth, debris or earth with a high void content.
5. Backfill all trenches and excavations immediately after installing pipes, or removal of forms, unless other protection is provided.
6. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.
7. Lay all piping on a compacted bed of sand at least 3 inches deep. Backfill around pipes with sand, 6 inch layers, and compact each layer.
8. Use sand for backfill up to grade for all piping under slabs or paved areas. All other piping shall have sand backfill to 6 inches above the top of the pipe.
9. Place all backfill above the sand in uniform layers not exceeding 6 inches deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
10. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T-99 or ASTM D-698 test.

## F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

## 3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

1. Placing fill over underground and underslab utilities.
  2. Covering exterior walls, interior partitions and chases.
  3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    - a. Pipe insulation is installed and fully sealed.
    - b. Pipe wall penetrations are sealed.
    - c. Pipe identification and valve tags are installed.
  2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

## 3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
  2. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, This Contractor must submit the following:
1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including marked-up or reproducible drawings and specifications.
  3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

## 3.5 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Submit three properly indexed and bound copies, in 'D' Ring style notebooks, of the Operations and Maintenance Instructions to the Architect/Engineer. Make all corrections or additions required.
- B. Manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.
- C. Operation and maintenance data shall consist of written instructions for the care, maintenance, and operation of all equipment and systems. Include all instruction books, cards, and manuals furnished with the equipment.

## 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The instructions shall include:
  1. Explanation of all system flow diagrams.
  2. Maintenance of equipment.
  3. Start-up procedures for all major equipment.
  4. Explanation of seasonal system changes.
- D. The Architect/Engineer shall be notified of the time and place instructions will be given to the Owner's representatives so he or his representative can attend if desired.
- E. Minimum hours of instruction for each item shall be:
  1. Domestic Hot Water System - 2 hours.
  2. Water Softener System - 1 hour.
- F. Operating Instructions:
  1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
  2. If the Contractor does not have staff that can adequately provide the required instructions he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

## 3.7 SYSTEM COMMISSIONING

- A. The plumbing systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.
- B. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- C. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

## 3.8 RECORD DOCUMENTS

- A. The following paragraph supplements Division 1 requirements:

Contractor shall maintain at the job site a separate and complete set of plumbing drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the plumbing systems.
- B. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations devices, requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.

## 3.9 PAINTING

- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer his color preference and furnish this color.
- E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- F. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.
- G. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
  - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
  - 2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.

## 3.10 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

## 3.11 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

END OF SECTION 22 05 00

## SECTION 22 05 29 - PLUMBING SUPPORTS AND ANCHORS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

## 1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

## PART 2 - PRODUCTS

## 2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter	
	Column #1	Column #2
2" and smaller	3/8"	3/8"
2-1/2" through 3-1/2"	1/2"	1/2"
4" and 5"	5/8"	1/2"
6"	3/4"	5/8"

Column #1: Cast iron pipe.

Column #2: Copper pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:
  - 1. Kitchen Areas
  - 2. Bear Building
  - 3. Seal Building

## 2.2 PIPE HANGERS AND SUPPORTS

- A. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58, 69, 89, and 127 (where applicable).



CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
- C. On all insulated piping, provide a semi-cylindrical metallic shield and fire resistant vapor barrier jacket.
- D. As an alternative to separate pipe insulation insert and saddle, properly sized integral rigid insulation sections may be used for this application.

Acceptable Products:

- Cooper/B-Line - Fig. B3380 through B3384
- Pipe Shields - A1000, A2000
- Erico - Model 124, 127

- E. Hangers in direct contact with copper pipe shall be coated with plastic with appropriate temperature range. HYDRA-ZORB clamps are permitted for this application for bare pipes within their temperature limits of -65°F to +275°F.
- F. Unless otherwise indicated, hangers shall be as follows:

1. Clevis Type:

- Service: Bare Metal Pipe  
 Insulated Cold Pipe  
 Insulated Hot Pipe - 3 inches and Smaller

Acceptable Products:	Bare Steel, Plastic or Insulated Pipe	Bare Copper Pipe
Anvil	Fig. 260	
Cooper/B-Line	Fig. 3100	Fig. B3100C
Erico	Model 400	
Nibco/Tolco	Fig. 1	Fig. 81PVC

2. Adjustable Swivel Ring Type:

- Service: Bare Metal Pipe - 4 inches and Smaller

Acceptable Products:	Bare Steel Pipe	Bare Copper Pipe
Anvil	Fig. 69	
Cooper/B-Line	Fig. B3170NF	Fig. B3170CTC
Erico	Model FCN	102A0 Series
Nibco/Tolco	Fig. 200	Fig. 203

- G. Support may be fabricated from U-Channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.

- 1. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- 2. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

H. Unless otherwise indicated, pipe supports for use with struts shall be as follows:

1. Clamp Type:

Service: Bare Metal Pipe  
 Insulated Cold Pipe  
 Insulated Hot Pipe - 3 inches and smaller

- a. Clamps in direct contact with copper pipe shall be plastic coated.
- b. Pipes subject to expansion and contraction shall have clamps slightly oversized to allow limited pipe movement.

Acceptable Products:	Bare Steel, Plastic or Insulated Pipe	Bare Copper Pipe
Unistrut	Fig. P1100 or P2500	
Cooper/B-Line	Fig. B2000 or B2400	Fig. BVT
Nibco/Tolco	Fig. A-14 or 2STR	

I. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

1. Beam Clamps:

Acceptable Products:

Anvil	Fig. 228, 292
Cooper/B-Line	Fig. B3054
Erico	Model 360
Nibco/Tolco	Fig. 329

2. Concrete Inserts, Single Rod Galvanized:

Acceptable Products:

Anvil	Fig. 282
Cooper/B-Line	Fig. B3014
Erico	Model 355
Nibco/Tolco	Fig. 310

3. Concrete Inserts, Continuous Strip Galvanized:

Acceptable Products:

Unistrut Corp	P3200 Series
Cooper/B-Line	Fig. B22-J
Erico	CONCT

- 4. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.
- J. Copper piping located in an exposed area, including indirect waste piping in kitchens and janitors closets, shall use split ring standoff hangers for copper tubing. Support shall have copper electroplating for corrosion resistance. Use electro-galvanized or more corrosion resistant and threaded rod for floor applications. Use anchors applicable to the wall type with corrosion resistant threaded rod for wall applications.

Acceptable Products:

Erico/M-Co	Model #456
B-Line	Fig. 3198HCT
Anvil	Fig. CT138R
Nibco/Tolco	Fig. 301CT

- K. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs.
- L. Welding:
1. Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and for protecting walls and ceilings from being damaged by smoke.

### 2.3 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. Concrete materials and workmanship required for the Contractor's work shall be provided by him. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.
  4. Equipment requiring bases is as follows:
    - a. Water Heater
    - b. Water Softener
- C. Roof Pipe Supports:
1. Provide pre-fabricated roof pipe supports for all piping installed on the roof.
  2. Support shall guide and align pipe while permitting longitudinal expansion.
  3. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
  4. Support shall be UV, corrosion and freeze/thaw resistant.
  5. Support shall include orange paint, reflective safety orange accents or similar markings for increased visibility.
  6. The strut system shall have galvanized finish.
  7. Acceptable Products: Anvil International HBS-Base Series, Cooper B-Line Dura-Blok, Erico Caddy Pyramid 50, 150, 300, or 600 (to match load), Miro Industries 1.5, 3-R, 4-R or 5-R (to match pipe).
- D. Supports:
1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
  2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.
- E. Grout:
1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
  2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
  3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

## 2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at his expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

## 2.5 ROOF PENETRATIONS

- A. Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots. Material shall match roofing membrane.
- B. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

## 2.6 PIPE SLEEVES AND LINTELS

- A. Each Contractor shall provide pipe sleeves and lintels for all openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.
- J. Wall Seals ("Link-Seals"):
1. Pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
  2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve. If piping carries only fluids below 120°F, sleeves may be thermoplastic with integral water seal and textured surface.
  3. Sleeves shall be at least 2 pipe sizes larger than the pipes.
  4. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.
  5. Sealing element shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	High/Low Temperature	Silicone	-67°F to 400°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant/Stainless	Nitrile	-40°F- to 210°F

6. Acceptable Manufacturers: Thunderline Corporation "Link-Seals", O-Z/Gedney Company, Calpico, Inc., Innerlynx, or Metraflex Company (cold service only).

## 2.7 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

## 2.8 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

## 2.9 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

## 2.10 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

## PART 3 - EXECUTION

## 3.1 PLUMBING SUPPORTS AND ANCHORS

- A. General Installation Requirements:
  - 1. Install all items per manufacturer's instructions.
  - 2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
  - 3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- B. Supports Requirements:
  - 1. Install roof pipe supports to resist wind movement per manufacturer's recommendations. Method of securing base to roof shall be compatible with roofing materials.
  - 2. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
  - 3. Set all concrete inserts in place before pouring concrete.
  - 4. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
  - 5. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
  - 6. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Pipe Requirements:
1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
  2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
  3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
  4. Piping shall not introduce strains or distortion to connected equipment.
  5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
  6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
  7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
  8. Provide at least one hanger adjacent to each joint in cast iron soil pipe, grooved end steel pipe with mechanical couplings, and glass pipe.
- D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:
1. Loads of 100 lbs.. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
  2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
    - a. The hanger is attached within 6" from a web/chord joint.
    - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
  3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
  4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- F. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- G. Spacing of Hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

	<u>Pipe Material</u>	<u>Maximum Spacing</u>
1.	Steel (Std. Weight or Heavier – Liquid Service):	
	1-1/4" & under	7'-0"
	1-1/2"	9'-0"
	2"	10'-0"
	2-1/2"	11'-0"
	3"	12'-0"
	4" & larger	12'-0"
2.	Steel (Std. Weight or Heavier – Vapor Service):	
	1-1/4" and under	9'-0"
	1-1/2"	12'-0"
	2" & larger	12'-0"
3.	Hard Drawn Copper & Brass (Liquid Service):	
	3/4" and under	5'-0"
	1"	6'-0"
	1-1/4"	7'-0"
	1-1/2"	8'-0"
	2"	8'-0"
	2-1/2"	9'-0"
	3"	10'-0"
	4"	12'-0"
4.	Cast Iron Soil Pipe - All Sizes:	
	Over 5' pipe lengths	10'-0"
	Less than 5' pipe lengths	5'-0"
	Support all direction changes and branch connections.	
5.	Flexible Plastic Pipe, Flexible Hose, and Soft Copper Tubing:	
	a. Continuous channel with hangers maximum 8'-0" O.C.	
6.	Installation of hangers shall conform to MSS SP-69, MSS SP-89 and the applicable Plumbing Code.	

END OF SECTION 22 05 29

## SECTION 22 05 53 - PLUMBING IDENTIFICATION

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Identification of products installed under Division 22.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. 3M, Bunting, Calpico, Craftmark, Emedco, Kolbi Industries, Seton, W.H. Brady, Marking Services.

## 2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

<u>O.D. of Pipe or insulation</u>	<u>Marker Length</u>	<u>Size of Letters</u>
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"

Plastic tags may be used for outside diameters under 3/4".

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- F. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.
- G. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.
- H. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape 6" wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- I. Tracer Wire:
  - 1. Single copper conductors shall be solid or stranded annealed or hard uncoated copper per UL83 and ASTM requirements. Tracer tape or copper-coated steel wire is not acceptable.
  - 2. Conductor shall be insulated with HMWPE as specified and applied in a concentric manner. The minimum at any point shall not be less than 90% of the specified average thickness in compliance with UL 83.
  - 3. Tracer wire shall be continuously spark tested at 7500 Volts DC. Other electrical and mechanical tests shall be in accordance with UL 1581.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
  - 1. All valves (except shut-off valves at equipment) shall have numbered tags.
  - 2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
  - 3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
  - 4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
  - 5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
  - 6. Number all tags and show the service of the pipe.
  - 7. Provide two sets of laminated 8-1/2" x 11" copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.
- D. Pipe Markers:
  - 1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Stencil Painted Pipe Markers:
  - a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
  - b. Apply primer on non-insulated pipes before painting.
  - c. Use background and letter colors as scheduled later in this section.
3. Apply markers and arrows in the following locations where clearly visible:
  - a. At each valve.
  - b. On both sides of walls that pipes penetrate.
  - c. At least every 20 feet along all pipes.
  - d. On each riser and each leg of each "T" joint.
  - e. At least once in every room.
4. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

## E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of Standard 90.1.

## 3.2 SCHEDULE

## A. Pipes to be marked:

Pipe Service	Lettering Color	Background Color
Condensate Drain	Black	Yellow
Domestic Cold Water	White	Green
Domestic Hot Water - 115°F	Black	Yellow
Domestic Hot Water - 140°F	Black	Yellow
Domestic Hot Water Circulating - 115°F	Black	Yellow
Domestic Hot Water Circulating - 140°F	Black	Yellow
Sanitary Sewer	Black	Yellow
Vent	Black	Yellow
Natural Gas	Black	Yellow
Non-Potable Water	Black	Yellow
All Underground Pipes	Varies	Varies
Tracer Wire - Water Pipe Lines	---	Blue
Tracer Wire - Natural Gas Pipe Lines	---	Yellow
Tracer Wire - All other buried types	---	Green

END OF SECTION 22 05 53



## SECTION 22 07 19 - PLUMBING PIPING INSULATION

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Piping Insulation.
- B. Insulation Jackets.

## 1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with five years minimum experience.
- B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required).

## PART 2 - PRODUCTS

## 2.1 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All purpose, white kraft jacket bonded to aluminum foil and reinforced with fiberglass yarn, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
- B. Type B: Elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.27 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 3/4" thick per layer where multiple layers are specified.
- C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.35 maximum 'K' value at 75°F; moisture resistant, non-combustible; suitable for -100°F to +900°F. For below grade installations use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose white kraft jacket for above grade installations.

## 2.2 VAPOR BARRIER JACKETS

- A. Kraft reinforced foil vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

## 2.3 JACKET COVERINGS

- A. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. 25/50 maximum flame spread/smoke developed.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

## 3.2 INSTALLATION

## A. General Installation Requirements:

1. Install materials per manufacturer's instructions, building codes and industry standards.
2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
3. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a 180° cylindrical segment the same length as metal shields. Inserts shall be a cellular glass (for all temperature ranges) or molded hydrous calcium silicate (for pipe with operating temperatures above 70°F), with a minimum compressive strength of 50 psi. Polyisocyanurate insulation with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3”75 and below, minimum 60 psi for pipe sizes 4” and above, and operate below 300°F. Factory fabricated inserts may be used. Rectangular blocks, plugs, or wood material are not acceptable. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor.
4. Neatly finish insulation at supports, protrusions, and interruptions.
5. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.
6. Shields shall be at least the following lengths and gauges:

	Pipe Size	Shield Size
a.	1/2" to 3-1/2"	12" long x 18 gauge
b.	4"	12" long x 16 gauge
c.	5" to 6"	18" long x 16 gauge

7. All piping and insulation that does not meet 25/50 that is located in an air plenum shall have written approval from the Authority Having Jurisdiction and the local fire department for authorization and materials approval. If approval has been allowed, the non-rated material shall be wrapped with a product that has passed ASTM E84 and/or NFPA 255 testing with a rating of 25/50 or below.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

8. On 1" and smaller piping routed through metal wall studs, provide a plastic grommet to protect the piping. The piping shall be insulated between the wall studs, and the insulation shall butt up to each stud.
- B. Insulated Piping Operating Below 60°F:
1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
  2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
  3. All balance valves with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.
- C. Insulated Piping Operating Between 60°F and 140°F:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.
- D. Exposed Piping:
1. Locate and cover seams in least visible locations.
  2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.
  3. On exposed piping serving kitchen equipment or plumbing fixtures, the piping does not need to be insulated if less than four feet in developed length. If piping is longer than four feet in developed length, the piping shall be insulated and have a plastic jacket.

## 3.3 INSULATION

- A. Type A Insulation:
1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
  2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
  3. Apply insulation with laps on top of pipe.
  4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F, seal fitting covers with vapor retarder mastic in addition to tape.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## B. Type B Insulation:

1. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
2. Self-seal insulation may be used on pipes operating below 170°F.

## C. Type C Insulation:

1. Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner.
2. Insulate fittings with prefabricated fittings.

## 3.4 JACKET COVER INSTALLATION

## A. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. Use plastic insulation covering on all exposed pipes including, but not limited to:
  - a. All exposed piping in areas noted on drawings.
  - b. All exposed piping below 8'-0" above floor.
  - c. All piping in mechanical rooms and/or tunnels that is subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)
  - d. All kitchen areas.
5. Elastomeric piping insulation may have two coats of latex paint instead of plastic jacket.

## 3.5 SCHEDULE

Piping System	Insulation Type/Thickness
A. Domestic Hot Water & Circulating - Potable and Non-Potable - up to 140°F	
Up to 1-1/2" Pipe Size	A / 1"
Above 1-1/2" Pipe Size	A / 1-1/2"
B. Domestic Cold Water - Potable and Non-Potable	A / 1"
C. Plumbing Vents Within 10' from Roof Penetration	A / 1/2"                      OR    B / 1/2"

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

Piping System	Insulation Type/Thickness
D. Cooling Coil Condensate Drains & Dedicated Floor Drain Branch Piping, Sanitary and Indirect Waste Piping Conveying Fluids below 55°F	B / 1/2"
E. Above Grade Drains at Ice Machines (include drain bodies, P-trap, and 10' of downstream drain piping)	A / 1"                      OR    B / 1"
F. Insulation Inserts at hangers	C - Match pipe insulation thickness

END OF SECTION 22 07 19



## SECTION 22 09 00 - INSTRUMENTATION

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Pressure Gauge.
- B. Pressure Gauge Accessories.
- C. Thermometers.
- D. Test Plugs.

## PART 2 - PRODUCTS

## 2.1 PRESSURE GAUGES

- A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for water or oil application, 1/4" bottom connection. Gauges shall be 1% full scale accurate with bronze bushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.
- B. Acceptable Manufacturers: U. S. Gauge Figure 5801, Marshalltown, Marsh, Weiss, Weksler, Ashcroft, Wika.
- C. Select gauge range for normal reading near center of gauge.

## 2.2 PRESSURE GAUGE ACCESSORIES

- A. All pressure gauges shall have valves and pressure snubbers. All pressure gauges on steam shall have pigtail syphon.
- B. Shut-off Valve: 1/4" ball valve as specified for each piping system.
- C. Pressure snubber, brass with 1/4" connections, porous metal type.

## 2.3 THERMOMETERS

- A. Dial Type:
  - 1. 4-1/2" diameter, hermetically sealed case. Stainless steel case and stem. Accuracy of 1% full scale with external recalibrator.
  - 2. Select thermometers for appropriate temperature range. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
  - 3. Stem lengths as required for application with minimum insertion of 2-1/2".
  - 4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Socket shall extend through insulation.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Alcohol/Spirit Filled Type:
1. 9" long phenolic case, steel stem, accuracy of 1% full scale. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
  2. Select thermometer for appropriate temperature range.
  3. Stem lengths as required for application with minimum insertion of 3-1/2".
  4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Wells shall extend through insulation.
- C. Select scales to cover expected range of temperatures.

## 2.4 TEST PLUGS

- A. Test Plug: 1/4" or 1/2" brass fitting and cap, with Nordel core for temperatures up to 275°F, for receiving 1/8" outside diameter pressure or temperature probe. Plugs shall be rated for zero leakage from vacuum to 500 psi.
- B. Provide extended units for all plugs installed in insulated piping.
- C. Test Kit: Carrying case, internally padded and fitted containing one 3-1/2" diameter pressure gauge with 0-100 psi range, one gauge adapter with 1/8" probes, two 1-1/2" dial thermometers with 0° to 220°F and -25°F to 125°F ranges and 5" stems.
- D. Acceptable Manufacturers: Sisco, Flow Design, or Peterson Equipment.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. General Installation Requirements:
1. Install per manufacturer's instructions.
  2. Coil and conceal excess capillary on remote element instruments.
  3. Install gauges and thermometers in locations where they are easily read from normal operating level.
  4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.
- B. Pressure Gauges:
1. Connect pressure gauges to suction and discharge side of all pumps.
- C. Thermometers:
1. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets.

2. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.

END OF SECTION 22 09 00



## SECTION 22 10 00 - PLUMBING PIPING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Domestic Water Piping System.
- D. Footing Tile.

## 1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

## 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

## PART 2 - PRODUCTS

2.1 COLD WATER - POTABLE AND NON-POTABLE  
HOT WATER - POTABLE AND NON-POTABLE  
TEMPERED WATER - POTABLE AND NON-POTABLE

- A. Design Pressure: 175 psi.  
Maximum Design Temperature: 200°F.
- B. Piping - All Sizes:
  - 1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.
  - 2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
  - 3. Fittings: Wrought copper solder joint, ANSI B16.22.
- C. Piping - 4" and Under (Contractor's Option):
  - 1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.
  - 2. Joints: Mechanical press connection.
  - 3. Fittings: Copper, ANSI B-16.22, with embedded EPDM o-ring, NSF-61.
  - 4. Acceptable Manufacturers: Viega ProPress, Elkhart Xpress, Nibco Press System Fittings and Valving.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## D. Shut-Off Valves:

## 1. Ball Valves:

## a. BA-1:

- 1) 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-255-FB-P-UL BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

NOTES:

- a) Provide extended shaft for all valves in insulated piping.
- b) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

## E. Check Valves:

1. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319-Y, Walworth #3406, Milwaukee #509, Watts #G-5000, Nibco T-413B.

## F. Strainers:

1. ST-1: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi CWP @ 150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT, Watts #777.

2.2 COLD WATER - POTABLE AND NON-POTABLE (UNDERGROUND)  
 HOT WATER - POTABLE AND NON-POTABLE (UNDERGROUND)  
 TEMPERED WATER - POTABLE AND NON-POTABLE (UNDERGROUND)

- A. Design Pressure: 150 psi.  
Maximum Design Temperature: 200°F.

## B. Piping - All Sizes:

1. Tubing: Type K annealed copper tube, ASTM B88.
2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
3. Fittings: Wrought copper solder joint, ANSI B16.22.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Piping - 1-1/2" and Under:
1. Design Pressure/Temperature: 100 psig at 180°F.
  2. Tubing: Cross-linked polyethylene (PEX), ASTM F876/F877, NSF Certified.
  3. Joints: Bending the tubing greater than eight (8) times the outside diameter shall be permitted. Bends less than eight (8) times the outside diameter shall be barbed insertion fittings provided by the manufacturer.
  4. Fittings: Brass or stainless steel with stainless steel or copper crimp ring. Fittings and tubing shall be a system provided by the same manufacturer. Fitting system shall conform to ASTM F1807.
- D. Pipe Sleeving - All Sizes:
1. Pipe: Schedule 40 rigid, unplasticized PVC-DWV, or ABS-DWV, normal impact Type 1, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
  2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
  3. Fittings: Unplasticized PVC-DWV, or ABS-DWV, normal impact Type 1, with solvent-weld socket type ends for Schedule 40 pipe. Provide long/extra long radius fittings to eliminate pipe kinking.
  4. Size: Minimum 6". Refer to drawings for additional sizes.
  5. Use: All underground piping to fixtures.

2.3 COMBINATION WATER & FIRE PROTECTION SERVICE  
FIRE PROTECTION SERVICE

- A. Design Pressure: 200 psi.  
Maximum Design Temperature: 150°F.
- B. Piping:
1. Pipe: Ductile iron pressure water pipe, ANSI/AWWA C151/A21.51, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4.
  2. Fittings: Ductile iron, ANSI/AWWA C110/A21.10, or ANSI/AWWA C153/A21.53, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4, mechanical joints.
  3. Joint: Mechanical joint with glands and gaskets and steel bolts. ANSI/AWWAC111/A21.11.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- 2.4 SANITARY DRAINAGE (ABOVE GROUND)  
SANITARY INDIRECT DRAINAGE (ABOVE GROUND)  
SANITARY VENT (ABOVE GROUND)  
STORM DRAINAGE (ABOVE GROUND)  
CONDENSATE DRAINAGE (ABOVE GROUND)
- A. Design Pressure: Gravity  
Maximum Design Temperature: 180°F
- B. Piping - All Sizes:
1. Pipe & Fittings: Standard weight cast iron soil pipe, corrosion protective coating inside and outside, ASTM A74, NSF Certified, CISPI Trademark.
  2. Joints: Compression gasket, ASTM C564 or lead and oakum, ASTM B29.
  3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.
  4. Limitations: Cast iron pipe not allowed for sanitary or vent in Seal building.
- C. Piping - 1-1/4" through 4":
1. Pipe: Type DWV hard temper seamless copper drainage tube, ASTM B306.
  2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
  3. Fittings: Cast brass solder joint drainage type, ANSI B16.23 or wrought copper solder joint drainage type, ANSI B16.29.
- D. Vent Flashing: Flash vents with premolded EPDM pipe flashing cones for single-ply membrane roofs.
- 2.5 SANITARY DRAINAGE (BELOW GROUND - INSIDE BUILDING)  
SANITARY VENT (BELOW GROUND - INSIDE BUILDING)  
STORM DRAINAGE (BELOW GROUND - INSIDE BUILDING)
- A. Design Pressure: Gravity  
Maximum Design Temperature: 180°F
- B. Piping - All Sizes:
1. Pipe & Fittings: Standard weight cast iron soil pipe, corrosion protective coating inside and outside, ASTM A74, NSF certified, CISPI trademark.
  2. Joints: Compression gasket, ASTM C564.
  3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

4. Limitations: Cast iron pipe not allowed for sanitary or vent in Seal building.
- C. Piping - 1-1/2" through 15":
1. Pipe & Fittings: Standard weight cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888, NSF certified, CISPI trademark.
  2. Joints: Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.
  3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.
  4. Limitations: Cast iron pipe not allowed for sanitary or vent in Seal building.
- D. Piping - 1-1/4" through 16" (Maximum Design Temperature: 140°F):
1. Pipe: Schedule 40 rigid, unplasticized PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
  2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
  3. Fittings: Unplasticized PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket ends for Schedule 40 pipe.
  4. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.
- 2.6 GREASE SANITARY DRAINAGE (BELOW GROUND – INSIDE BUILDING)  
 GREASE SANITARY DRAINAGE (ABOVE GROUND – INSIDE BUILDING)  
 GREASE SANITARY VENT (BELOW GROUND – INSIDE BUILDING)  
 GREASE SANITARY VENT (ABOVE GROUND – INSIDE BUILDING)
- A. Design Pressure: Gravity.
1. Design Temperature: 200°F Minimum.
- B. Piping – All Sizes:
1. Pipe and Fittings: Extra heavy weight cast iron soil pipe, corrosion protective coating inside and outside, ASTM A74, NSF certified, CISPI trademark.
  2. Joints: Compression gasket, ASTM C564.
  3. Adapters: Transition from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C564, 300 Series stainless steel shield, clamps, and screws with not less than four screw-type clamps, FM 1680 or ASTM C1540.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 2.7 FOOTING TILE

- A. Schedule 40 Perforated PVC Footing Tile - ASTM D1785/76 or DWV Perforated Footing Tile - ASTM D2665/76.
- B. Geotextile Fabric: As recommended by the manufacturer for this application. Acceptable Manufacturers: Typar, Cerex, Big 'O'.

## 2.8 UNIONS

- A. Copper pipe - wrought copper fitting - ground joint.
- B. Black Steel (Schedule 40) Pipe - malleable iron, ground joint, 150 psi, bronze to bronze seat.
- C. Galvanized Steel Pipe - galvanized malleable iron, ground joint, 150 psi, bronze to bronze seat.

## 2.9 AIR VENTS

- A. Provide means for venting air at all high points in the piping system and at all other points where air may be trapped.
- B. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

## 2.10 RELIEF VALVES

- A. RV-4: (Domestic Hot Water) Pressure and Temperature relief, cast bronze body and internal parts, stainless steel spring, test lever, threaded inlet and outlet. Maximum setting of 150 psi and 210°F temperature. Capacities ASME certified and labeled. Acceptable Manufacturers: Cash Series FV, Watts #40, #120, #N240, #340.

## 2.11 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250°F operating temperature, taps for determining flow with a portable meter, positive shut-off valves for each meter connection, memory feature, tight shut-off, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units which sense pressure across a valve). Graph shall extend below the specified minimum flow.
- C. Flow rate of 0.5 GPM or larger: Valves in copper piping shall be brass or bronze. Acceptable Manufacturers: Flow Design "Accusetter", Preso "B+", Armstrong "CVB", Bell & Gossett "Circuit Setter Plus", Griswold "Quickset", Gerand "Balvalve Venturi" or Nibco Globe Style balancing valve.
- D. Flow rate less than 0.5 GPM: Valves in copper piping shall be brass or bronze. Cv value shall be less than 1.0 when valve is completely open, and minimum balanceable flow rate

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

shall not exceed 0.1 GPM with a meter reading of at least 2.5 feet. Acceptable manufacturers: Bell & Gossett "Circuit Setter RF", Flow Design, Preso, Armstrong, Griswold, Gerand, or Nibco balancing valve.

- E. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

## 2.12 DRAIN VALVES

- A. Drain valves shall be shutoff valves as specified for the intended service with added 3/4" male hose thread outlet and cap.

## 2.13 CONNECTIONS BETWEEN DISSIMILAR METALS

- A. Connections between dissimilar metals shall be insulating dielectric types that allow no metal path for electron transfer and that provide a water gap between the connected metals.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze and stainless steel are commonly used and require isolation from each other with the following exceptions:
  - 1. Iron, steel, and stainless steel connected to each other.
  - 2. Brass, copper, and bronze connected to each other.
  - 3. Brass or bronze valves and specialties connected to steel or iron in closed systems. Where two brass items occur together, they shall be connected with brass nipples.
  - 4. Brass or bronze valves or specialties under 3/4" size connected to steel, iron, or stainless steel.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
  - 1. Dielectric union rated for 125 psi CWP and 250°F.
  - 2. Where a sweat-to-screw union is used, the union shall be soldered onto the copper pipe prior to screwing the union onto opposing pipe material.
  - 3. Install dielectric unions per manufacturer's recommendations.
  - 4. Acceptable Manufacturers: HCI Terminator U, Central Plastics, Wilkins DUX-HT, Watts.
- F. Flanged Joints (any size):
  - 1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

## 2.14 LOCK OUT TRIM

- A. Provide lock out trim for all quarter turn shutoff valves opening to atmosphere and installed in domestic water piping over 120°F, in compressed air piping, and as indicated on the drawings.

## 2.15 VALVE OPERATORS

- A. Provide handwheels for gate valves and gear operators for butterfly valves.

## 2.16 VALVE CONNECTIONS

- A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

## PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Install all products per manufacturer's recommendations.
- B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- C. Remove scale and dirt, on inside and outside, before assembly.
- D. Connect to equipment with flanges or unions.
- E. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.

## 3.2 TESTING PIPING

- A. Sanitary Drainage:  
Sanitary Vent:
  1. Test all piping with water to prove tight.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Test piping before insulation is applied.
  3. Hydrostatically test all soil, waste, and vent piping inside of building with 10 feet head of water for 15 minutes. Inspect before fixtures are connected. If leaks appear, repair them and repeat the test.
  4. Hydrostatically test interior downspouts with 10 feet head of water for 15 minutes with no leaks.
  5. A smoke/air test at the same pressure may be used in lieu of the hydrostatic water test. Exception: Smoke/air test shall not be performed on plastic piping.
  6. Test force mains with water at 105% of the operating pump discharge pressure for 15 minutes.
  7. Test pressures stated above shall be as listed or as required by the Authority Having Jurisdiction, whichever is most stringent.
- B. Hot Water - Potable and Non-Potable:  
Cold Water - Potable and Non-Potable:  
Service Water:
1. Test pipes underground or in chases and walls before piping is concealed.
  2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.
  3. Test the pipe with 100 psig water pressure or equal inert gas such as nitrogen.
  4. Hold test pressure for at least 2 hours.
  5. Test to be witnessed by the Architect/Engineer's representative, if requested by the Architect/Engineer.
- C. Fire Service:
1. Hydrostatically test the entire system for two hours at 200 psig. Maximum leakage shall be:
    - a. Interior Piping: 0 quarts per hour.
    - b. Underground Piping: 2 quarts per 100 joints per hour.
- D. All Other Piping:
1. Test piping at 150% of normal operating pressure.
  2. Piping shall hold this pressure for one hour with no drop in pressure.
  3. Test piping using water, nitrogen, or air as compatible with the final service of the pipe. Do not use combustible fluids.



4. Drain and clean all piping after testing is complete.

### 3.3 CLEANING PIPING

#### A. Assembly:

1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer's representative. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Notify the Architect/Engineer's representative before starting any post erection cleaning in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer's representative with regard to specific procedures and scheduling. Dispose of cleaning and flushing fluids properly.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

#### B. All Water Piping:

1. Flush all piping using faucets, flush valves, etc. until the flow is clean.
2. After flushing, thoroughly clean all inlet strainers, aerators, and other such devices.
3. If necessary, remove valves to clean out all foreign material.

#### C. Fire Service:

1. Flush all underground piping with minimum flow equal to the system design flow but not less than the following:
  - a. 390 gpm for 4" pipes.

### 3.4 INSTALLATION

#### A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
  5. Slope water piping and arrange to drain at low points.
  6. Install bell and spigot piping with bells upstream.
  7. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
  8. Seal pipes passing through exterior walls with a wall seal per Section 22 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
  9. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.
  10. All vertical pipe drops to sinks or other equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted.
- B. Installation Requirements In Electrical Rooms:
1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- C. Valves/Fittings and Accessories:
1. Provide clearance for installation of insulation and access to valves and fittings.
  2. Provide access doors for concealed valves and fittings.
  3. Install valve stems upright or horizontal, not inverted.
  4. Provide one plug valve wrench for every ten plug valves 2" and smaller, minimum of one. Provide each plug valve 2-1/2" and larger with a wrench with set screw.
  5. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.
- D. Underground Piping:
1. Install buried water piping outside the building with at least 5 feet of cover.
  2. Underground fire protection service piping shall have at least 6-1/2 feet of cover, or as recommended by NFPA 24, whichever is greater.
  3. Install thrust blocking and restraints on all underground fire protection service piping per NFPA 24 and as shown on drawings.

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4. Lay all underground piping in trenches. Provide and operate pumping equipment to keep trenches free of water.
5. For all underground piping, provide a foundation (the layer below the bedding) if the trench bottom is unstable. Lay underground plastic piping on 4" to 6" of sand bedding. When the trench is in rock, lay underground metallic piping on 6" of sand bedding. Provide recessed areas for pipe bells and joints. After joints are made, any misalignment in elevation shall be corrected by tamping sand around the pipe. Backfill with sand in uniform layers not over 6" deep to the spring line of all underground pipes, and carefully compact each layer to 90 percent Standard Proctor density. Backfill with sand up to 6" above pipe for landscaped areas. Remaining backfill may be soil. Under paving and buildings, the remaining backfill shall be sand and compacted to 98 percent Standard Proctor density.
6. As an option, the Contractor may provide factory applied protective coatings consisting of a polyethylene plastic film bonded to the pipe surface by a hot applied thermo-plastic adhesive.
  - a. Acceptable Manufacturer: Republic Steel Corp. "X-Tru-Coat"
7. Exercise care in handling, storing and laying pipe to avoid damaging factory applied coatings. If any damage occurs, repair the coating to a condition equal to the original.
8. Field application of protective coatings to joints, fittings and to any damaged factory applied coatings shall be similar to factory applied coatings specified above and shall be done in strict accordance with recommendations of the supplier of pipe coatings.
9. After completion of the fabrication, laying and field coating of the joints and fittings, but prior to backfilling, inspect the entire line in the presence of the Architect/Engineer's representative with an electronic holiday detector. Any defects in the protective coatings shall be repaired in accordance with requirements for original coatings.
10. Coat flange bolts and nuts in pits and below ground at the time of installation with a corrosion protective coating.

## E. Sanitary and Storm Piping:

1. Install all sanitary piping inside the building with a slope of at least the following:

<u>Pipe Size</u>	<u>Minimum Slope</u>
3" and under	- 0.25" per foot
4" and over	- 0.125" per foot

- a. All sanitary systems transporting grease laden waste shall be sloped a minimum of 0.25" per foot regardless of size.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Slope sanitary and storm piping outside the building to meet the invert elevations shown on the drawings and to maintain a minimum velocity of 3 feet per second.
3. All sanitary and storm piping shall have at least 42" of cover when leaving the building.
4. Install horizontal offset at all connections to roof drains to allow for pipe expansion.
5. Install a length of ductile iron piping where underground cast iron storm or sanitary piping system passes through or under building footings and foundations.

## 3.5 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.
- B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.
- D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.
- E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.
- F. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.
- G. Provide flanges or unions at all final connections to equipment, traps and valves.
- H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shut-off valves.
- I. Use full and double lengths of pipe wherever possible.
- J. Unless otherwise indicated, install all piping, including shut-off valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or equipment.

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- K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- L. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Provide and operate sufficient pumping equipment to maintain excavations, trenches and pits free of water. Dispose of pumped water so operation areas and other facilities are not flooded. Pipe laying shall follow excavating as closely as possible.
- M. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for air lines, and from top, bottom or side for liquids.
- N. Do not use geotextile fabric with footing tile if silt content of soil exceeds 40% or if clay content exceeds 50%. The fabric shall be installed around 1" river rock or 2" limestone.

## 3.6 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal water and compressed air lines, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate and venting.
- B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.
- C. Provide drain valves at all low points of water piping systems for complete or sectionalized draining.
- D. Provide drip legs at low points and at the base of all risers in compressed air pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.
- E. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install compressed air and gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.
- F. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.
- G. Install air vents in accessible locations. If necessary to trap and vent air in a remote location, install an 1/8" pipe from the tapping location to an accessible location and terminate with a venting device.
- H. All vent and drain piping shall be of same materials and construction for the service involved.

## 3.7 PLUMBING VENTS

- A. Vent as shown on the drawings and in accordance with all codes having jurisdiction.
- B. Extend the high side of the soil and waste stacks at least 12" above roof.

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- C. Flash pipes at roof with premolded EPDM pipe flashing cones adhered to roof membrane by General Contractor. Secure top of cone with stainless steel clamp and seal watertight.
- D. Increase vent pipes through the roof two pipe sizes with long increasers located at least 12" below the roof.
- E. In no case shall the vent through the roof be less than 4" in diameter.
- F. Vent pipes through the roof shall be located a minimum of 15 feet from any air intake or exhaust opening on the roof.

## 3.8 BRANCH CONNECTIONS

- A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.
- B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- C. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.
- D. Branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- E. Forged weld-on fittings are limited as follows:
  - 1. Must have at least same pressure rating as the main.
  - 2. Main must be 2-1/2" or larger.
  - 3. Branch line is at least two pipe sizes under main size.

## 3.9 JOINING OF PIPE

- A. Threaded Joints:
  - 1. Threads shall conform to ANSI B2.1 "Pipe Threads".
  - 2. Ream pipe ends and remove all burrs and chips formed in cutting and threading.
  - 3. Protect plated pipe and valve bodies from wrench marks when making up joints.
  - 4. Apply thread lubricant to male threads as follows:

Vents and Roof Conductors:	Red graphite
All Other Services:	Teflon tape
- B. Flanged Joints:
  - 1. Steel pipe flanges shall conform to ANSI B16.5 "Steel Pipe Flanges and Flanged Fittings". Cast iron pipe flanges shall conform to ANSI B16.1 "Cast Iron Flanged and Flanged Fittings". Steel flanges shall be raised face except when bolted to flat face cast iron flange.

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2. Bolting for services up to 500°F shall be ASTM A307 Grade B with square head bolts and heavy hexagonal nuts conforming to ANSI B18.2.1 "Square and Hex Bolts" and B18.2.2 "Square and Hex Nuts".
3. Set flange bolts beyond finger tightness with a torque wrench for equal tension in all bolts. Tighten bolts so those 180° apart are torqued in sequence.
4. Gaskets for flat face flanges shall be full face type. Gaskets for raised faced flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Unless otherwise specified gaskets shall meet the following requirements:
  - a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
  - b. Maximum pressure rating of at least 250 psig.
  - c. Minimum temperature rating: -10°F.
  - d. Maximum temperature rating of at least 170°F for water systems operating 140°F and less.

## C. Solder Joints:

1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
2. Flux shall be non-acid type.
3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove discs and seals during soldering if they are not suitable for 470°F.

## D. Mechanically Coupled Grooved Joints:

1. Mechanical coupling connections shall mechanically engage, lock and seal the grooved pipe ends in a positive couple. Each coupling shall consist of malleable iron housing clamps, steel bolts and nuts, and sealing gasket designed so internal pressure tends to increase the tightness of the seal.
2. Use grooved mechanical couplings and fasteners only in accessible locations.
3. Final tightening of bolts shall be with a torque wrench for equal tension in all bolts.

## E. Mechanical Press Connection:

1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.

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2. Fully insert tubing into the fitting and mark tubing.
  3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
  4. Joint shall be pressed with a tool approved by the manufacturer.
  5. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.
- F. Compression Gasket Joints - Sanitary Pipe & Storm Pipe:
1. Joint shall be one piece double seal compression type gasket made specifically for joining cast iron soil pipe. Gasket shall be neoprene, permitting joint to flex as much as 5 degrees without loss of seal. Gasket shall be extra heavy weight class, conforming to ASTM C-564.
- G. Solvent Weld Joints (PVC):
1. Make joints with a two-step process. Use primer conforming to ASTM F656 and solvent cement conforming to ASTM D2564.
- H. Sleeve Gaskets (No-Hub) (Sanitary and Storm Pipe):
1. Gasket shall be heavy weight class, conforming to ASTM C564.
  2. The gasket shall have an internal center stop.
  3. The gasket shall be covered by a stainless steel band secured with a minimum of four stainless steel bands per fitting/joint.
  4. Sleeve gaskets shall be installed in accordance with the manufacturer's installation instructions.

## 3.10 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Provide necessary connections at the start of individual sections of mains for adding chlorine.
- B. Before starting work, verify system is complete, flushed and clean.
- C. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- D. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- E. Bleed water from outlets to ensure distribution and test residual at minimum 15% of outlets.
- F. Maintain disinfectant in system for 24 hours.
- G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.



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- H. Flush disinfectant from system until residual is equal to that of incoming water or 1.0 mg/L.
- I. Take samples no sooner than 24 hours after flushing, from 2% of outlets and from water entry, and analyze in accordance with AWWA C651.

## 3.11 SERVICE CONNECTIONS

- A. Provide new sanitary and/or storm sewer services. Before commencing work check invert elevations needed for sewer connections, confirm inverts and verify these can be properly connected with slope for drainage and cover to avoid freezing.
- B. Provide new water service with water meter with bypass valves. Provide sleeve in wall for service main per Section 22 05 29.

END OF SECTION 22 10 00

## SECTION 22 10 23 - NATURAL GAS AND PROPANE PIPING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Natural Gas Piping System.

## 1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

## 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

## PART 2 - PRODUCTS

2.1 NATURAL GAS (0 TO 125 PSI)  
PROPANE (0 TO 125 PSI)

- A. Design Pressure: 125 psi.  
Maximum Design Temperature: 350°F
- B. Piping - 2" and Under:
  - 1. Pipe: Standard weight steel, threaded and coupled, ASTM A53.
  - 2. Joints: Screwed. (NOTE: For below ground, all sizes to have welded joints.)
  - 3. Fittings: 150# steam - 300# CWP, black malleable iron, banded, ASTM A197, ANSI B16.3.
  - 4. Unions: 250# - 500# CWP, black malleable iron, ANSI B16.39, ground joint with brass seat.
- C. Piping - 2-1/2" and Over:
  - 1. Pipe: Standard weight black steel, beveled ends, ASTM A53.
  - 2. Joints: Butt welded and flanged.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade I, ANSI B16.9.
4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5.

## D. Shut-Off Valves/Throttling Valves:

1. BA-13: 2" and under, threaded 600 psi CWP; UL listed for 250# LP, flammable liquid, heating oil, natural and manufactured gases, 150 psi steam, bronze body and chrome plated brass ball, Teflon seats and packing. Apollo #80-100, Nibco #T580-70-UL or #T585-70-UL, Watts #B-6000.
2. PL-1: 2" and under, 125# steam @ 450°F, 175# CWP @ 180°F, cast iron body, screwed, full port. Walworth #1700, DeZurik #425, S-RS49.
3. PL-2: 2-1/2" thru 4", 125# steam @ 450°F, 175# CWP @ 180°F, flanged, cast iron body, full port. Walworth #1700F, DeZurik #425, F-RS49.

## 2.2 DRAIN VALVES AND BLOWDOWN VALVES

- A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

## PART 3 - EXECUTION

## 3.1 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.
- C. Connect to all equipment with flanges or unions.
- D. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for treatment.

## 3.2 TESTING PIPING

- A. Low Pressure - Up to 1 psi:
  1. Test piping with 20 psi air pressure. System must hold this pressure without adding air for two hours.
- B. A non-combustible odorant, such as oil of wintergreen, may be added to help locate leaks.

## 3.3 CLEANING PIPING

- A. Assembly:
  1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.

2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.
3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

## 3.4 INSTALLATION

- A. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.
- B. Install piping to conserve building space, and not interfere with other work.
- C. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide clearance for access to valves and fittings.
- G. Provide access doors where valves are not exposed.
- H. Prepare pipe, fittings, supports, and accessories for finish painting.
- I. Install valves with stems upright or horizontal, not inverted.
- J. Provide shut-off valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
- K. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shut-off valves.
- L. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.
- M. Provide flanges or unions at all final connections to equipment, traps and valves.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- N. Seal pipes passing through exterior walls with a wall seal per Section 23 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
- O. All vertical pipe drops to equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted.
- P. Each above ground portion of a gas piping system, other than corrugated stainless steel tubing systems, that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than corrugated stainless steel tubing, shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.
- Q. Gas piping shall not be used as a grounding conductor or electrode.
- R. Where a lightning protection system is installed, the bonding of the gas piping shall be in accordance with NFPA 780, Standard for the Installation of Lightning Protection Systems.

## 3.5 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.
- B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.
- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. **All fittings shall be long radius type**, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.
- F. Use full and double lengths of pipe wherever possible.
- G. Cut all pipe to exact measurement and install without springing or forcing.
- H. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 3.6 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage.
- B. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install gas pipes with bottom of pipe and eccentric reducers in a continuous line.
- C. Provide drip legs at low points and at the base of all risers in gas pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

## 3.7 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.
- B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- C. Use of forged weld-on fittings is also limited as follows:
  - 1. Must have at least same pressure rating as the main.
  - 2. Header or main must be 2-1/2" or over.
  - 3. Branch line is at least two pipe sizes under header or main size.
- D. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- E. All branch piping connections for natural gas shall take off on the top or on the side of the main.

## 3.8 JOINING OF PIPE

- A. Threaded Joints:
  - 1. Ream pipe ends and remove all burrs and chips.
  - 2. Protect plated pipe and valve bodies from wrench marks when making up joints.
  - 3. Apply Teflon tape to male threads.
- B. Welded Joints:
  - 1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
  - 2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
  - 3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.
5. Backing rings shall be used for all butt weld joints 3" size and over, and for all sizes where operating pressure is over 200 psig and/or temperature is over 400°F. Backing rings shall be of the material being welded.

## 3.9 SERVICE CONNECTIONS

- A. Provide new gas service complete with gas meter and regulators. Verify gas service pressure with the Utility Company.

END OF SECTION 22 10 23

## SECTION 22 10 30 - PLUMBING SPECIALTIES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Floor Drains.
- B. Cleanouts.
- C. Traps.
- D. Backflow Preventers.
- E. Water Hammer Arresters and Air Chambers.

## 1.2 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

## PART 2 - PRODUCTS

## 2.1 CLEANOUTS

- A. Provide cleanouts as specified on drawings.
- B. Coordinate floor cleanout cover with surrounding floor finish. Provide either solid, recessed for tile or terrazzo or carpet marker as applicable.
- C. Cleanouts on exposed pipes shall be cast iron with heavy duty cast brass plug with raised head.
- D. Cleanout shall be same size as the pipe up to 6" and 6" for larger pipes.

## 2.2 TRAPS

- A. Provide all individual connections to the sanitary system with P-traps, except where such drains discharge directly into a properly trapped collection basin or sump. Unless otherwise specified or shown, traps shall be:
  - 1. Chromium plated cast brass when used with plumbing fixtures or when installed exposed in finished spaces.
  - 2. Insulated at accessible lavatories.
  - 3. Cast iron, deep-seal pattern where concealed above ceiling, below grade or in unfinished areas.
  - 4. Deep-seal pattern of the same material and/or coating where drainage lines are of special materials or coatings such as Duriron, glass, etc.
- B. All traps shall have accessible, removable cleanouts, except where installed on floor drains with removable strainers.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Each trap shall be completely filled with water at the end of construction but before building turnover to the Owner. All floor drains, floor sinks, trench drains, etc. shall be filled with water and a 1/2" minimum layer of mineral oil.

## 2.3 FLOOR DRAINS AND SINKS

- A. Provide floor drains and sinks as specified on the drawings.

## 2.4 BACKFLOW PREVENTERS

- A. Provide backflow preventers as specified on the drawings.

## 2.5 WATER HAMMER ARRESTERS AND AIR CHAMBERS

- A. Provide water hammer arresters as specified on the drawings.
- B. ANSI A112.26.1; sized in accordance with PDI WH-201, precharged for operation between -100°F and 300°F and maximum 250 psig working pressure.
- C. Air chambers shall meet the requirements of the applicable plumbing code. Minimum 12" long at fixtures and minimum 24" long on risers. Air chambers shall be the same size or larger than the piping it is connected to.

## PART 3 - EXECUTION

## 3.1 INSTALLATION AND APPLICATION

- A. Coordinate construction to receive drains at required invert elevations.
- B. Install all items per manufacturer's instructions.
- C. Water Hammer Arresters and Air Chambers:
  - 1. Install water hammer arresters in accessible locations. Provide access doors as required. Coordinate type with Architect/Engineer/Owner.
  - 2. Install air chambers at each fixture not protected by a water hammer arrester.
- D. Cleanouts:
  - 1. Provide cleanouts where shown on the drawings and as required by code, but in no case farther apart than 50 feet in pipe less than 6" size and 75 feet apart in 6" and larger pipes inside the building.
  - 2. Provide cleanouts at bases of all sanitary and storm risers.
  - 3. Extend cleanouts to the floor with long sweep elbows.
  - 4. Install a full size cleanout within 5 feet of the foundation inside or outside of building.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

5. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with graphite and linseed oil. Ensure clearance at cleanouts for rodding of drainage system.
  6. Wall cleanouts shall be installed above the flow line of the pipe they serve, but no less than 12" above the finished floor.
- E. Floor Drains:
1. Use alternate sealing method when installing drains in existing floor slabs.
  2. Coordinate sloping requirements with the architectural plans and specifications.
- F. Backflow Preventer:
1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
  2. Units shall be field tested and tagged in accordance with manufacturer's instructions and applicable codes by a certified tester before initial operation.
  3. Install unit between 12" and 60" above finish floor.

END OF SECTION 22 10 30



## SECTION 22 11 23 - DOMESTIC WATER PUMPS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Domestic Water In-Line Circulators.

## 1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 22 05 00.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Pumps with motors operating above the RPM the pump curves are based on shall have impellers trimmed to deliver GPM and head scheduled.

## PART 2 - PRODUCTS

## 2.1 GENERAL

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless specified otherwise.
- D. Pump connections shall be flanged, whenever available.
- E. Domestic hot water pumps shall be suitable for 225°F water.
- F. Submitted pump selections must have a diameter impeller that meets or exceeds the scheduled pump. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.

## 2.2 DOMESTIC WATER IN-LINE CIRCULATORS

- A. Provide pumps as specified on the drawings.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. General Installation Requirements:
  - 1. Install all products per manufacturer's recommendations.
  - 2. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

## B. In-Line Pump:

1. Support in-line pumps individually so there is no strain on the piping. Install with a minimum of five diameters of straight pipe on pump suction and discharge.
2. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
3. Pumps shall be factory aligned. If alignment is not satisfactory, as determined by the Architect/Engineer, manufacturer shall provide a factory trained representative to field align the shafts.

END OF SECTION 22 11 23

## SECTION 22 30 00 - PLUMBING EQUIPMENT

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Water Heaters.
- B. Water Softeners.

## 1.2 QUALITY ASSURANCE

- A. Products and installation of specified products shall conform to recommendations and requirements of the following organizations:
  - 1. American Gas Association (AGA).
  - 2. National Sanitation Foundation (NSF).
  - 3. American Society of Mechanical Engineers (ASME).
  - 4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
  - 5. National Electrical Manufacturers' Association (NEMA).
  - 6. Underwriters' Laboratories (UL).

## 1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 22 05 00.
- B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.
- C. Include heat exchanger dimensions, size of tappings, and performance data.
- D. Include dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.
- E. Submit manufacturer's installation instructions including control and wiring diagrams.
- F. Submit manufacturer's certificate that pressure vessels meet or exceed specified requirements.
- G. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- H. Submit a current water analysis from the actual water source serving the project site for softening equipment verification before sending shop drawings to the Architect/Engineer.

## 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

## 1.5 REGULATORY REQUIREMENTS

- A. Water heaters shall conform to AGA, ANSI/NFPA 54, ANSI/NFPA 70, ANSI/UL 1453 as applicable.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Conform to ANSI/ASME Section 8 Division 1 for fabrication of steel pressure vessels.
- C. Conform to ANSI/ASME Section 10 for manufacture of fiber-reinforced plastic pressure vessels.

## PART 2 - PRODUCTS

## 2.1 WATER HEATERS

- A. All water heaters shall be as scheduled on the drawings.

## 2.2 COMMERCIAL WATER SOFTENER

- A. Automatic simplex water softener to remove hardness to no more than 0.030 grains per gallon mg/L as determined by an ASTM Standard Soap Test Method.
- B. Performance as indicated on drawings.
- C. Softener Tank: Fiberglass reinforced polyester, designed for a minimum working pressure of 100 psig, hydrostatically tested at 150% of working pressure. Softener tank not over 12 inches diameter.
- D. Distribution System: Soft water collector and backwash distributor, inverted dish type lower distribution system. Distribution shall be covered with 2 layers of graded gravel to evenly distribute the service and backwash water and support the mineral bed tank.
- E. Brine Tank: Rigid polyethylene combination salt storage and brine tank, size not over 18" diameter, 40" height, with tight fitting cover, corrosion free elevated salt platform; float operated safety shut-off inside chamber housing, automatic air eliminator. Brine tank valve to reduce brine to softener, prevent air entrance into system, refill brine tank to correct water level, regardless of salt level in tank; adjustable salt dosage for regeneration.
- F. Mineral: High quality non-phenolic resin, minimum exchange capacity of 30,000 grains when regenerated with 15 lbs. of salt per cubic foot. Solid media, of the proper particle size (not more than 4% through 40 mesh U.S. standard screens, wet screening); media shall contain no agglomerates, shells, plates, or other shapes to interfere with normal function of water softener.
- G. Water Testing Equipment: Complete with sample cock installed to obtain samples of effluent water. Furnish a complete test kit for conducting soap tests.
- H. Automatic Controls:
  - 1. The main control shall activate diaphragm valves to accomplish the regeneration steps of backwash, brine-slow rinse, purge and service. The diaphragm valve nest shall incorporate self-adjusting flow regulators to properly control the rate of flow during the backwash (to prevent resin loss), brine-rinse and fast rinse positions regardless of pressure fluctuations between 30 and 100 psig, and shall open and close slowly to prevent noise and hydraulic shock. All seats and valves shall be interchangeable, and repaired or replaced without removing the piping or control mechanism.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. The control valve mechanism shall be designed to provide partial (1/4 design flow) hard water bypass to service during regeneration.
3. All control mechanisms shall be enclosed in a UL listed NEMA 3 enclosure. Unit shall have provisions for individual adjustment of backwash and rinse cycles, and for manually regenerating the softener during power failures.
4. Regeneration shall be controlled by:
  - a. **Time Clock:** Seven-day calendar clock that permits regeneration at any time of the day or night, any or every day of the week.
- I. Acceptable Manufacturers: Hellenbrand H-125, Culligan "HI-FLO 2", Bruner, Eco-Water, Marlo.
- J. Extra Stock:
  1. Furnish extra materials as listed below that match products installed and that are packaged and labeled for storage.
    - a. Provide 120 lbs. additional salt in the same form as the original load. Salt shall be delivered and stored on pallet(s). Locate the pallet(s) per the Owner's direction.
- K. Warranty:
  1. Provide a standard one-year warranty on the entire unit from the date of final acceptance.
- L. Acceptable Manufacturers: Hellenbrand H-125, Culligan, Marlo, Diamond, Eco-Water.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install all items in accordance with manufacturer's instructions.

## 3.2 WATER HEATER INSTALLATION

- A. Install water heaters on concrete bases. Coordinate sizes and locations of concrete bases. Refer to Section 22 05 29.
- B. Install water heaters level and plumb, according to drawings, manufacturer's instructions, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend drain piping full size from relief valve and discharge by positive air gap onto closest floor drain. Discharge pipe material shall be same as domestic water piping.
- D. Install gas water heaters according to NFPA 54.



## 3.3 WATER SOFTENER INSTALLATION

- A. Verify connection sizes and piping type with cold water and soft cold water piping. Provide dielectric connection between dissimilar metals. Pressure gauges are required at hard water inlet and soft water outlet of each softener.
- B. Provide system start-up and subsequent service, with stocking of spare parts by authorized dealer or factory trained personnel.
- C. Provide complete instructions covering installation and operation of the softening system in booklet form. All components shall be easily identified, in exploded views, by individual part number.
- D. Provide one hour of instruction and orientation to the Owner's maintenance staff by factory trained personnel. System walk-through, including programming of any system controllers shall be included in training.

END OF SECTION 22 30 00

## SECTION 22 40 00 - PLUMBING FIXTURES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. All plumbing fixtures.

## 1.2 SUBMITTALS

- A. Submit product data under provisions of Section 22 05 00. Submittals shall include fixture carriers for record purposes only. Architect/Engineer does not review or approve carriers except for manufacturer.
- B. Include fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. Wall Hung Fixture Carriers:
  - 1. Material: All Metal, ASME/ANSI A112.6.1M.
  - 2. Acceptable Manufacturers: Zurn, Smith, Wade, Josam, Watts, Mifab.
  - 3. Water closet carrier shall be rated to support 500 lbs. unless noted otherwise on the drawings.
- B. All fixtures shall be as scheduled on the drawings.
- C. All china shall be from the same manufacturer where possible.
- D. All lavatory and sink trim shall be from the same manufacturer where possible.
- E. All fixtures shall be lead free. Faucets, traps, stops, and other fixture accessories shall not contain more lead than allowed per the latest State or Federal Act.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. General Installation Requirements:
  - 1. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
  - 2. Install each fixture with trap easily removable for servicing and cleaning. Use screwed tailpiece couplings. Connect fixture waste to stack with slip fitting.

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3. Provide fixtures with chrome plated rigid or flexible supplies, loose key stops, reducers, and escutcheons.
  4. Install components level and plumb.
  5. Caulk joint between finish floor and floor mounted fixtures and between finish walls and wall mounted fixtures with silicon caulk. Caulk the joint, between rim and fixture where a fixture builds into a counter top, with caulking compound. Refer to DIVISION 7 for "Caulking" requirements. Color to match fixture.
  6. Where there is a possibility of water following pipe brackets, etc., into a wall; caulk escutcheons, space around brackets, etc., to exclude water. Refer to DIVISION 7 for "Caulking" requirements.
  7. Refer to Plumbing Material List for fixture mounting heights.
  8. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.
- B. Wall-Mounted Fixture Requirements:
1. All wall-mounted fixtures shall have compatible carriers designed for their intended service and suitable for the space available and configuration of fixtures. All carriers shall extend to the floor and be anchored to the slab.
- C. Floor-Mounted Fixture Requirements:
1. Where floor mounted fixtures are installed on a sloped floor, the open void below the fixture shall be grouted, leveled, and caulked to eliminate stress on the fixture and to prevent water migration to the floor below.
- D. Exposed or Inside Accessible Cabinets Traps, Valve and Pipe Requirements:
1. All traps exposed under fixtures or inside accessible cabinets shall be chrome plated brass.
  2. All water or waste piping for plumbing fixtures that is exposed or inside cabinets shall be chrome plated.
  3. All exposed flush valves for water closets and urinals shall have a chrome plated hanger to anchor the piping to the wall.
  4. All exposed water supply piping and fittings in a finished space to a shower valve, hose bibb, or other water outlet shall be chrome plated.
- E. ADA Lavatory Requirements:
1. All handicapped accessible lavatory traps, piping and angle stops shall be installed with an insulating kit specially manufactured for this installation. Armaflex with duct tape is not acceptable.

## F. ADA Water Closet Requirements:

1. Handicapped accessible water closet flush valve handles shall face the center of the stall.
2. Coordinate flush valves in handicap accessible locations with grab bars installed by the General Contractor. Make modifications required to flush valve after review by Architect/Engineer.

## 3.2 ADJUSTING AND CLEANING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.
- B. At completion, clean plumbing fixtures, equipment, and faucet aerator screens.

## 3.3 FIXTURE ROUGH-IN SCHEDULE

- A. Rough-in fixture piping connections in accordance with table on plumbing drawings of minimum sizes for particular fixtures.

END OF SECTION 22 40 00



## SECTION 225300 - LIFE SUPPORT SYSTEM

## PART 1 GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. This Section includes:

1. Piping systems.
2. Pumps.
3. Water treatment types.
4. Air compressor.
5. Water filter systems.
6. Ozone equipment.
7. Instrument equipment.
8. Life Support Contractor Experience Requirements.
9. Related Sections include the following:

- a. Division 22 Section 22 53 50 "Common Work Results for Life Support."

## 1.3 CODE AND PERMIT COMPLIANCE

- A. Work shall be in accordance with all applicable codes. Where the codes and drawings do not agree, the code shall take precedence; however, code shall take precedence over what is shown only when it is more stringent than that indicated. Items that are allowed by codes which are less stringent than that shown on the drawings shall not be substituted.
- B. Contractors shall familiarize themselves with all requirements as to permits, fees, etc., and shall comply. All permits, licenses, inspections and arrangements required for the work shall be provided by the Contractors at their expense.
- C. Drawings, plans, schematics, and diagrams indicate the general location and the arrangement of piping systems. Install piping systems per industry standards and manufacturer's recommendations.

## 1.4 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the minimum working-pressure ratings of 100 psig. Connected equipment, such as filters, shall be rated for the working pressures scheduled on the life support drawings.

## 1.5 SUBMITTALS

## A. Product Data:

1. Shop drawings shall be submitted for all piping and equipment.
2. Submit piping plan coordination drawings showing equipment, piping and valves.
3. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

## 1.6 LIFE SUPPORT CONTRACTOR EXPERIENCE QUALIFICATION REQUIREMENTS

- A. Life Support Contractor (LSC) is required to have experience equal to or exceeding the below listed requirements. The Owner and the Life Support Designer, Alvine Aquatics, will have exclusive authority to decide if proposed LSC qualification experience submittal is adequate to meet the experience required to install the life support systems, including, but not limited to: plastic piping, equipment, instrumentation, and low voltage wiring. LSC shall submit their firm and lead installer's qualifications as the initial life support submittal after the apparent low bidder is identified from the bid process. If LSC's qualifications submittal is approved, the LSC will be approved as a subcontractor on the project to the successful prime contractor awarded this project.
- B. If the LSC qualifications are not approved, the LSC will be rejected as a subcontractor on this project, and the apparent low bidder shall add a different LSC to their team and repeat the LSC qualifications submittal process.
- C. The LSC shall submit documentation of three (3) projects in the last five (5) years that address adequate experience with the project elements listed below. Experience documentation submitted shall include: Project name, date of completion, LSC staff who was lead installer, the value of LSC contract, and contact info for an owner representative that can be reached for reference on said project.
1. Project name.
  2. Project location.
  3. Date of completion.
  4. Description of project scope executed by the LSC.
  5. Name(s) of LSC lead installer(s).
  6. Contract value of the project scope executed by the LSC.
  7. Contact information for an owner representative who can be reached for reference on the project.
- D. The LSC experience qualification submittal shall demonstrate direct experience with or equivalent experience to the following scope items:
1. Successful furnishing and installation of complex plastic piping systems, including Schedule 80 PVC pressure piping systems and below grade installation of C900 PVC pressurized piping systems. Underground piping work experience shall include trenching, bedding and backfill work, the lay-up and connection of the pipe and fittings, pipe flushing and the pressure testing and documentation of the piping systems.
  2. Successful furnishing and installation of specialty water equipment including or similar to the following: large water filters, premanufactured process water skids (ozone contact skids, for example), high quality/purity air compressor packages and piping, oxygen

concentrators, ozone generators, plastic pumps, chemical resistant process/industrial pumps, high purity water systems (RO or distilled water, for example), cooling tower filtration systems, and medical gas piping.

3. Successful furnishing and installation of low voltage controls and instrumentation, including or similar to: level sensors and controllers, flow sensors, pump controllers, automatic valve controllers, ORP/pH sensors and controllers, and all associated wiring and conduit.

#### 1.7 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Factory startup shall be required for all specialized equipment.

#### 1.8 DELIVERY, STORAGE AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean equipment and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect equipment openings and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store equipment in dry location.
- C. Retain protective covers and/or protective coatings during storage.
- D. Protect equipment against damage from sand, grit and other foreign matter.
- E. Comply with manufacturer's written rigging instructions.

#### 1.9 LIFE SUPPORT PIPING

- A. Stainless Steel Pipe And Fittings (Ozone Piping):
  1. Stainless Steel Pipe and Fittings: Type 316L meeting ASTM specifications.
  2. Wall Thickness: Minimum 0.065 inch.
  3. Piping Tests: Test with air at 200 psi prior to connection to equipment.
  4. Piping Insulation: 1/2 inch unicellular foam.
  5. Welding Materials: Comply with Section IX of ASME Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
  6. Gasket Material: Thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures. Gaskets shall be removed prior to welding.
- B. Compressed Air Piping:
  1. Low Pressure Piping System: ASME B31.9 for piping operating at pressure of 125 psig or less and at a temperature of 200 deg F or less.
  2. Steel Pipe: ASTM A53 welded or Type S, seamless, Grade B, Schedule 40 black or hot dipped zinc coated with wrought-steel or malleable pipe fittings.



3. Valves: Suitable for required service; include PTFE seats.
    - a. Ball Valves: Full port with threaded ends.
  4. Piping Connection: Connect to equipment using unions and valves.
- C. Exhibit Water Piping Aboveground:
1. All piping 12 inches in diameter and smaller shall be Schedule 80 PVC plastic, Type 1, Grade 1, ASTM D1785 unless otherwise shown (except where specified elsewhere).
  2. Fittings (all PVC pipe):
    - a. Materials:
      - 1) Fittings shall be Schedule 80, PVC (polyvinyl chloride) plastic, Type 1, Grade 1, molded socket type, ASTM D2467.
    - b. Construction:
      - 1) Molded fittings 8 inches in diameter and smaller shall be the same material and schedule rating as the adjoining pipe.
        - (a) Fittings 8 inches and smaller shall be manufactured by Dura Plastics, Chemtrol, or equivalent. If fitting dimensions are larger than Dura Plastics or Chemtrol, the Contractor shall be responsible for all piping adjustment to accommodate larger dimensions.
  3. Joints shall be solvent welded in accordance with fitting manufacturer's instructions unless otherwise shown.
- D. Exhibit Water Piping Underground:
1. Piping and fittings 4 inches and larger in diameter: AWWA C900 PVC plastic, Pressure Pipe Class 150, DR-18, integral bell pipe with factory installed gaskets meeting requirements of ASTM F 477. Fittings shall meet requirements of ASTM D1599.
  2. Piping and fittings less than 4 inches in diameter: Schedule 80 PVC plastic, Type 1, Grade 1, ASTM D1785 and ASTM D2467.
- E. Nonpotable Water Piping:
1. Piping: Schedule 80 PVC plastic, Type 1, Grade 1, ASTM D1785
  2. Fittings: Schedule 80, PVC (polyvinyl chloride) plastic, Type 1, Grade 1, molded socket type, ASTM D2467.
- F. Flexible Connectors:
1. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125 psig minimum working pressure rating at 220 degrees F unless higher working pressures are indicated. Units may be straight or elbow type, unless otherwise indicated.

## G. Pipe Supports:

1. Pipe supports shall be manufactured of Type 316 SST, Type 6061-T6 aluminum or fiberglass components.
2. Support spacing shall be determined for the size and type of material.
3. Bolts and nuts shall be of non-corrosive material.

## H. Ozone System Valves:

1. Shutoff Valves: Tri-Clover model 181R-MP.
  - a. Diaphragm: PTFE faced butyl.
2. Check Valves: Tri-Clover model B45-MP.

## I. Water System Valves: All valves and valve operators in life support piping system shall be furnished and installed by the Life Support Contractor (excluding valves on pre-fabricated skids).

1. Manufacturers:
  - a. ASAHI America, Inc.
  - b. Hayward Flow Control.
  - c. Spears Manufacturing Co.
2. Valves shall be the line size of the pipe they are installed on.
  - a. Valves up to 2": Plastic ball valves.
  - b. Valves over 2": Plastic butterfly valves.
3. Plastic Butterfly Valves: 150 psig working pressure, PVC body and disc, EPDM liner and seals, 316 SST stem, non-plastic exterior parts epoxy coated.
  - a. Lug Type Valves: 316 SST lugs.
  - b. All valves installed with shafts horizontal.
  - c. Valves 8 Inches and Smaller: High impact polypropylene lever handle with trigger for 7 stop positions or more.
  - d. Balancing Valves: Worm gear type operator.
  - e. Provide memory – lock type valves on all pool bottom exhibit pool return (effluent) lines.
4. Plastic Ball Valves: 150 psig working pressure, 250 degrees F maximum operating temperature, full port design, PVC (Type I, ASTM D 1784 Cell Classification 12454) body design, PTFE seat, EPDM O-ring, full Schedule 80 bore, and high impact polypropylene or ABS tee handle; with true union connections.
5. Plastic Check Valves: 150 psig working pressure, wafer swing type, externally spring loaded, flanged PVC body and disc with EPDM seat.
6. Plastic Check Valves (Small): 150 psig working pressure, union type PVC body with solid thermoplastic ball, EPDM seat and seals, socket or screwed connection.

## 1.10 PUMPS - GENERAL REQUIREMENTS

- A. Factory assembled, tested and cleaned; flanges, openings or nozzles protected during shipment.
- B. Balance: Rotating parts, statically and dynamically.
- C. Suitable for continuous operation at 104 degrees F unless noted otherwise.
- D. Pump Motors: Operate at 1750 or 3450 rpm unless specified otherwise. Include built-in thermal-overload protection or select each motor to provide external thermal overload protection if internal protection is not included.
- E. Motors shall be an standard JM type open, drip-proof (ODP) or totally enclosed, fan-cooled (TEFC) construction. Motors shall have NEMA Class F or H insulation.
- F. Suction and discharge gauge tap and casing, drain and vent taps.
- G. Motors shall be energy efficient. Minimum efficiency as indicated according to IEEE 112, Test Method B. Include motors with higher efficiency than “average standard industry motors” according to IEEE 112, Test Method B, if efficiency is not indicated.
- H. Manufacturers:
  - 1. Met-Pro Global Pump Solutions (Fybroc, Sethco, and Dean Pumps).
  - 2. Pentair Aquatic Eco-Systems.
  - 3. MDM Incorporated.
  - 4. Approved equal in writing by the Life Support Designer.

## 1.11 CLOSE-COUPLED, END-SUCTION PUMPS

- A. Description: Centrifugal, close-coupled, end-suction, volute type, back pull-out; rated for operation at up to 42 psi, continuous water temperature of 104 degrees F, and 130 degrees F ambient air temperature.
  - 1. Body: Glass filled polypropylene thermoplastic or FRP, noncorrosive, with flanged piping connections (ANSI 150), and drain plug at low point of volute.
  - 2. Hair and Lint Strainer: Integral or bolt-on with SS bolts, Noryl or polypropylene thermoplastic body with plastic basket, clear Lexan or polycarbonate thermoplastic lid.
  - 3. Impeller: Noryl or glass filled PPO resin enclosed design.
  - 4. Volute and Motor Adapter: Noryl.
  - 5. Gaskets: Buna N rubber, compression resistant.
  - 6. Shaft and Internals: All stainless steel and rated for saltwater applications.
  - 7. Bearings: Permanently-lubricated, double sealed, stainless steel, single row ball bearings.
  - 8. Motor: Directly mounted to pump body and with supporting legs as integral part of motor enclosure. Motor shall be approved by the manufacturer for use with variable speed controllers if 5 HP or greater.

## 1.12 FIBERGLASS OR PVC BASKET STRAINERS (SUCTION)

## A. Manufacturer:

1. Hayward Flow Control.
2. Fluidtrol.
3. Pentair Water.
4. Spears.

B. Body of strainer shall be FRP or PVC (Class 12454 per ASTM D1784) with removable drain plug.

C. Furnish with heavy duty stainless steel basket with one extra basket for every pump. Verify the mesh/perforation size with the Life Support Designer. Cover shall be PVC, acrylic or Lexan and lock to strainer on EPDM O-ring seal.

D. The strainer shall have a pressure rating of 150 PSI at 70 deg F (non-shock).

## PART 2 PRODUCTS

## 2.1 COMPRESSED AIR EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

## 1. Rotary-Scroll Air Compressors:

- a. Boge.
- b. Kaeser.

## 2. Desiccant Air Dryers:

- a. Hankison.
- b. Kaeser.
- c. Puregas.

B. Duplex Air Preparation System:

1. The air preparation system shall consist of two (2) regenerative air dryers, air and oil filters, dew point monitor, air receiver, control panels, air compressors and other required appurtenances. The air preparation system shall be able to provide a dry ambient air supply that is clean, cool and oil-free with a dewpoint of not more than -80 degrees F. The system shall be DUPLEX in that two air compressors shall be provided and operated in a lead-lag configuration. One air compressor and one dryer shall be sized to provide adequate air for all specified ozone equipment.
2. All components for the air preparation system shall be provided by the same manufacturer. To simplify installation and construction, all of the components shall be mounted on a single frame. Furnish the skid base with mounting lugs for bolting to the

floor. Seismic ratings for skid anchoring to be provided by the equipment supplier as required. The Air Prep Skid shall be constructed of the following materials:

- a. Type 316 stainless steel, or
  - b. Non-metallic base, or
  - c. 300 Series stainless steel.
  - d. None of the detailing shall allow for exposed ferrous metal.
3. Air supply: Air for the ozone generator will be supplied from ambient air at temperature between 65 and 85 degrees F and relative humidity between 40 and 80 percent.
- C. Construction of Equipment: ASME B19.1, "Safety Standard for Air Compressor Systems;" or ASME B19.3, "Safety Standard for Compressors for Process Industries," as appropriate.
- D. Air Compressors:
1. The air compressors shall be single stage, oil flooded, air-cooled rotary screw type mounted in a sound deadening enclosure. The air compressors shall be furnished by the ozone generator supplier as appurtenances to the ozone generators. Compressors shall be Boge, Kaeser, or equal. Compressor package shall be provided by the Ozone Water Systems, Phoenix, Arizona.
  2. The air compressors shall be manufactured under strict ISO 9001 quality control standards.
  3. The capacity and electrical requirements for the air compressors shall be as shown on the drawings. The discharge pressure shall be 110 psig. The air compressors shall be capable of continuous full flow operation 24 hours per day at rated capacity and pressure.
  4. The drive motor for the air compressors shall have a TEFC enclosure. Motor winding shall be 100 percent copper. Motor service factor shall be a minimum of 1.15 and motor RPM shall be 1750. Motor insulation shall be Class "F". Motor efficiency shall be 94 percent or higher.
  5. Starters for the air compressors shall be magnetic, direct on-line type.
  6. The drive for the air compressors shall be direct drive or V-belt type. V-belt type shall include automatic V-belt tensioning device with visual adjustment indicator. V-belts shall be 100 percent oil resistant.
- E. Control Panel: The air compressors shall include a control panel with a NEMA 4 enclosure with a hinged door. All electrical components shall be UL approved and labeled as required. Electric schematic diagram shall be mounted on the inside of the control cabinet door.
1. The control panel shall not allow manual restart of the air compressors if the system is set in the "Auto-Restart" mode. When in the "Auto-Restart" mode, the air compressors shall automatically start when the air pressure reaches the low air pressure set point.
  2. The control panel shall include devices to shut down the air compressors in the event of motor overload, high air temperature, incorrect rotation or loss of drive.
  3. The control panel shall include automatic control for both air compressors and shall include switchable modulation as an option. Only one air compressor shall operate as the duty unit. If the duty air compressor cannot provide sufficient capacity, the stand-by air compressor shall be automatically activated. The control panel shall have the necessary devices to allow the STATE to rotate which air compressor is duty and which is stand-by. The air compressors shall automatically load after starting if the system demands it. The

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air compressors shall have adjustable time delay relays to shut down the air compressors after running unloaded for a pre-determined duration to avoid excessive motor starting. The compressors shall turn on at 90 PSIG and shall cut-out at 110 PSIG.

4. The control panel shall be completely prewired to provide a fully automatic operation of the compressors and it shall include the following features:
    - a. Disconnect switches
    - b. Magnetic starters
    - c. Push buttons in front panel
    - d. Running lights in front panel
    - e. Warning lights for low oil level and high oil temperature
    - f. Contacts for remote indication of failure
    - g. Stainless steel or heavy plastic labels for all instruments, controls and functions.
  5. Lead-Lag Controller: The DUPLEX air compressors shall be automatically cycled based on a load switch controller. Even load operation of all compressors shall be provided between cyclic priority change and a weekly timer if desired. The base cycling shall be based on a pressure switch. Visible data on the controller shall include pressure display, compressor in load condition, minimum and maximum switching pressure points, actual time, and software version.
- F. Internal Piping: All air and oil piping shall be made of steel and shall feature flexible connections with O-ring seals.
- G. Lubrication and Cooling System: The air compressors shall be provided with differential pressure oil circulation systems. Air compressors requiring an oil pump and/or oil stop valve are not acceptable. The air compressors shall be factory filled with semi-synthetic or optional full synthetic lubricant.
1. Each air compressor shall be provided with an oil filter. Oil filters shall be spin-on type with 99 percent removal efficiency at 10 microns.
  2. Each air compressor shall be provided with a thermostatic control valve to maintain optimum operating temperature.
  3. Each air compressor shall be rated for a minimum working pressure of 200 psig.
  4. Each air compressor shall be provided with an ASME-coded separator tank with integral oil separator. Oil separation system shall include three stages: mechanical separation and two-stage coalescing filter. Air compressors shall have a maximum oil carry-over of 2 to 5 ppm. Each separator tank shall include a sump pressure gauge, fill plug, oil level sight glass, quick disconnects for measuring air pressure differential across the filter element and ASME coded safety relief valve. Each separator tank shall be equipped with quick disconnects and oil drain hoses to allow pressurized oil changes.
  5. Each air compressor shall be provided with oil coolers and aftercoolers. These devices shall be integrally mounted to the compressor enclosure. Aftercooler approach temperature shall be less than 95 degrees F. Oil coolers shall include drain plugs to ensure complete oil removal without costly flushing.
- H. Air Receiver. Air receiver shall be ASME approved and bear appropriate code symbols horizontal or vertical welded steel tank with integral legs, suitable for the working pressure of 200 psig. Air receiver shall have threaded connections for an inlet, outlet, drain, pressure gauge and pressure switch. The outlet shall have an ASME approved pressure relief valve as well as a pressure gauge.

The drain connection shall have a plug valve, a strainer and an automatic condensate trap piped to the nearest floor drain or similar drainage point. The automatic condensate trap shall include a timer with field adjustable time value. The receiver shall be primed and painted.

- I. Factory Pre-piping: Entire unit, except where otherwise indicated.
- J. Regenerative Air Dryer: The regenerative air dryer shall be of the heatless adsorptive type using molecular sieves, activated alumina, or silica gel. Air dryer shall be able to provide a minus 100 degree F dew point. Dual towers shall be provided for continuous operation. Each tower shall be of such capacity that the total cycle of drying, reactivation, and cooling will be a maximum of 8 hours. Dryer reactivation shall be automatic. The reactivation cycle shall be controlled by timers and activated by either a pneumatic cylinder with its own compressor or a motor operator. Air dryer assembly shall include pre and post air filters. Maximum purge loss through the air dryer shall not exceed 2.5 cfm.
- K. Air and Oil Filters: Air and oil filters, complete with manual blow-off valves for removing desiccant dust and 99.99 percent of oil aerosols from the effluent gas stream, shall be supplied in the air preparation piping system prior to the ozone generators. At a minimum, air and oil filters shall include centrifugal separator, two air line filters, oil removal filter and oil vapor absorber. Bypass assemblies shall be provided to ease change out of filter elements.
- L. Dew Point Monitor: The dew point monitor shall be provided to ensure dryness of the incoming air to the ozone generator. The dew point monitor shall include an alarm output and other devices necessary to provide the required control and safety shutdown functions. The dew point monitor shall be single channel, aluminum oxide hygrometer type. The monitor shall also include an analog output for interface into the ozone system interface control panel for display and set point adjustment.
- M. Condensate Management System (CMS): A filter CMS shall be integrated into the skid air preparation package. All filter condensate drains shall be directed to the condensate management system. A proper sized muffler and condensate collection chamber shall be installed prior to the CMS to reduce pressure on the discharge as well as ensure proper operation of the system.
- N. Specialties:
  1. Safety Valves: ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels" construction, National Board certified, labeled, and factory-sealed; constructed of bronze body with poppet safety valve for compressed-air service.
    - a. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
  2. Automatic Drain Valves: Corrosion-resistant metal body and internal parts, rated for 200 psig minimum working pressure, capable of automatic discharge of collected condensate.
  3. Pressure Regulators: Bronze body, direct acting, spring loaded, manual pressure-setting adjustment, and rated for 250 psig inlet pressure, except where otherwise indicated.
    - a. Type: Diaphragm operated.
  4. Coalescing Filters: Capacities and types indicated. Equip with activated carbon capable of removing water and oil aerosols, with color-change dye to indicate when carbon is

saturated and warning light to indicate when selected maximum pressure drop has been exceeded.

- O. Warranty: The air preparation system shall be warranted to be free of defects in material and workmanship for a minimum of 12 months. Air compressors shall be warranted to be free of defects in material and workmanship for a minimum 24 months without restrictions based on the purchase of special lubricants or maintenance kits.
- P. Supplier: The Air Compressor package shall be provided by Ozone Water Systems, (480-451-2400), Phoenix, Arizona or pre-approved equal at time of bid.
- Q. Start-Up Services: On-site start-up services shall be provided by factory trained technicians at no charge to assure equipment is running and adjusted to factory specifications. Maintenance training shall be given to maintenance personnel to assure they understand routing maintenance procedures. The maintenance training shall be conducted at the time of equipment start-up.

## 2.2 WATER FILTER SYSTEMS

### A. Propeller Washed Bead Filters:

- 1. Vessel:
  - a. Materials of Construction: All filter vessels shall be constructed isophthalic polyester resin reinforced with C-Veil or Type E Glass (as chop or sprayed mat) as specified in the Laminate. The polyester resin used for the corrosion barrier shall be resin manufactured with FDA approved ingredients. The structural laminate may be the same resin used for the corrosion barrier or an alternate isophthalic polyester resin. All filter vessel fabrication will conform to NBS PS 15-69, ASTM D4097 (as applicable, this filter is designed for 20 psi in lieu of an atmospheric vessel and the design Safety factor is 5:1), and ASTM C-582 construction standards.
  - b. Corrosion Barrier Laminate: All internal wet surfaces shall be consist of a minimum 100 mils thickness consisting of a surface layer of C-veil with 90 percent resin and 10 percent glass, followed by an inner layer of one layer of 1.5 oz. chopped strand mat with 70 percent resin and 30 percent glass reinforcement.
  - c. Structural Laminate: The structural laminate shall consist of an isophthalic polyester resin reinforced with Type E Glass (as chop or sprayed mat).
  - d. Structural Design Pressure: Filter vessels shall be designed for 20 psi working pressure and a 30 psi test pressure.
  - e. Fittings:
    - 1) 5.01 FRP threaded nozzles shall be conically gusseted with minimum strength requirements of 1500 ft-lbs of bending and 200 ft-lbs of torque and suitable for connection to PVC pipe.
    - 2) 5.02 Influent and Effluent Fittings: Influent and effluent fittings shall be fiberglass reinforced plastic FIPT. All flow distributor plumbing and diffusers shall be of PVC, ABS, or similar construction and shall have threaded connections.
  - f. Vessel Support: The filter vessels shall be supported on an integral skirt, designed and constructed per ASTM D-4097.



2. Filter Design Details:
  - a. Process Design: The influent diffuser will be designed to distribute the incoming flow without disturbing the media surface. The media retention screen shall be constructed of 316 stainless steel unless otherwise specified. Titanium media retention screens shall be provided for units scheduled for use in saltwater. The bead retention screen is designed to retain the filter media during filtration and distribute the backwash water evenly across the media bed while rinsing during a backwash.
  - b. A minimum of 20 inches of bead media shall be provided above the top of the Influent diffuser. The manufacturer will provide sufficient media to fulfill this depth.
    - 1) Bead Media
    - 2) Effective Size 3-4 mm
    - 3) Uniformity Coefficient Less than 1.5
    - 4) Specific Gravity.92 to.95
    - 5) Beads shall be composed of high density polyethylene
  - c. Each filter shall be installed with a pressure relief valve preset at 20 psi to prevent over pressurization of the filter hill.
  - d. Each filter shall be installed with a liquid filled pressure gauge mounted on the filter that shall be connected to the influent piping with a scale of 0-30 psi.
  - e. The manufacturer shall provide a 2-year written structural warranty. All material in contact with the process water shall be of non-metallic construction. All hardware, including lifting lugs, mounting brackets, hold-downs and bolts shall be fiber reinforced plastics or Type 316 stainless steel, titanium or approved substitute.
  - f. Propeller Design: The filter shall be provided with a motor and direct drive propeller for mixing up the bead media during the backwash procedure. The motor and propeller shall be removable for service. All propeller, motor, mounting, coupling, and bearing components shall be stainless steel for filters scheduled for use in saltwater systems.
3. Manufacturer
  - a. Aquaculture Systems Technologies, LLC.  
Aquaculture Systems Technologies, LLC  
108 Industrial Ave.  
Jefferson, LA 70121  
(504) 837-5575 / (800) 939-3659 phone  
(504) 837-5585 fax  
info@BeadFilters.com
  - b. Approved equal in writing by the Life Support System Designer.

### 2.3 DISINFECTION EQUIPMENT

#### A. Ozone Generation System (Large Central System):

1. General: The ozone generators, air preparation system, ozone monitors, ozone destruct units, venturi injectors, pressure ozone contactors (non-concrete), instrumentation,

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interlocks, and all appurtenances shall be furnished by a single manufacturer/supplier as a complete system. The manufacturer and supplier shall have at least five years of experience in designing, manufacturing, and installing similar ozone equipment. The components of the ozone generation system shall be as detailed in this section. One ozone skid shall be provided. Skid will consist of items as listed below. Items not on the skid will be water contact equipment (water pump, injector, contact tank, etc.).

2. Ozone Generators: The ozone generators shall be a corona discharge type with stainless steel components. The ozone generators shall be air-cooled. All materials in contact with ozone shall be Type 316 stainless steel, glass or other ozone resistant materials. The ozone generator cabinets shall be weatherproof and constructed of Type 316 SST or other approved corrosion resistant material. Cabinets shall be equipped with latch bolts for ease of opening and dielectric replacement without having to remove any other equipment.
  - a. Capacity. Each ozone generator shall be able to produce ozone from clean dry air at a minimum of 3 percent concentration by weight or from oxygen at minimum concentration of 10 percent by weight at a minimum operating pressure of 15 psig. Each ozone generator shall be capable of being varied between 20 and 100 percent of its specified capacity. Production capacity shall be as specified in the schedule on the drawings.
  - b. Power Consumption. The power consumption of each ozone generator system, including ozone generator and air preparation equipment, shall not exceed 12 kWh per pound of ozone produced. The CONTRACTOR shall coordinate all electrical requirements and advise the equipment supplier.
  - c. Ambient Condition: The ozone generators and air preparation system shall be designed for operation in an air-conditioned room with an ambient temperature range of 65 to 85 degrees F.
  - d. Cooling: The ozone generators shall be air-cooled.
  - e. Unless otherwise shown, the ozone generators shall be provided with compressed air from the air preparation system. Ozone generators shall be capable of operating with feed gas pressures up to 20 psig. Oxygen concentrators shall be provided for ozone generators specified to be oxygen-fed.
  - f. Ozone Generators:
    - 1) These ozone generators shall be skid mounted. Generators shall be mounted on and firmly attached to stainless steel or FRP support stands. These support stands shall be 30 to 36 inches tall. The stands shall be firmly attached to the floor of the skid in accordance with all applicable codes.
3. Instrumentation and Controls: Each ozone generator shall be furnished with an electrical and instrumentation control panel. Each panel shall contain breakers, controllers, indicators, recorders and totalizers, as specified herein. These specifications are intended to provide the CONTRACTOR and ozone generator manufacturer with the minimum items required to be included in the control panel. The intent of these Specifications is to provide a system which can be operated reliably and which can be accurately monitored and controlled. Each control panel shall be housed in a NEMA 4X enclosure with Type 316 SST mounting hardware. Where practical, one control panel could be provided for all ozone generators and/or the entire ozone generation system. As a minimum, the control panels shall include the following:
  - a. Branch circuit breakers to auxiliaries.

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- b. High air temperature power disconnect safety cut-off switch and alarm light.
- c. Low gas flow power disconnect safety cut-off switch on air feed gas to the ozone generator and alarm light.
- d. Incoming line current indicator dials.
- e. Secondary voltage and/or frequency indicator dial.
- f. At least one industrial thermometer (25 degrees F to 125 degrees F range) and one pressure gauge (0 to 25 psig) in the air/oxygen piping ahead of each ozone generator.
- g. At least one rotameter in the air/oxygen stream feeding each ozone generator. Rotameter shall calibrate to read in SCFM. The scale of the rotameter shall be suitable for the range of air/oxygen flow rates for the ozone generator.
- h. The dew point monitor shall activate a safety cut-off switch to shutdown the ozone generators if the dew point rises above minus 60 degrees F.
- i. Contacts for remote indicator of running and failure status. Additional contacts shall also be provided for controlling start/stop/sequence of remote devices, including but not limited to the ozone destruct unit, as required to provide a complete and fully functional ozone generation system.
- j. The following status lights shall be provided:
  - 1) On/Off indication for Main Ozone Injector Pump (POI-1)
  - 2) Ozone generator fault
  - 3) Air gas flow fault
  - 4) Cooling water flow fault
  - 5) Cooling water temperature fault
  - 6) Ambient ozone fault
  - 7) Ozone destruct unit fault
  - 8) Ozone injector pump off or fault
- k. The ozone generator shall be equipped with a variable output controlled with a 10:1 turndown ratio. The variable output controllers for the ozone generators will be manually adjusted by the operator. The ACS will open and close the ozone gas supply valves for each injection point to maintain ORP within high and low ORP set points.
- l. Each ozone generator control panel shall contain interlocking devices to provide safe start-up and shut-down of the ozone generation system. The ozone generators shall be shut down using relays located in the control panel upon activation of the following disconnect safety cut-off switches, signals from the Building Automation System (BAS), or other signals:
  - 1) High electrical current
  - 2) Low cooling water flow
  - 3) High air temperature
  - 4) Low feed gas flow
  - 5) High dew point temperature
  - 6) Dielectric rupture
  - 7) High ambient ozone alarm generated by the ambient ozone concentration monitor
  - 8) Failure of the ozone destruct unit
  - 9) A shutdown signal from the BAS (Remote Shutdown)

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- m. Each ozone generator shall be provided with a suitable combining line starter with built-in circuit breaker. Circuit breaker trip rating shall exceed the rated amperage by not more than 75 percent. Ozone generator skids with multiple generators shall be provided with a single point electrical connection that serves all the generators.
  - n. Type 316 SST sampling taps, including valves and appropriate tubing or pipe connections, shall be provided to monitor the output from each generator.
  - o. Backflow Prevention Panel: Each ozone generator shall be provided with a backflow prevention panel on the discharge side of the generator to prevent process water from backflowing into the generators. This panel shall include 1/2-inch FNPT ozone gas and compressed air connections. Ozone gas and compressed air piping shall be Teflon tubing or welded Type 316 SST. The panel shall include a UV resistant PVC enclosure with a clear polycarbonate or acrylic viewing panel. Viewing panel shall be hinged to allow access to equipment. All metal hardware shall be Type 316 SST. Internal backflow prevention equipment shall include the following:
    - 1) Normally closed electrically and pneumatically actuated valve. All materials in contact with the ozone gas shall be PVDF or Viton. Both power and compressed air from the air preparation system (immediately upstream from the ozone generator) shall be used to open the valve. If either power or air pressure to the valve are lost, the valve shall automatically close. This valve shall be manufactured by George Fischer, or equal.
    - 2) A clear glass water trap with a Type 316 SST float mechanism shall be provided downstream of the valve. This mechanism shall send a signal to automatically close the valve if and when water enters the water trap. A Type 316 SST needle valve shall be provided to manually drain water from the trap after it enters the assembly. The mechanism shall include a clear glass window to provide visual indication of backflow problems.
    - 3) A Type 316 SST check valve shall be provided downstream of the water trap.
    - 4) The backflow prevention panel shall be manufactured by Ozone Water Systems, or equal (480-421-2400 Tel).
4. All items required for the ozone generation system shall be manufactured or supplied by Ozone Water Systems (480-421-2400), Phoenix, AZ, or approved equal in writing by the Life Support Designer.

**B. Instrument Equipment – Furnished by Ozone Equipment Vendor:**

- 1. ORP Sensors:
  - a. Manufacturers: Signet Scientific or approved equal.
  - b. Description: Ozone level shall be measured in water lines (salt or fresh) for control.
  - c. Flat surface or bulb electrode shall be installed in pipe tee.
  - d. 4-20 mA signal shall be sent through two wires to transmitter.
  - e. Transmitter shall measure pH or ORP for operator use. Mount transmitter in NEMA 4X enclosure.
  - f. ORP sensor shall have local readout for operator use: Signet #5700 ORP monitor or equal.
  - g. Minimum of one high ORP level relay signal output at 24vdc.
  - h. The ORP sensors shall be provided by the skid assembler/ozone equipment vendor in the water inlet and outlet lines of each ozone contact skid and anywhere else in

ozone disinfection system as required for correct operation. The ozone equipment vendor shall also furnish any other ORP sensors shown in the life support plans or schematics for installation by the Life Support Contractor.

- 1) Wet-tap sensor ports (Signet #3719 or approved in equal) shall be provided to allow the easy installation and removal of the ORP electrodes without the need for process shutdown during routine electrode maintenance and calibration. This shall be achieved with double O-ring seals and a retraction assembly; no separate valve shall be required. A cam-activated automatic locking system shall assure operator safety.
  - 2) The Ozone Equipment Vendor shall initially calibrate the ORP sensors and install them into the contact skid lines during the start-up process. The Ozone Equipment Vendor shall train the owner on proper ORP maintenance and calibration.
2. Ambient Ozone Analyzer:
- a. Manufacturers:
    - 1) Analytical Technology, Inc. (ATI) or approved equal.
  - b. Description:
    - 1) Dual channel ambient ozone levels in the ozone generator room and near the ozone contact skids. Analyzer shall go into alarm if ozone level setpoints are exceeded, i.e., an ozone leak occurs.
  - c. Alarms:
    - 1) Each detection channel shall be furnished with an Amseco Model CSH24W colored strobe/horn unit to be mounted where indicated on the life support system drawings. Strobe/horn units shall be 24V powered by the ambient ozone analyzer.
  - d. Setpoints:
    - 1) Each detection channel shall have two programmable setpoints from 5 to 100% of the sensor range. Upon reaching the first setpoint, the analyzer shall energize the strobe/horn unit on that channel. On reaching the second setpoint, the analyzer shall send a shutdown signal to the active ozone generator.
  - e. Power Supply Module:
    - 1) 120V, 1-phase 60 Hz, and capable of powering 24V alarms.
  - f. Enclosure:
    - 1) NEMA 4X enclosure shall house two detection channel modules and the power supply module.

3. Rotameters: Provided by ozone equipment vendor.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Brooks.
    - 2) Signet Scientific.
  - b. Description: Rotameters shall be utilized to meter and control the flow of 1 percent ozone gas.
  - c. Rotameter shall be designed with screwed ends, spring loaded pistons, and union bodies for maintenance. Meters shall be rated for 150 psi working pressure.
  - d. Meters shall be calibrated in cubic feet per hour.
  - e. Meter shall have 316 stainless steel floats with 10-inch lens scales with accuracy of  $\pm 2$  percent. Body shall have Viton "O" rings, 316 stainless steel ends, with borosilicate glass tubes and packing glands.
  - f. Rotameters shall be furnished with 316 stainless steel flow control valve at outlet to permit balancing of the flow rate.

C. Pressure Ozone Contacting Systems:

1. General: The size and configuration of the pressure ozone contacting system, including all items listed below, shall be determined by the manufacturer and shall be sufficient to provide a minimum of 95 percent ozone mass transfer efficiency into solution based on the ozone generator capacities indicated on the drawings.
2. The pressure ozone contacting system shall consist of an ozone injector pump, venturi injector, piping, reaction vessel, degas relief valve, demister assembly, backpressure valve, ozone destruct unit, mass transfer multiplier nozzles, skid and all required hardware, mounting brackets and accessories.
3. Ozone Injector Pump: The ozone injector pump shall be constructed as specified under the Close-coupled, End-suction Pumps Section.
4. Venturi Injectors: One high efficiency, venturi type, differential pressure injector shall be installed after the booster pump. Injector shall be operated at the flow and inlet pressure scheduled on the drawings to produce the scheduled gas suction capacity. One injection train shall be operated. The injector shall be sized to assure that the applied ozone dosage does not exceed ozone solubility under design operating conditions. The injector shall have Kynar (PVDF) inlet and outlet and FNPT gas suction port. The injector shall be equipped with a check valve and isolation valve at the open suction port to prevent motive water from flooding the ozone gas line in the event of a system failure. The injectors shall be constructed of either PVDF or stainless steel. The injector shall only be manufactured by Mazzei Injector Corp.
5. Reaction Vessel and Relief Valve: Reaction vessel and relief valve shall be a composite material suitable for ozone contact, such as Polyethylene.
6. Degas Relief Valve: Degas relief valve shall be Type 316L stainless steel or PVC with Viton gasket seat. A P-trap and demister assembly shall be provided with liquid drain valve. Materials of the P-trap and demister assembly shall be suitable for continuous exposure to moist ozone gas.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

7. Mounting Skid: The entire pressure ozone contacting system shall be mounted on a single skid constructed of Type 304 or Type 316 stainless steel. The dimensions of the skid shall not exceed those scheduled on the plans.
8. Backpressure Control Valve: A Type 316 SST backpressure control valve shall be provided as required for proper operation of the system.
9. Electrical Coordination: The skid assembler shall be responsible for providing all appurtenances (wiring, conduit, disconnects, motor starters, etc.) on the skid required for the ozone injector pump. The Electrical Contractor shall provide all conduit, wiring, etc., required to connect to a single point power connection on the skid to power the skid pump. Miscellaneous electrical skid accessories shall be provided with 120/1/60 cord-and-plug connections for connection to outlets provided by the Electrical Contractor.
10. Ozone Destruct Unit:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Ozone Solutions.
    - 2) Fin-Tek.
    - 3) Ozone Water Systems.
    - 4) Preapproved equal.
  - b. Description: Unit shall receive gas from system and destroy residual gases.
  - c. If required by the destruct, a blower shall be provided downstream of destruct to draw gas through destruct.
  - d. Gas shall pass through gas catalytic filter and electric coil tube heater. Heater with regulator shall operate at a preset temperature range by the catalyst material. The heater may be omitted if the ozone gas is produced from ultra-dry air and is approved by the Life Support Designer.
  - e. All parts in contact with ozone shall be constructed of resistant material, Type 316 stainless steel, FRP with Derakane 411.
  - f. Provide orifice/damper on inlet to unit for air balancing.
  - g. Install stainless steel off gas demister and p-traps with automatic drain valve on inlet to unit.
  - h. Unit shall be 110/230 volt with on/off disconnect.
11. Piping: As indicated on the drawings, piping shall be Schedule 80 PVC (upstream of venturi injector), Type 316 SST (downstream of venturi injector), and vinyl ester FRP (to ozone destruct unit).
12. The manufacturer of the pressure ozone contacting system shall be responsible that all materials exposed to ozone and the process fluid shall be completely inert to any destructive action by ozone and ozonated, chlorinated freshwater.
13. The ORP sensors shall be installed on the water inlet and outlet lines of each ozone contact skid by the skid assembler.
  - a. Wet-tap sensor ports (Signet #3719 or approved in equal) shall be provided to allow the easy installation and removal of the ORP electrodes without the need for process shutdown during routine electrode maintenance and calibration. This shall be achieved with double O-ring seals and a retraction assembly; no separate valve shall be required. A cam-activated automatic locking system shall assure operator safety.

14. All items required for the pressure ozone contacting system shall be manufactured or supplied by Ozone Water Systems (480-421-2400), Phoenix AZ, or preapproved equal in writing by the Life Support Designer.

D. Backflow Prevention Device:

1. Backflow Prevention: Supply an active backflow prevention device for each ozone generator, quantity of two (2) required. Consisting of a mechanical float valve, normally closed solenoid valve responding to a water sensing probe; or other mechanical/electronic device designed to positively prevent backflow of water into each generator.
2. Unit shall be manufactured by Ozone Water Systems, Model BFP-1, (480-421-2400; [www.ozonewatersystems.com](http://www.ozonewatersystems.com) <<http://www.ozonewatersystems.com>) or preapproved equal in writing by the Life Support Designer.

E. Ozone Disinfection System Owner Training

1. No less than four hours of onsite, in person training shall be given to the Owner's life support operations staff. This training shall be scheduled with the Owner after the successful start-up of the life support systems but should not be coordinated less than 48 hours in advance unless acceptable to the Owner. The training shall include, but not be limited to, the following scope:
  - a. Start-up and shutdown procedures for each equipment skid.
  - b. Adjustment/balancing of air, ozone, and water valves included in the ozone equipment package.
  - c. Troubleshooting common equipment warning messages, lights, and alarms.
  - d. ORP sensor installation, removal, cleaning, and calibration.
  - e. ORP set point adjustment via the ozone control system.
  - f. Emergency operations and common repair procedures.
  - g. Parts/repair source contact information.

2.4 ULTRAVIOLET STERILIZERS:

A. Usage:

1. The ultraviolet sterilizers for treatment of filtered water.

B. Requirements:

1. Submittals shall be in accordance with procedures set forth in the General Conditions.
2. Provide in quantities and capacities as given on the drawings.
3. All equipment shall be in conformance with all local, state and federal codes, statutes and ordinances where they apply, including required Underwriter Laboratory (U.L.) approvals

C. Quality Assurance:

1. Manufacturer's Qualifications: The manufacturer shall have at least 10 years experience in the manufacture of similar items with a record of successful installations.



## D. Coordination:

1. Verify all electrical, life support and other trades requiring that interface with the sterilizer.

## E. Submittals:

1. Submit dimensions of all components, capacities, bill of materials, electrical requirements, and installation recommendations.
2. Submit literature/data from the manufacturer of the lamps.
3. Warranty: Guarantee all equipment furnished under this Section against defects in workmanship or materials for 1 year from original date of purchase on the power supply and all gasket seals. A 3 year warranty on the UV sterilizer's plastic body housing due to failure of plastic from UV light exposure.

## F. Design and Performance:

1. Basic performance rating shall be greater than 99.9 percent bacterial reduction across the sterilizer.
2. Units shall conform to the requirements listed in the equipment schedule shown on the drawings. Sterilizers shall operate at flow rates to achieve a minimum light intensity of 30,000 micro-watts-sec per square centimeter at end of lamp life with a minimum UVT of 90 percent.
3. The water containment vessel shall be of the "L"-type design with the main quartz sleeve retaining end fully flanged for access into the vessel for inspection and service if required.
4. The UV reactor shall accept its respective UV lamps through only one end of the vessel.
5. The water containment vessel shall utilize quartz sleeves that are open on only one end and held in place by a single piece retainer section and sealed by a suitable O-ring material.
6. All electrical connection to the unit's lamps shall be made only on one end of the unit.
7. Pressure drop across the sterilizer, from inlet to outlet, shall be no greater than five psi when operated at an intensity of 45,000 micro-watt-sec per square centimeter.
8. Maximum design operating pressure shall be greater or equal to 150 psi; test pressure shall be no less than 150 psi.
9. Temperature limitations are from 35 degrees F to 80 degrees F process water temperatures at ambient air temperatures from 25 degrees F to 100 degrees F.
10. Water flow pattern shall have proven performance to create sufficient turbulence to assume full exposure to ultraviolet rays.
11. Proof of UV dose vs. water flow rates must be able to be demonstrated using industry accepted calculation methods and be provided for review at time of submittal by the contracting engineer.
12. Minimum lamp life under the specific design ratings shall be 9,000 hours to 80 percent UV-C output.
13. Electronic Power Supplies:
  - a. Each UV lamp shall be powered by one electronic power supply.
  - b. The electronic power supply shall not be frequency dependant.
  - c. Each lamp within the unit shall operate on its own circuit within the power supply so as to prevent consecutive lamp failures should one lamp fail.
  - d. Power supplies shall have cord-and-plug electrical connections.

## G. Materials:

1. Long lasting GPH/T6 low pressure, high output lamps constructed of hard quartz non-ozone producing glass and be of the linear type design in T6 series diameters.
2. Medium pressure lamp systems shall also be acceptable.
3. The lamps shall use an internal coating to reduce the effects of solarization and have a minimum end of life UV-C output of 80 percent.
4. The lamps shall have a stepped ceramic base design to prevent arcing of the lamps electrical terminals.
5. Lamp sleeves shall be quartz glass specifically designed for transmission of UV light.
6. All wetted components shall be Schedule 40 or Schedule 80 Type I PVC, DuPont Teflon plastic, quartz glass, or Type 316 stainless steel.

## H. Electrical and Instrumentation:

1. Power shall be 120 volt or 230 volt, 60 Hz, single phase.
2. 208 volt, three phase power supplies shall be approved in writing by the Life Support Designer.

## I. Manufacturer and Supplier:

1. Emperor Aquatics, Inc., 2229 Sanatoga Station Road, Pottstown, PA 19464. Telephone: (610) 970-0440 · Fax: (610) 970-0443 · info@emperoraquatics.com.
2. Engineered Treatment Systems, LLC, 238 Commercial Drive, PO Box 392, Beaver Dam, WI, 53916. Telephone: (920) 885-4628. Website: www.etsindustrial.com.
3. Approved equal in writing by the Life Support Designer.

## 2.5 LIFE SUPPORT SYSTEM INSTRUMENTATION – PROVIDED BY LSS CONTRACTOR

## A. Flow Meters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Midwest Instruments and Controls.
  - b. Blue-White Industries.
  - c. Description: Insertion type flow meters shall be paddlewheel type with sensing device.
    - 1) Meter shall be sized for gpm at locations shown on plans. Place meter in location for accurate measurement as designated by supplier.
    - 2) Body of meter shall be water-proof and corrosion-resistant material with propylene or PVDF with polypropylene paddlewheel.
    - 3) Unit shall be mounted on a tee with flanged or saddle for precise positioning in the pipe line.
    - 4) The meter shall be furnished with a digital indicator.

## B. Level Sensing:

1. Manufacturers: Flowline of San Diego, CA ([www.flowline.com](http://www.flowline.com)).
2. Description: Level sensor shall be ultrasonic type for controlling the liquid levels.
  - a. Unit shall be Flowline Echosonic II GP Model LU27-01.
  - b. Provide with self-contained, 120V Flowline Model L155-1411 remote controller/monitor panel with visible display in a Flowline Model LM921000 NEMA 4X polycarbonate enclosure. The controller allows adjustment of level sensing setpoints:
    - 1) Low level – open two-position automatic makeup valve or start makeup pump.
    - 2) High level – close two-position automatic makeup valve or stop makeup pump.
  - c. The Life Support Contractor shall provide all required nonmetallic, watertight conduit and sensor cable required to locate the ultrasonic level sensor at the exhibit pool remote from the level sensor controller/monitor panel in the pump room. See the Life Support drawings for the sensor and controller/monitor locations.
    - 1) Sensor cable shall be 22 Gauge or larger two-wire cable.
    - 2) The sensor cable length shall not exceed 1000 feet between the controller/monitor panel and the ultrasonic level sensor.
  - d. Installing Contractor shall provide an isolation (“ice cube”) relay between the level sensor controller panel and any two-position automatic make-up valve directly powered by it.
  - e. See the life support drawings for additional information on the makeup pumps and automatic makeup valves that shall be controlled by a level sensor controller.

## PART 3 EXECUTION

## 3.1 PIPING INSTALLATIONS

- A. Refer to Division 22 Section “Common Work Results for Life Support” for basic piping installation requirements.
- B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- D. Install piping at a uniform grade of 0.2 percent (1 inch in 40 feet) upward in direction of flow.
- E. Reduce pipe sizes using eccentric reducer fitting installed with straight side up.
- F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- G. Anchor piping for proper direction of expansion and contraction.
- H. Install automatic control valves, separable wells and taps, furnished or required by this or other contractors. Installation shall be in accordance with valve manufacturer/supplier.

- I. For Underground Piping: See Civil Specification Section 31 for excavation, bedding and backfill requirements. Install exhibit water piping in accordance with manufacturer requirements and per AWWA C605. Provide concrete thrust blocks at all tees, elbows and reducers, as recommended by the piping manufacturer.

### 3.2 HANGERS AND SUPPORTS

- A. Piping shall be supported by stainless steel, fiberglass, or plastic pipe hangers rated for use with Schedule 80 PVC piping.
- B. Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

### 3.3 PIPE JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Common Work Results for Life Supports" for joint construction requirements for stainless steel tubing and solvent-welded joints for PVC and FRP piping.

### 3.4 CONCRETE BASES

- A. Concrete equipment bases are being shown on the Architectural drawings. Coordinate the final dimensions and locations of the bases with the General Contractor.

### 3.5 EQUIPMENT INSTALLATION

- A. Installation of Equipment: Comply with ASME B19.1 or ASME B19.3 as appropriate.
- B. Anchor premanufactured equipment skids to concrete substrate according to the manufacturer's written instructions.
- C. Install accessories and specialties as indicated. Set and connect units according to manufacturers' written instructions. Install units plumb, level and firmly anchored in locations indicated. Maintain manufacturers' recommended clearances. Orient so controls needing service are accessible.

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the final connection and start-up of the following life support equipment:
  1. Ozone generation system, including air preparation skids, ozone generator skids, ozone splitter panels and control valves, and ozone contact skids.
  2. Commercial water softening systems.
  3. Pumps that are controlled by variable frequency drives.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. The Life Support Contractor shall receive all manufactured equipment and install per manufacturers' recommendations, with proper clearances for Owner maintenance.
- D. All pipe fittings and valves shall be cleaned prior to being placed in position and protected against damage and dirt. Hangers shall be placed to prevent pipe stresses on equipment. Torque wrench shall be used to prevent excessive torque on all equipment.
- E. All piping systems shall be vented, flushed, and hydrostatically tested per the requirements of AWWA C605 and AWWA M23. All testing shall be carried out in the presence of the Owner's Representative.
- F. The Life Support Contractor shall document any and all piping that fails or is damaged during construction and submit a report to the General Contractor, the Architect, and the Life Support Designer stating the cause and extent of the damage and the proposed method of repair. All repairs shall be made with the materials specified for new construction. Material substitutions must be reviewed by the Life Support Designer. Any debris, such as rock, dirt, and/or pipe/fitting fragments, that enter the piping through holes or fractures must be removed prior to the start-up of the life support systems.
- G. The Life Support Contractor shall remove all dirt and construction debris from the pools prior to start-up of the life support systems serving them. This cleaning shall be done in the presence of the Owner's representative.
- H. The Life Support Contractor shall balance all water flows with the assistance of the Owner.
- I. All equipment, when being started, shall be in the presence of the Owner's representative. The Life Support Contractor shall provide adequate instruction on the proper operation and maintenance of all life support equipment.
- J. At completion of project, the Life Support Contractor shall tag all valves per the Owner's preferred naming convention and submit a valve schedule and plan to the Owner.

## 3.7 PUMP INSTALLATION

- A. Install pumps according to manufacturer's written instructions.
- B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so piping is not supported by pumps.
- D. Provide 4 inch thick reinforced concrete pad with chamfered edges, 4 inches larger than pump on all sides.
- E. Provide a calibrated pump curve for each pump.

## 3.8 CONNECTIONS

- A. Piping installation requirements are specified in Sections 22 53 00 and 22 53 50. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install isolation valves on the suction side of each pump.
- F. Install non-slam check and balance valves on discharge side of each pump.
- G. Make piping connections to dissimilar-metal water piping with dielectric fittings. Refer to Division 22 Section "Common Work Results for Life Support" for dielectric fittings.

### 3.9 ELECTRICAL CONNECTIONS

- A. Install electrical connections for power, controls, and devices. Electrical power wiring, devices, and connections are specified in Division 26 Sections.
- B. Ground equipment.
  - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

END OF SECTION 225300

## SECTION 225350 - COMMON WORK RESULTS FOR LIFE SUPPORT

## PART 1 GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. This Section includes the following basic mechanical materials and methods to complement other Division 22 Sections.
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Transition fittings.
  - 3. Grout.
  - 4. Mechanical sleeve seals.
  - 5. Nonshrink grout for equipment installations.
  - 6. Sealants.
  - 7. Electrical wire.
  - 8. Delivery and storage of materials.
  - 9. Cooperation with other contractors.
  - 10. Coordination of work.
  - 11. Incidental work.
  - 12. Electrical wiring.
  - 13. Laying out of work.
  - 14. Data and measurements.
  - 15. Position of outlets.
  - 16. Protection of apparatus.
  - 17. Access to equipment.
  - 18. Examination of premises.
  - 19. Firestopping penetrations.
  - 20. Sealing of exterior openings.
  - 21. Piping systems – common requirements.
  - 22. Concrete base construction requirements.
  - 23. Erection of metal supports and anchorage.
  - 24. Installation requirements common to equipment specification sections.
  - 25. Adjusting.
  - 26. Lubrication.
  - 27. Incidental work.
  - 28. Test reports.

### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
  - 2. CPVC: Chlorinated polyvinyl chloride plastic.
  - 3. NP: Nylon plastic.
  - 4. PE: Polyethylene plastic.
  - 5. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
  - 1. CR: Chlorosulfonated polyethylene synthetic rubber.
  - 2. EPDM: Ethylene propylene diene terpolymer rubber.
- H. The following are industry abbreviations for Contractors:
  - 1. GC: General contractor.
  - 2. MC: Mechanical contractor.
  - 3. EC: Electrical contractor.
  - 4. PCC: Project control contractor.
  - 5. LSC: Life support contractor.

### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Transition fittings.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
- B. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.



- C. As-built Coordination Drawings: Contractor shall maintain in field a marked up set of coordination drawings that accurately show all change in field that occurred. Submit to Architect these marked up as-builts as part of project closeout.

#### 1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, “Structural Welding Code—Steel”.
- B. Electrical Characteristics for Life Support Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

#### 1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Mechanical Sleeve Seals:
    - a. Thunderline/Link-Seal.
  - 2. Sealants:
    - a. Dow Corning
    - b. Pecora

- c. Sonneborn
  - d. Tremco
3. Firestopping Materials:
- a. Dow Corning
  - b. Metacaulk
  - c. Specified Technologies, Inc.
  - d. 3M Fire Protection Products
  - e. Tremco Sealants & Coatings
- 2.2 PIPE AND PIPE FITTINGS
- A. Refer to individual Division 22 piping Sections subsections 22 53 00 for pipe and fitting materials and joining methods.
  - B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- 2.3 JOINING MATERIALS
- A. Flange Bolts and Nuts: 316 stainless steel, unless otherwise indicated.
  - B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
  - C. Solvent Cements: Manufacturer's standard solvent cements for the following:
    - 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - D. Plastic Pipe Seals: ASTM F 477, elastomeric gasket.
- 2.4 TRANSITION FITTINGS
- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
    - 1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
    - 2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
    - 3. Aboveground Pressure Piping: Pipe fitting.
- 2.5 MECHANICAL SLEEVE SEALS (LINK-SEAL)
- A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve.
    - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
    - 2. Pressure Plates: Glass reinforced nylon polymer.

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3. Connecting Bolts and Nuts: 316 stainless steel of length required to secure pressure plates to sealing elements.
4. Mechanical sleeve seals shall be PSI-Thunderline/Link-Seal Model LS-316 or approved in writing equal.
5. Where pipes must pass through cast concrete walls and floors of new structures, install non-metallic high density polyethylene PSI-Thunderline/Link-Seal Model CS Century-Line sleeves with integrally formed water stops and end caps to facilitate attaching the sleeve to the wall or floor form.
  - a. Note: Link-Seal modular seals installed in Century-Line sleeves is the preferred method of penetrating watertight walls at pools, skimmer boxes, drain boxes, and other structures.
6. Where pipes must pass through cored holes in concrete walls or floors, refer to the mechanical sleeve seal manufacturer's recommended installation procedures to ensure a watertight seal.

## 2.6 GROUT

- A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
  1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  2. Design Mix: 5000-psi, 28-day compressive strength.
  3. Packaging: Premixed and factory packaged.

## 2.7 SEALANTS

- A. Polyurethane Sealant: Single component, chemical curing, non-staining, non-bleeding, capable of continuous water immersion, non-sagging type for application in vertical joints and in horizontal joints, color as selected; manufactured by Pecora, Tremco, Sonneborn, or approved equal.
- B. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- C. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- D. Joint Backing: ANSI/ASTM D1056; round, closed cell, polyethylene foam rod; oversized 30% to 50% larger than joint width; manufactured by Sonneborn or approved equal.
- E. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.
- F. Firestopping Materials: Subject to compliance with the requirements of Sections 1-14, provide one of the following:
  1. SpecSeal 100 Fire Stop Sealant – Specified Technologies, Inc.
  2. CP-25 WB+ Fire Stop Sealant – 3M Fire Protection Products
  3. Tremstop Fyre-Sil Sealant – Tremco Sealants & Coatings

4. Metacaulk
5. Dow Corning

## 2.8 ELECTRICAL WIRE

- A. All wiring materials covered by this section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable. All wiring running exposed in return air plenums shall be plenum-rated cable for fire and smoke spread.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Fabrication, erection and installation of the complete life support system shall be done by qualified personnel experienced in such work and shall proceed in an orderly manner so as not to hold up the progress of the project. The Life Support Contractor shall check all areas and surfaces where life support equipment or materials are to be installed and report any unsatisfactory conditions before starting work. Commencement of work signifies the Contractor's acceptance of the conditions as fit and proper for the execution of the mechanical work.
- B. Equipment and systems shall be installed in accordance with manufacturer's instructions, requirements or recommendations.

### 3.2 DELIVERY AND STORAGE OF MATERIALS

- A. Each Contractor shall make provisions for the delivery and safe storage of materials and shall make the required arrangements with other Contractors for the introduction into the building of equipment too large to pass through finished openings. Materials shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected. All openings of piping, conduits, and equipment shall be kept covered and sealed to prevent dust and dirt from entering.
- B. The Contractor shall be responsible for adequately protecting all supplies and equipment during cold weather. All items subject to cold weather damage shall be protected by covering, insulating or storing in a heated space.

### 3.3 COOPERATION WITH OTHER CONTRACTORS

- A. Perform the mechanical work in conformance with the construction called for by other trades and afford other contractors reasonable opportunity for the execution of their work. Properly connect and coordinate the life support work with the work of other contractors at such time and in such a manner as not to delay or interfere with their work.
- B. Examine the contract documents for the General, Life Support, Mechanical and Electrical work and the work of other trades. Coordinate life support work accordingly.

- C. Promptly report to the Architect/Engineer any delay or difficulties encountered in the installation of the life support work which might prevent prompt and proper installation of work required from other trades.

### 3.4 COORDINATION OF WORK

- A. The Life Support Contractor shall plan all work so it proceeds with a minimum of interference with other trades. It shall also be the responsibility of the Life Support Contractor to inform the General Contractor of all openings required in the building construction for the installation of the life support work. The Life Support Contractor shall cooperate with all other contractors in furnishing material and information, in proper sequence, for the correct location of all sleeves, inserts, foundations, wiring, etc. Provisions shall be made for all special frames, openings and sleeves as required.
- B. The Life Support Contractor shall pay for extra cutting and patching made necessary by his failure to properly direct such work at the correct time.

### 3.5 ELECTRICAL WIRING

- A. All wiring and conduit shall be run parallel to, or at right angles to, the building structure and shall be concealed in finished spaces.
- B. All electric wiring shall be done in accordance with the National Electrical code. All line voltage and low voltage wire shall be installed in non-metallic flexible conduit or electrical tubing. Flexible conduit shall not exceed 6 feet in length. Conduit may be run exposed in mechanical rooms or in areas where other piping is exposed.
- C. Low voltage wiring in equipment rooms or concealed in walls shall be in one of the non-metallic raceways mentioned above. Final connection shall be made with exposed wiring which shall be protected by a suitable protective grommet and the end of the non-metallic container shall be securely fastened. Jacketed harnesses may be used where a number of wires are run together.

### 3.6 LAYING OUT WORK

- A. The Contractor shall carefully lay out all work in advance of installation using data and measurements from the site, the appropriate architectural and structural drawings, and shop drawings. Equipment layout and all system layouts shall confirm adequate clearances for installation, operation, maintenance and code required clearances from the structure or other equipment and systems. The layout shall not cause problems of operation, maintenance or clearance for items installed by other contractors.
- B. Prior to installation of any work, make certain the location does not conflict with other items in or near the same location. If the layouts so prepared indicate that the required conditions cannot be met in the space provided, the Contractor shall so inform the Architect/Engineer prior to installation and shall request clarification.
- C. Failure to properly coordinate and lay out the work will require correction by the Contractors at their own expense.

### 3.7 DATA AND MEASUREMENTS

- A. The data given herein and on the drawings is as accurate as could be secured; absolute accuracy is not guaranteed. The Contractors shall obtain exact locations, measurements, levels, etc., at the site and shall adapt their work to actual conditions. The Contractor shall examine the General Construction, Life Support, Mechanical, Electrical, and other applicable drawings and the Specifications. Plans and specifications are available for examination at the office of the Architect/Engineer. Only Architectural drawings, Structural drawings, and site measurements may be utilized in calculations. Mechanical, Electrical, and Life Support drawings are diagrammatic or schematic.

### 3.8 PROTECTION OF APPARATUS

- A. Take such precautions as necessary to properly protect all apparatus, fixtures, appliances, material, equipment and installations from damage of any kind. Failure to provide such protection to the satisfaction of the Architect/Engineer shall be sufficient cause for the rejection of any particular piece(s) of material, apparatus, equipment, etc., concerned.

### 3.9 ACCESS TO EQUIPMENT

- A. All motors, valves, control devices, specialties, etc., shall be located to provide for easy access for operation, repair and maintenance; if concealed, access doors shall be provided.
- B. Access doors (AD) required for access to equipment requiring inspection or service shall be provided. This Contractor shall provide all access doors not already furnished by other contractors but which are required for access to mechanical equipment. Doors shall be 12 inches by 12 inches unless shown otherwise. Person access doors shall be 18 inches by 18 inches minimum.

### 3.10 EXAMINATION OF PREMISES

- A. The Contractor shall examine the premises and all conditions thereon and/or therein. The bid proposal shall take into consideration all such conditions which may affect the work under this contract.

### 3.11 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL / FLOOR ASSEMBLIES

- A. Contractors shall provide proper sizing when providing sleeves or core-drilled holes to accommodate their work through penetrating items. All voids between sleeve or core-drilled hole and pipe passing through shall be firestopped to meet the requirements of ASTM E814. Install all materials complete, attached securely and permanently in place in accordance with manufacturers' printed directions.

### 3.12 SEALING OF EXTERIOR OPENINGS

- A. Openings around pipes, conduits, etc., in exterior walls above grade shall be sealed with polyurethane sealant. Sleeves shall be installed at time concrete walls or slabs are built with a minimum of ¼-inch clearance to be packed and sealed.

## B. Preparation:

1. Clean and prepare joints in accordance with manufacturer's instructions.
2. Remove loose materials and foreign matter which might impair adhesion of sealant.
3. Verify that joint backing and release tapes are compatible with sealant.
4. Perform preparation in accordance with ASTM C804 for solvent release sealants.
5. Protect elements surrounding the work of this Section from damage or disfiguration.

## C. Installation:

1. Perform installation in accordance with ASTM C804 for solvent release sealants.
2. Install sealant in accordance with manufacturer's instructions.
3. Measure joint dimensions and size materials to achieve required width/depth ratios.
4. Install joint backing to achieve a neck dimension no greater than 1/3 the joint width.
5. Install bond breaker where joint backing is not used.
6. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
7. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
8. Tool joints concave.

## 3.13 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual subsections of Specification Section 22 53 00 specify unique piping installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.
- C. Install piping at indicated slope, generally one inch in forty feet.
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- F. Locate groups of pipes parallel to each other, spaced to permit insulation and valve servicing.
- G. Install fittings for changes in direction and branch connections.
- H. Keep all pipe and equipment openings closed during construction except when actual work is being performed on that item or system.
- I. Install piping free of sags or bends with ample space between piping to permit proper insulation applications.
- J. Install piping tight to slabs, beams, joists, columns, walls and other permanent elements of the building unless otherwise indicated. Provide space to permit insulation applications with 1 inch clearance outside the insulation. Allow sufficient space above ceiling panels to allow for ceiling panel removal.

- K. Install piping to allow for expansion and contraction without stressing pipe, adjacent building structure or connecting equipment. Install expansion loops or compensators where indicated.
- L. During construction, avoid any undue loads, forces or strains on valves, equipment, pumps flanges, or building elements with piping connections or piping systems.
- M. Drill and deburr all openings which are made after erection of the piping system.
- N. Joints for other piping systems are specified within the respective piping system specifications.
- O. Pipe hangers for insulated pipe with vapor barrier jackets shall be installed around the outside of the insulation and a metal insulation support shield provided to prevent crushing of the insulation.
- P. Install couplings according to manufacturer's written instructions.
- Q. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2. Build PVC sleeves into new walls and slabs as work progresses.
  - 3. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
  - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants.
  - 5. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
  - 6. Sleeves should not support piping.
- R. Aboveground, Exterior-Wall, Pipe Penetrations (not watertight pool walls): Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve according to the mechanical sleeve seal manufacturer's recommendations for the specific pipe size.
  - 1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- S. Underground, Exterior-Wall, Pipe Penetrations (not watertight pool walls): Install PVC "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve according to the mechanical sleeve seal manufacturer's recommendations for the specific pipe size.
  - 1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.



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- T. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Install in accordance with manufacturer's written instructions.
- U. Verify final equipment locations for roughing-in.
- V. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- W. Provide isolation valves on both sides of pumps, coils, control valves, and similar equipment to allow repairs without drain down of entire system.
- X. Provide isolation valves on all branch piping within 3 feet of the main.
- Y. Sensors and other instrumentation shall not be installed higher than 7'-0" above finished floor, so as to be accessible and/or readable.

## 3.14 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
  - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  - 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
  - 3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    - b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
    - c. Align threads at point of assembly.
    - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
    - e. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
  - 4. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- B. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
- C. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.

## 3.15 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping 2-inch NPS and smaller, adjacent to each control valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
  - 2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.

## 3.16 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect/Engineer.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install life support equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.
- G. Bare, scratched or marred areas on equipment shall be cleaned and touched up with the same paint as applied at the factory or approved substitute.

## 3.17 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions at project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7. Use 3000-psi, 28-day compressive-strength concrete.

8. Pads poured on reinforced concrete slabs shall have 6 x 6 x 10/10 welded wire fabric and shall be doweled to the slab. Self-supporting isolating pads shall have #4 reinforcing bars at 12 inches center to center each way and shall have an expansion joint around the perimeter of the adjoining slab.
9. Install concrete inertia bases under base mounted pumps that are structurally supported above the ground. See drawings for detail, and fabricate/install per, Mason Industries recommendations.

### 3.18 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."
- C. Metal supports and/or anchorage, except stainless steel or aluminum, shall be primed and then painted with at least two coats of epoxy paint.

### 3.19 GROUTING

- A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's written instructions.

### 3.20 LUBRICATION

- A. Contractor shall run in all bearings and, after they are run in, shall drain and flush bearings and refill with a new oil charge. Equipment shall be so arranged that tools (screwdrivers, wrenches, etc.) will not be required to make lubrication points accessible. Extensions on grease or oil fittings shall be provided where required for access to lubricate and shall be vertical and upright. Contractor shall lubricate all equipment immediately prior to acceptance by Owner.

## 3.21 TEST REPORTS

- A. Upon completion of the work, the entire system shall be tested and proven for capacity of equipment, balance of system, proper operation of controls, and comfort of conditioned spaces. Contractor shall take water flow readings and submit copy of same to demonstrate proper flow according to the performances shown on the plans and noted in the specifications. All motors shall be checked for overload. Lubricate all moving parts and clean or replace filters.
- B. Submit three (3) copies of all tests to the Architect/Engineer for review prior to date of substantial completion.
- C. All equipment and systems discrepancies shall be corrected prior to final acceptance.

END OF SECTION 225150

## SECTION 23 05 00 - BASIC HVAC REQUIREMENTS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 23 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced in the specification section.

## 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make his portion of the Mechanical Work a finished and working system.

## 1.3 ALTERNATES

- A. Alternate Bid 6: Add alternate for constructing Bear Den at corner.

## 1.4 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL &amp; CONTROL CONTRACTORS

- A. Definitions:
  - 1. "Mechanical Contractors" refers to the following:
    - a. Plumbing Contractor.
    - b. Air Conditioning and Ventilating Contractor.
    - c. Fire Protection Contractor.
    - d. Testing, Adjusting, and Balancing Contractor.
  - 2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
  - 3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
  - 4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.

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5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
  - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.

## B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
  - a. Light fixtures.
  - b. Gravity flow piping, including steam and condensate.
  - c. Electrical busduct.
  - d. Sheet metal.
  - e. Electrical cable trays, including access space.
  - f. Sprinkler piping and other piping.
  - g. Electrical conduits and wireway.

## C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
  - a. Computer Room Air Conditioning Units.

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- b. Condensing Units.
    - c. Make-Up Air Units.
    - d. Packaged Rooftop Units.
  2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
  3. Temperature Control Subcontractor's Responsibility:
    - a. Wiring of all devices needed to make the Temperature Control System functional.
    - b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
    - c. Coordinating equipment locations (such as P.E.'s, E.P.'s, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
  4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.
- D. Electrical Contractor's Responsibility:
  1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
  2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
  3. Provides motor control and temperature control wiring, where so noted on the drawings.
  4. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
  5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.5 QUALITY ASSURANCE

- A. Contractor's Responsibility Prior to Submitting Pricing Data:
  1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Madison, Wisconsin Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.



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2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
  3. Pay all charges for permits or licenses.
  4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
  5. Pay all charges arising out of required inspections by an authorized body.
  6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
  7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.
- E. Examination of Drawings:
1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
  2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
  3. Scaling of the drawings is not sufficient or accurate for determining these locations.
  4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
  5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
  6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
  7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
  8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
    - a. Any item listed as furnished shall also be installed, unless otherwise noted.

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- b. Any item listed as installed shall also be furnished, unless otherwise noted.

## F. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

## G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit MEP.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

## 1.6 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

<u>Referenced Specification Section</u>	<u>Submittal Item</u>
23 05 93	Testing, Adjusting, and Balancing
23 34 23	Power Ventilators
23 37 00	Grilles, Registers, and Diffusers
23 74 11	Rooftop Air Conditioning Units
23 74 23.13	Gas Fired Make-Up Air Units
23 82 00	Terminal Heat Transfer Equipment

**Referenced Specification Section**

23 83 00

**Submittal Item**

Radiant Floor Heating Systems

- B. In addition to the provisions of Division 1, the following provisions are required:
1. Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
  2. The Contractor shall submit one electronic copy of each shop drawing for review by the Architect/Engineer BEFORE releasing any equipment for manufacture or shipment.
  3. Shop drawings which are larger than 11"x 17" or are plan size layout or erection drawings such as ductwork layout drawings shall be submitted on reproducible media. Submit one reproducible and one print of each drawing or plan. All Contractor approval stamps shall be made on the reproducible.
  4. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. CONTRACTOR'S APPROVAL STAMP IS REQUIRED ON ALL SUBMITTALS. APPROVAL WILL INDICATE THE CONTRACTOR'S REVIEW of all material and a COMPLETE UNDERSTANDING OF EXACTLY WHAT IS TO BE FURNISHED. Contractor shall clearly mark all deviations from the contract documents on all submittals. IF DEVIATIONS ARE NOT MARKED BY THE CONTRACTOR, THEN THE ITEM SHALL BE REQUIRED TO MEET ALL DRAWING AND SPECIFICATION REQUIREMENTS.
  5. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  6. The Contractor shall clearly indicate the size, finish, material, etc.
  7. Assemble and submit by specification section numbers for all submittals. All sets shall be identical and contain an index of the items enclosed with a general topic description on the cover.
  8. Each set shall be bound in a manufacturer's folder or inside of a manila file folder.
  9. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is relevant to the work.
  10. Failure to comply with the above shall be reason to resubmit all shop drawing submittals.
  11. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be

responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

#### 1.7 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
  - 1. Condensing Units
  - 2. Gas Fired Make-Up Air Units
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

#### 1.8 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

#### 1.9 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

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- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

## 1.10 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

## 1.11 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

## PART 2 - PRODUCTS

NOT APPLICABLE

## PART 3 - EXECUTION

## 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employee and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety

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precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

## 3.2 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:
  - 1. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
  - 1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    - a. Duct wall penetrations are sealed.
    - b. Main, branch and flexible ducts are installed.
    - c. Diffusers, registers and grilles are installed and connected to ductwork.
  - 2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  - 3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

## 3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  - 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
  - 2. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, This Contractor must submit the following:
  - 1. Operation and maintenance manuals with copies of approved shop drawings.

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2. Record documents including marked-up or reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

## 3.4 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Submit three properly indexed and bound copies, in 'D' Ring style notebooks, of the Operations and Maintenance Instructions to the Architect/Engineer. Make all corrections or additions required.
- B. Manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.
- C. Operation and maintenance data shall consist of written instructions for the care, maintenance, and operation of all equipment and systems. Include all instruction books, cards, and manuals furnished with the equipment.
- D. Operation and Maintenance Instructions shall include:
  1. Notebooks shall be heavy duty locking three ring binders and incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. Provide "Wilson-Jones" or equal, color black. Size notebooks a minimum of 1/2" thicker than material for future inserts. Label the spine and front cover of each notebook. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other forms of binding will be acceptable.
  2. Prepare binder covers (front and spine) with printed title "Operation and Maintenance Instructions", Title of project and subject matter of binder when multiple binders are required.
  3. Title page with project title, Architect, Engineer, Contractor, and Subcontractors with addresses, telephone numbers, and contacts.
  4. Table of Contents describing all index tabs.
  5. Listing of all Subcontractors and major equipment suppliers with addresses, telephone numbers, and contacts.
  6. Index tabs dividing information by specification section, major equipment, or systems. All tab titling shall be clearly printed under reinforced plastic tabs. All

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

equipment shall be labeled to match the identification in the construction documents.

7. Copies of warranties.
8. Copies of all final approved shop drawings and submittals. Include Architect/Engineer's shop drawing review comments.

## 3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The instructions shall include:
  1. Explanation of all air handling systems.
  2. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
  3. Maintenance of equipment.
  4. Start-up procedures for all major equipment.
  5. Explanation of seasonal system changes.
- D. The Architect/Engineer shall be notified of the time and place instructions will be given to the Owner's representatives so he or his representative can attend if desired.
- E. Minimum hours of instruction for each item shall be:
  1. Air Handling System(s) - 8 hours.
  2. Exhaust System(s) - 1 hour.
  3. Controls - 4 hours.
- F. Operating Instructions:
  1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
  2. If the Contractor does not have staff that can adequately provide the required instructions he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

## 3.6 SYSTEM COMMISSIONING

- A. The mechanical systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B. Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels. Areas with mechanical cooling shall be maintained below 60% RH.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

## 3.7 RECORD DOCUMENTS

- A. The following paragraph supplements Division 1 requirements:

Contractor shall maintain at the job site a separate and complete set of mechanical drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the mechanical systems.
- B. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- C. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

## 3.8 PAINTING

- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has

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been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor.

- C. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer his color preference and furnish this color.
- E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- F. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
  - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
  - 2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.

## 3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

## 3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

END OF SECTION 23 05 00

## SECTION 23 05 29 - HVAC SUPPORTS AND ANCHORS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Equipment Bases and Supports.
- B. Sleeves and Seals.
- C. Cutting of Openings.
- D. Escutcheon Plates and Trim.

## 1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

## PART 2 - PRODUCTS

## 2.1 FOUNDATIONS, BASES, AND SUPPORTS

## A. Basic Requirements:

- 1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
- 2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

## B. Equipment Roof Support (Curbs and Rails):

- 1. Rooftop equipment such as packaged air handling units, roof hoods and rooftop exhaust fans shall be provided with curbs by the unit manufacturer.
- 2. Where not furnished with rooftop equipment, provide prefabricated curbs or rails as follows:
  - a. 12" high above the top surface of the roof (not the roof structure).
  - b. 14 or 18 gauge galvanized sheet metal, as required for the equipment weight.
  - c. Internal reinforcing.
  - d. Pressure treated wood nailer.
  - e. 18 gauge counter flashing completely covering nailer.
  - f. Factory insulated with rigid fiberglass.
- 3. Match units to the building roof with either a raised cant to match roof insulation (for built-up roofs), or with no cant (for single-ply roofs).
- 4. Where legs of equipment rest on rails, provide 1/4" bent plates 18" long.

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5. Acceptable Manufacturers: Thy, Pate, United, Roof Products Systems or Portals Plus.
6. Equipment requiring curbs or rails is as follows:
  - a. Condensing Units

## 2.2 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at his expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

## 2.3 SLEEVES AND LINTELS

- A. Each Contractor shall provide sleeves and lintels for all duct openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- E. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

## 2.4 ESCUTCHEON PLATES AND TRIM

- A. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

## 2.5 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

## PART 3 - EXECUTION

## 3.1 HVAC SUPPORTS AND ANCHORS

- A. General Installation Requirements:
  - 1. Install all items per manufacturer's instructions.
- B. Supports Requirements:
  - 1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
  - 2. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
  - 3. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
- C. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- D. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

END OF SECTION 23 05 29



## SECTION 23 05 53 - HVAC IDENTIFICATION

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Identification of products installed under Division 23.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. 3M, Bunting, Calpico, Craftmark, Emedco, Kolbi Industries, Seton, W.H. Brady, Marking Services.

## 2.2 MATERIALS

- A. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- B. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Equipment:
  - 1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
  - 2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
  - 3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of Standard 90.1.

END OF SECTION 23 05 53





## SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Testing, adjusting, and balancing of air systems.

## 1.2 QUALITY ASSURANCE

- A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years' experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.
- B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

## 1.3 REFERENCES

- A. AABC - National Standards for Total System Balance, 2002.
- B. ADC – Test Code for Grilles, Registers, and Diffusers.
- C. AMCA – Publication 203-90; Field Performance Measurement of Fan Systems.
- D. ASHRAE - 2003 HVAC Applications Handbook; Chapter 37, Testing, Adjusting and Balancing.
- E. ASHRAE/ANSI - Standard 111-1988; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.
- F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Sixth Edition, 1998.
- G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing, Third Edition, 2002.
- H. TABB – International Standards for Environmental Systems Balance.

## 1.4 SUBMITTALS

- A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.
- B. Submit four (4) certified copies of test reports to the Architect/Engineer for approval in soft cover, 3-hole binder manuals, with cover identification. Include index page and indexing tabs.

## 1.5 REPORT FORMS

- A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.

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- B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.
- C. Refer to PART 4 for required reports.

## 1.6 WARRANTY/GUARANTEE

- A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 man-hours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

## 1.7 SCHEDULING

- A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the Architect/Engineer prior to performing each test.

## PART 2 - PRODUCTS

NOT APPLICABLE

## PART 3 - EXECUTION

## 3.1 GENERAL REQUIREMENTS

- A. All procedures must conform to a published standard listed in Paragraph 1.2. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in Paragraph 1.2.
- B. Recorded data shall represent actual measured or observed conditions.
- C. Cut insulation, ducts, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.
- D. Permanently mark setting of dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- F. Installations with systems consisting of multiple components shall be balanced with all system components operating.

## 3.2 EXAMINATION

- A. Before beginning work, verify that systems are complete and operable. Ensure the following:
  - 1. General Equipment Requirements:
    - a. Equipment is safe to operate and in normal condition.
    - b. Equipment with moving parts is properly lubricated.
    - c. Temperature control systems are complete and operable.
    - d. Proper thermal overload protection is in place for electrical equipment.
    - e. Direction of rotation of all fans and pumps is correct.
    - f. Access doors are closed and end caps are in place.
  - 2. Duct System Requirements:
    - a. All filters are clean and in place. If required, install temporary media.
    - b. Duct systems are clean and free of debris.
    - c. Manual volume dampers are in place, functional and open.
    - d. Air outlets are installed and connected.
    - e. Duct system leakage has been minimized.
- B. Report any defects or deficiencies to Architect/Engineer.
- C. Promptly report items that are abnormal or prevent proper balancing.
- D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- E. Beginning of work means acceptance of existing conditions.

## 3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Architect/Engineer for spot checks during testing.
- B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

## 3.4 INSTALLATION TOLERANCES

- A.  $\pm 10\%$  of scheduled values:
  - 1. Adjust air inlets and outlets to  $\pm 10\%$  of scheduled values.
- B. Adjust supply, return, and exhaust air-handling systems to  $+10\%$  /  $-5\%$  of scheduled values.

## 3.5 ADJUSTING

- A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Once balancing of systems is complete, at least one damper must be 100% open.
- C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.
- D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.

## 3.6 SUBMISSION OF REPORTS

- A. Fill in test results on appropriate forms.

## PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

## 4.1 GENERAL REQUIREMENTS

- A. Title Page:
  - 1. Project name.
  - 2. Project location.
  - 3. Project Architect.
  - 4. Project Engineer (KJWW Engineering Consultants).
  - 5. Project General Contractor.
  - 6. TAB Company name, address, phone number.
  - 7. TAB Supervisor's name and certification number.
  - 8. TAB Supervisor's signature and date.
  - 9. Report date.
- B. Report Index
- C. General Information:
  - 1. Test conditions.
  - 2. Nomenclature used throughout report.
  - 3. Notable system characteristics/discrepancies from design.
  - 4. Test standards followed.
  - 5. Any deficiencies noted.
  - 6. Quality assurance statement.
- D. Instrument List:
  - 1. Instrument.
  - 2. Manufacturer, model, and serial number.
  - 3. Range.
  - 4. Calibration date.

## 4.2 AIR SYSTEMS

- A. Air Moving Equipment:
  - 1. General Requirements:
    - a. Drawing symbol.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- b. Location.
  - c. Manufacturer, model, arrangement, class, discharge.
  - d. Fan RPM.
  - e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
  - f. Final frequency of motor at maximum flow rate (on fans driven by VFD).
2. Flow Rate:
    - a. Supply flow rate (cfm): specified and actual.
    - b. Return flow rate (cfm): specified and actual.
    - c. Outside flow rate (cfm): specified and actual.
    - d. Exhaust flow rate (cfm): specified and actual.
  3. Pressure Drop and Pressure:
    - a. Filter pressure drop: specified and actual.
    - b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
    - c. Inlet pressure.
    - d. Discharge pressure.
- B. Fan Data:
1. Drawing symbol.
  2. Location.
  3. Manufacturer and model.
  4. Flow rate (cfm): specified and actual.
  5. Total static pressure: specified and actual. (Indicate measurement locations).
  6. Inlet pressure.
  7. Discharge pressure.
  8. Fan RPM.
- C. Electric Motors:
1. Drawing symbol of equipment served.
  2. Manufacturer, Model, Frame.
  3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
  4. Measured: Amps in each phase.
- D. Air Terminal (Inlet or Outlet):
1. Drawing symbol.
  2. Room number/location.
  3. Terminal type and size.
  4. Velocity: specified and actual.
  5. Flow rate (cfm): specified and actual.
  6. Percent of design flow rate.

END OF SECTION 23 05 93



## SECTION 23 07 13 - DUCTWORK INSULATION

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Ductwork Insulation.
- B. Insulation Jackets.

## 1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in ductwork insulation application with five years minimum experience. When requested, installer shall submit manufacturer's certificate indicating qualifications.
- B. Materials: UL listed in Category HNKT; flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723.
- C. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 maximum 'K' value at 75°F; foil scrim kraft facing, 1.0 lb./cu. ft. density.
- B. Type F: Flexible High Temperature Wrap; ASTM E2336 rating as 2-hour separation with zero clearance to combustible materials over the full length. Material to be totally scrim encapsulated. Material to be a minimum 1-1/2" thick with a minimum core density of 6 pcf. Wrap system should offer zero clearance to combustibles per ASTM E2336 at all locations, comply with all applicable codes, and be approved by AHJ. If system is not rated for zero clearance per ASTM E2336 at all locations with single layer, a two layer system shall be provided with zero clearance per ASTM E2336 at all locations. Material must be tested and listed for installation on grease ducts and installed per listed design. Refer to Section 23 33 00 for prefabricated, pre-insulated access doors required for grease duct systems.

## 2.2 JACKETS

- A. Vapor Barrier Jackets: Kraft reinforced foil scrim vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 25 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Install materials after ductwork has been tested.
- C. Clean surfaces for adhesives.
- D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.
- E. Exterior Duct Wrap - Flexible, Type A:
  - 1. Apply with edges tightly butted.
  - 2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.
  - 3. Seal joints with adhesive backed tape.
  - 4. Apply so insulation conforms uniformly and firmly to duct.
  - 5. Provide high-density insulation inserts at trapeze duct hangers and straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
  - 6. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Architect/Engineer.
  - 7. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.
  - 8. Staples may be used, but must be covered with tape.
  - 9. Vapor barrier must be continuous.
  - 10. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.
- F. Exterior Fire Protection, Flexible Type - Type F:
  - 1. Cut and secure duct wrap around ductwork, support angles, and hangers per manufacturer's recommendations.
  - 2. Seal all joints as required to maintain enclosure rating.
  - 3. Installation shall be rated for 2 hours, unless otherwise noted.
  - 4. Provide manufacturer's recommended assembly to protect all access doors to maintain enclosure rating and to permit easy replacement of insulation.
- G. Continue insulation with vapor barrier through penetrations unless code prohibits.
- H. Provide 2" wide, 24" high, 26 gauge, galvanized sheet metal corner protection angles for all externally insulated ductwork extending to a floor or curb.



## 3.2 SCHEDULE

- A. Refer to Section 23 31 00 for scheduling of insulation.

END OF SECTION 23 07 13



## SECTION 23 31 00 - DUCTWORK

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Galvanized Ductwork
- B. Aluminum Ductwork
- C. Ductwork Reinforcement
- D. Ductwork Sealants
- E. Rectangular Ductwork - Single Wall
- F. Round and Flat Oval Ductwork - Single Wall
- G. Exposed Ductwork (Rectangular, Round, or Oval)
- H. Flexible Duct
- I. Grease Exhaust Duct
- J. Leakage Testing
- K. Ductwork Penetrations

## 1.2 DEFINITIONS

- A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
- B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.

## PART 2 - PRODUCTS

## 2.1 GALVANIZED DUCTWORK

- A. General Requirements:
  - 1. Duct and reinforcement materials shall conform to ASTM A653 and A924.
  - 2. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
  - 3. Ductwork reinforcement shall be of galvanized steel.
  - 4. Ductwork supports shall be of galvanized or painted steel. Slip cable hangers are acceptable. Acceptable manufacturers are Gripple, Ductmate, Duro Dyne, or Architect/Engineer approved.
  - 5. All fasteners shall be galvanized or cadmium plated.

## 2.2 ALUMINUM DUCTWORK

- A. General Requirements:
  - 1. Material: ASTM B209; aluminum sheet, Alloy 3003-H14. Aluminum connectors and bar stock: Alloy 6061-T6. Aluminum or stainless steel fasteners are acceptable.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. All ductwork in Seal building shall be aluminum.
3. All duct gauges and reinforcement shall be as called for in Tables 2-50, 2-51, 2-52, and 3-14 of the SMACNA HVAC Duct Construction Standards.
4. Ductwork reinforcement shall be of aluminum.
5. Ductwork supports shall be of aluminum, painted steel. Slip cable hangers are acceptable. Acceptable manufacturers are Gripple, Ductmate, Duro Dyne, or Architect/Engineer approved.
6. All other requirements are as noted for galvanized rectangular sheet metal duct.

## 2.3 DUCTWORK REINFORCEMENT

## A. General Requirements:

1. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.
  - a. Ducts must be over 18" wide.
  - b. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
  - c. Tie rods must not exceed 1/2" diameter.
  - d. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

## 2.4 DUCTWORK SEALANTS

- A. One part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M. All other mastics shall be marked UL 181A-M.
- B. Pressure sensitive tape used for sealing ductwork shall be minimum 2.5-inch wide, listed and marked UL 181A-P, having minimum 60 oz/inch peel adhesion to steel, and service temperature range from -20°F to +250°F.
- C. Where pressure sensitive tape is called for on drawings and specifications for sealing flexible ductwork, tape shall be minimum 2.5-inch wide, UL 181 B-FX listed, and marked tape having minimum 60 oz/inch peel adhesion to steel and service temperature range from -20°F to +250°F. Acceptable manufacturers include: Venture Tape 1581A, Compac #340, Scotch Foil Tape 3326, Polyken 339.

## 2.5 RECTANGULAR DUCT - SINGLE WALL

## A. General Requirements:

1. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
2. Offsets and transitions shall not exceed the angles in Figure 4-7.

## B. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:

1. All ducts shall be cross-broken or beaded.
2. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:

## a. Type 1:

- 1) **Description:** Single wall type with 22-gauge (0.029") or heavier vanes, 3-1/4" blade spacing, and 4" to 4-1/2" radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.
- 2) **Usage:** Limited to 3,000 fpm and vane lengths 36" and under.

## b. Type 2:

- 1) **Description:** Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.
- 2) **Usage:** No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.

## c. Type 3 (acoustical - where acoustical lagging is located or as noted on drawings):

- 1) **Description:** Same as Type 2, except filled with fiberglass and with slotted or perforated inner curve. Minimum insertion loss of 9 dB at 250 Hz and 6 dB at 1 KHz.
- 2) **Usage:** No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.

## d. Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.

## e. Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.

## f. Omitting every other vane is prohibited.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. **Mitered elbows (with or without turning vanes) may not be substituted for radius elbows.** Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.
4. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45° entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.
5. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.
6. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45° rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.
7. Cushion heads are acceptable only downstream of TAB devices in ducts up to  $\pm 2$ " pressure class, and must be less than 6" in length.
8. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
  - a. Apply sealant to all inside corners. Holes at corners are not acceptable.
  - b. Acceptable Manufacturers: Ductmate Industries - 25/35/45, Nexus, Mez, or WDCI. Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

## 2.6 ROUND AND FLAT OVAL DUCTWORK - SINGLE WALL

- A. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Architect/Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
- B. Snap lock seams are not permitted.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.
- D. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
- E. Duct and fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.
- F. Ductwork shall be suitable for velocities up to 5,000 fpm.
- G. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
- H. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
- I. Ducts with minor axis less than 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
- J. Reinforce flat oval ducts with external angles. Internal tie rods are permitted only as indicated for rectangular ductwork.
- K. Transverse Joint Connections:
  - 1. Crimped joints are not permitted.
  - 2. Ducts and fittings 36" in diameter and smaller shall have slip joint connections. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
  - 3. Ducts and fittings larger than 36" shall have flanged connections.
  - 4. Secure all joints with at least 3 sheet metal screws before sealing.
  - 5. Slide-on flanges as manufactured by Ductmate Industries, Accuflange, or Sheet Metal Connectors are acceptable. Self-sealing duct systems are also acceptable (Lindab, Ward "Keating Coupling").

## 2.7 EXPOSED DUCTWORK (RECTANGULAR, ROUND, AND FLAT OVAL)

- A. The following applies to all ductwork exposed in finished areas in addition to requirements noted above:
  - 1. Provide extra shipping protection. Use Cardboard or other protective means to prevent dents and deformed ends.
  - 2. Provide cardboard or other means of protection during field fabrication. Protect from scratches. Provide stiffeners to retain shape during fabrication.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. Remove all identification stickers and thoroughly clean exterior of all ducts.
  4. Locate fitting seams on least visible side of duct.
  5. Provide exterior finish suitable for field painting without further oil removal.
  6. Provide ramp-type internal joint couplings. Provide bead of sealant around the inside of the duct about 1/2" from the end of the duct. Slide-on flanges as manufactured by Ductmate Industries, Accuflange or Sheet Metal Connectors are acceptable. Self-sealing duct system is also acceptable (Lindab, Ward "Keating Koupling").
  7. The system shall be free of visible dents and scratches when viewed from normal occupancy.
  8. All insulation shall be internal, except at reheat coils.
- B. Alternate manufacturers, including shop fabricated duct, must be reviewed before installation. The following information is required:
1. Metal gauge of duct and fittings.
  2. Fitting type and construction.
  3. Type and size of reinforcement.

## 2.8 FLEXIBLE DUCT

- A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.
- B. Flame Spread/Smoke Developed: Not over 25/50.
- C. Flexible duct shall have corrosion-resistant wire helix, bonded to an inner liner that prevents air from contacting the insulation, covered with 1-1/2", 3/4 pound density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh.
- D. Inner liner shall be airtight and suitable for 6" WC static pressure through 10" diameter and shall be airtight and suitable for 4" WC static pressure 12" through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "U" value shall not exceed 0.23 Btuh/ft<sup>2</sup>/°F. Temperature range of at least 0-180°F. Maximum velocity of 4,000 fpm.
- E. Usage:
1. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.
  2. Connections to air inlets and outlets. Do not exceed 6'-0" in length.
- F. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- G. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.

## 2.9 GREASE EXHAUST DUCT FIELD FABRICATED

- A. Exposed ductwork shall be 16 gauge minimum, Type 304L stainless steel. Concealed ductwork may be 16 gauge black steel.
- B. All joints and fittings shall be continuously welded and liquid-tight.
- C. Exposed ductwork shall have a #3 finish. Concealed ductwork may have a mill finish.
- D. Do not penetrate fire rated partitions, unless protected as required by applicable codes.
- E. Provide pre-fabricated access doors and labels required by NFPA 96 on sides of duct at least 1.5" from bottom. Provide access at each change in direction and at maximum 20-foot intervals in horizontal ducts. Provide access at every floor for vertical ducts.
- F. Where grease ducts are 20" x 20" or larger, install access for personnel to enter duct. Duct supports must be sized to support the duct weight and an additional 800 lbs per NFPA 96.
- G. Install ducts with proper clearance to combustible and limited-combustible materials.
- H. Grease ducts installed with volume dampers shall conform to the damper specified in ductwork accessories.
- I. Refer to Section 23 07 13 for duct insulation material and insulated access door when required to provide proper enclosure of ductwork.

## 2.10 GREASE EXHAUST DUCT (RECTANGULAR)

- A. Ductwork system shall be labeled and listed to ASTM E2336.
- B. Ductwork shall be constructed from 20 gauge galvanized steel (G-60 or G-90) and stiffened according to manufacturer's design standards. Ductwork must be rectangular.
- C. Ductwork shall be factory coated with fire resistive coating at a minimum coverage as specified by manufacturer.
- D. Seal ductwork with fire resistive gasket and caulk to achieve a liquid-tight seal. Double row of gasket shall be used on all Ductmate M35, 45 and rolled steel angle flanges.
- E. Mechanical joints shall be Ductmate flanges or rolled steel angles per manufacturer's specifications.
- F. Ductwork shall include hood and fan transitions, cleanout ports, fire suppression and washdown nozzles, expansion joints, and other ductwork provided by manufacturer to ensure completely rated system.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- G. Ductwork that requires zero clearance to combustibles shall be enclosed in an enclosure as required by the IMC code or enclosure labeled and listed to ASTM E2336. Seal and/or firestop ductwork through non-rated and up to two-hour rated penetrations.
- H. Provide all duct access doors and labels required by NFPA 96. Provide access at each change in direction and spaced according to local jurisdiction requirements.
- I. Do not penetrate fire-rated partitions unless protected as required by applicable codes.
- J. Anchor duct with manufacturer-approved materials and spacing.
- K. Acceptable Manufacturers: Conquest Firespray.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Provide openings in ducts for thermometers and controllers.
- B. Locate ducts with space around equipment for normal operation and maintenance.
- C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms
- D. During construction provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.
- E. Repair all duct insulation and liner tears.
- F. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.
- G. Insulate terminal air box reheat coils. Seal insulation tight to form a tight vapor barrier.
- H. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.
- I. Install all exterior ductwork per SMACNA Fig. 6-3. Where drawings do not indicate otherwise, ductwork seams and joints shall be sealed watertight and pitched to shed water.
- J. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible.
- K. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 3.2 DUCTWORK APPLICATION SCHEDULE

USAGE	MATERIAL	PRESSUR E CLASS	SEAL CLASS †	INSULATION (Refer to Section 23 07 13 for insulation types)
Supply Duct from Fan to Outlet	Galvanized Sheet Metal - Rectangular	+2"	A	1-1/2" thick Type A
Supply Duct from Fan to Outlet	Galvanized Sheet Metal - Round	+2"	A	1-1/2" thick Type A
Return Duct	Galvanized Sheet Metal	-2"	A	None
General Exhaust Duct	Galvanized Sheet Metal	-1"	A	None
Grease Exhaust Duct	Refer to "Grease Exhaust Duct"	-2"	---	None (with Metal-Fab System). Where concealed 1- 1/2" thick Type A where no fire rating is needed; or type F where fire rating is needed.
Ductwork Accessories (Fabric Flex Connectors, Equipment Flanges, etc.)	---	---	---	1-1/2" thick Type A
† Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual				

## 3.3 DUCTWORK SEALING

## A. General Requirements:

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.
4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.

## B. For Seal Class A ducts, all transverse joints, longitudinal seams, and duct wall penetrations shall be sealed. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.

1. Continuously welded and locking-type longitudinal joints and seams in ducts operating at static pressures less than 2 inches of water column pressure classification shall not require additional closure systems.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 3.4 TESTING

- A. Duct - 2" WG or Less (positive or negative):
1. Systems shall not leak more than shown in Table 4-1 of SMACNA HVAC Air Duct Leakage Test Manual for Seal Class A.
  2. Leak testing of these systems is not normally required for interior ductwork. However, leak tests will be required if, in the opinion of the Architect/Engineer, the leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.
  3. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
  4. Seal ducts to bring the air leakage into compliance.
  5. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.
- B. Test procedure shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:
1. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.
  2. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
  3. All joints shall be felt by hand, and all discernible leaks shall be sealed.
  4. Totaling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.
  5. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Architect/Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.
  6. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.
  7. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.
  8. The required leakage class for Seal Class A, both round and rectangular ducts, shall be 4.
  9. Positive pressure leakage testing is acceptable for negative pressure ductwork.

## C. Grease Exhaust Duct:

1. A light test shall be performed by passing a lamp having a power rating of not less than 100 watts through the entire section of ductwork to be tested. The lamp shall be open to emit light equally in all four directions.
2. Testing of the entire exhaust duct system including the hood-to-duct connection shall be performed. Ductwork shall be permitted to be tested in sections provided every joint is tested.
3. Leakage testing shall occur prior to use or concealment of the duct system. Ducts shall be considered concealed where installed in shafts or covered by insulation or wrap that prevents ductwork from being visibly inspected on all sides. The test shall be performed in the presence of the code official.

## 3.5 DUCTWORK PENETRATIONS

- A. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms.

END OF SECTION 23 31 00



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS



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## SECTION 23 33 00 - DUCTWORK ACCESSORIES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Manual Volume Dampers.
- B. Fabric Connectors.
- C. Drip Pans.
- D. Duct Access Doors.
- E. Duct Test Holes.
- F. Control Dampers.
- G. Damper Actuators.

## 1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 05 00.
- B. Submit manufacturer's installation instructions.

## PART 2 - PRODUCTS

## 2.1 MANUAL VOLUME DAMPERS

- A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.
- B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.
- C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.
- E. Provide locking quadrant regulators on single and multi-blade dampers.
- F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
- G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

## 2.2 FABRIC CONNECTORS

- A. Fabric connectors shall be installed between all fans or fan units and metal ducts or casings to prevent transfer of fan or motor vibration.
- B. The fabric connectors shall be completely flexible material which shall be in folds and not drawn tight.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Fabric connectors shall be of glass fabric double coated with neoprene, with UL approval. Weight = 30 oz. per square yard minimum. Fabric shall not be affected by mildew and shall be absolutely waterproof, airtight and resistant to acids, alkalies, grease and gasoline, and shall be noncombustible.
- D. Fabric connections shall not exceed 6" in length on ductwork that has a positive pressure. On ductwork that has a negative pressure, the length shall not exceed 2" in length.
- E. All corners shall be folded, sealed with mastic and stapled on 1" centers.
- F. Fabric connectors shall not be painted.
- G. Unless otherwise shown on the drawings, the fabric connection at the inlet to centrifugal fans shall be at least one duct diameter from the fan to prevent inlet turbulence.
- H. Acceptable Materials: Durodyne MFN-4-100, Vent Fabrics, Inc. "Ventglas", or Proflex PFC3NGA.

## 2.3 DRIP PANS

- A. Install drip pans under all rooftop exhaust fans, intake hoods, exhaust hoods and other roof penetrations that do not have ductwork below them to intercept dripping water.
- B. Drip pans shall be 22 gauge minimum cross-broken or reinforced sheet metal with 2" welded upturned lips.
- C. Pans shall extend 6" in all directions beyond the opening and shall have the top of the lip located 25% of the maximum throat dimension below the opening.
- D. Insulate interior of drip pan with 1" thick elastomeric foam insulation. Adhere foam to drip pan with standard foam adhesive.

## 2.4 DUCT ACCESS DOORS

- A. Fabricate per Fig. 7-2 and 7-3 of the SMACNA HVAC Duct Construction Standards and as indicated.
- B. Review locations prior to fabrication. Install access doors at fire dampers, smoke dampers, motorized dampers, fan bearings, filters, automatic controls, humidifiers, louvers, duct coils and other equipment requiring service inside the duct.
- C. Construction shall be suitable for the pressure class of the duct. Fabricate rigid, airtight, and close-fitting doors of materials identical to adjacent ductwork with sealing gaskets butt or piano hinges, and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- D. Access doors with sheet metal screw fasteners are not acceptable.
- E. Minimum size for access doors shall be 24" x 16" or full duct size, whichever is less.
- F. Provide quantity of access doors such that two hands can fit inside ductwork to manually reset fire dampers. This will typically require one access door on the bottom and one access door on an accessible side of the duct for sizes 12x12 and smaller.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 2.5 GREASE DUCT ACCESS DOORS

- A. Provide pre-fabricated and pre-insulated duct access doors by the same manufacturer as the fire resistive duct wrap.

## 2.6 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

## 2.7 CONTROL DAMPERS

- A. Rectangular Control Dampers - Standard Construction:
  1. Shall be licensed to bear the AMCA Certified Rating Seal.
  2. Test leakage and pressure drop per AMCA 500.
  3. Frame: Hat-shaped channel, minimum 12 gauge extruded aluminum, and minimum 4" deep. Caulk or weld seams to prevent leakage.
  4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide and overlapping blades and blade seals (overlapping blade seals only is unacceptable).
  5. Shaft: Non-cylindrical, solid aluminum shaft with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
  6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
  7. Blade Seals: Extruded silicone gaskets secured in an integral slot within the blade.
  8. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
  9. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
  10. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
  11. Maximum Leakage: 9 cfm at 1" w.c. pressure differential for a 24"x24" damper.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

12. Maximum Pressure Drop for Opposed Blade Damper: 0.15" for 8,000 cfm through a 24"x24" damper (2000 fpm).
13. Maximum Pressure Drop for Parallel Blade Damper: 0.08" for 8,000 cfm through a 24"x24" damper (2000 fpm).

## 2.8 DAMPER ACTUATORS

## A. Damper Actuators - Electronic - Spring Return:

1. Damper actuators shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 20 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).
2. Following power interruption, spring return mechanism shall close the damper. Mechanical spring shall be rated for a minimum of 60,000 full cycles. Provide breathable membrane in actuator housing to compensate for pressure differential and allow for 95% non-condensing relative humidity in the airstream.
3. Mount actuators with motor outside of airstream whenever possible. Unit casings shall have housing with proper weather, corrosive, or explosion-proof construction as required by application.
4. Actuators shall be rated for 60,000 full cycles at rated torque with 2-year unconditional warranty. Size actuators per damper manufacturer's recommendations.
5. Provide end switches as required for the sequence of operation.
6. Provide analog feedback signal for positive position indication. Refer to FMCS points list.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

## A. General Installation Requirements:

1. Install accessories in accordance with manufacturer's instructions.
2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Architect/Engineer.
3. Coordinate and install access doors provided by others.
4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

5. Grease duct access doors shall be installed per approvals from manufacturer's ICC-ES Evaluation Report.
  6. Provide duct test holes where indicated and as required for testing and balancing purposes.
- B. Manual Volume Damper:
1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing. Use splitter dampers only where indicated.
  2. Provide ceiling access doors for manual volume dampers.
- C. Drain Pan:
1. Drain pans shall be installed per ASHRAE 62.1.
    - a. All drain pans shall be field tested under normal operating conditions to ensure proper drainage.
    - b. Field testing of drain pans is not required if units with factory installed drain pans have been certified (attested in writing) by the manufacturer for proper operation when installed as recommended.

END OF SECTION 23 33 00



## SECTION 23 34 23 - POWER VENTILATORS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Roof Exhaust Fans.
- B. Rooftop Fan Curbs.
- C. Wall Exhausters.

## 1.2 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300.
- C. Fabrication: Conform to AMCA 99.

## 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00. Include product data on wall and roof exhausters, and ceiling and cabinet fans.
- B. Provide multi-rpm fan curves with specified operating point clearly plotted.
- C. Submit manufacturer's installation instructions.

## 1.4 EXTRA STOCK

- A. Provide one (1) extra belt set for each fan unit.

## PART 2 - PRODUCTS

## 2.1 ROOFTOP EXHAUST FAN - BELT DRIVEN

- A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.
- E. V-belt drive with adjustable pitch drive sheave and adjustable motor mountings for belt tensioning.
- F. Motor mounted outside of air stream and ventilated with outside air. Motor not less than 1/3 HP.
- G. Aluminum or brass bird screen. Plastic mesh will not be allowed.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- H. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- I. Furnish normally closed, electric motorized damper. Provide step down transformer if required. Install and wire damper to open when fan runs.
- J. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods.
- K. Mill aluminum finish.
- L. Furnish permanently lubricated sealed ball type motor and drive shaft bearings sized for 200,000 hours life at specified operating conditions. Drives sized for 150% of rated motor horsepower. Drive assembly and wheel supported by vibration isolators.
- M. Acceptable Manufacturers: Aerovent "FACX", Cook "ACE-B", Greenheck "GB", Carnes "VEB", Penn DX, ACME PV, or ILG CRB, Twin City BCRD.

## 2.2 ROOFTOP EXHAUST FAN - DIRECT DRIVEN

- A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.
- E. Direct drive, motor mounted outside of air stream and ventilated with outside air.
- F. Aluminum or brass bird screen. Plastic mesh will not be allowed.
- G. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- H. Furnish solid-state dial speed controller. Mount and wire inside fan unless shown otherwise on the drawings. Provide permanent marking at balanced point.
- I. Furnish normally closed, electric motorized damper. Provide step-down transformer if required. Install and wire damper to open when fan runs.
- J. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods.
- K. Mill aluminum finish.
- L. Furnish permanently lubricated sealed ball type motor and drive shaft bearings. Motor and wheel supported by vibration isolators.
- M. Acceptable Manufacturers: Aerovent "FACX", Cook "ACE-D", Greenheck, ILG – CRD, ACME PX, Penn DX, Carnes, Twin City DCRU.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 2.3 ROOFTOP EXHAUST FAN - VERTICAL DISCHARGE - BELT DRIVEN (GREASE EXHAUST)

- A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backwards inclined blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. V-belt drive with adjustable pitch drive sheave and adjustable motor mountings for belt tensioning.
- E. Motor mounted outside of air stream and ventilated with outside air. Motor not less than 1/3 HP.
- F. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- G. Permanently lubricated, permanently sealed, self-aligning ball bearings.
- H. Include ventilated curb cap and hinged base with restraining means.
- I. All fans serving range hoods shall have extended shrouds to discharge at least 40" above roof and built-in grease trough with drain.
- J. Mill aluminum finish.
- K. Acceptable Manufacturers: ACME, Cook, Greenheck, Penn, Twin City.

## 2.4 ROOFTOP FAN CURBS

- A. Furnish and install prefabricated roof curbs for all rooftop fans.
- B. Size curb to match the curb cap of fan.
- C. Top of all curbs shall be at least 12" above the top of the roof. Increase curb height to allow for roof insulation.
- D. Unitized construction, continuous arc welded corner seams. Insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board. Damper support angle. Pressure treated wood nailer.
- E. If called for in the drawings, curbs shall be of the sound attenuation type. Sound attenuation curbs shall reduce the fan sone rating by at least 40% and not decrease fan cfm more than 8% (which is accounted for in the scheduled fan cfm). Baffles shall be removable for access to the dampers.
- F. 14-gauge aluminum construction.
- G. Curb without cant.
- H. Acceptable Manufacturers: Same manufacturer as the fan, Pate, RPS or Thy.

## 2.5 WALL EXHAUST FAN - DIRECT DRIVEN

- A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.
- E. Direct drive, motor mounted outside of air stream and ventilated with outside air.
- F. Aluminum or brass bird screen. Plastic mesh will not be allowed.
- G. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- H. Furnish solid-state dial speed controller. Mount and wire inside fan unless shown otherwise on the drawings. Provide permanent marking at balanced point.
- I. Furnish normally closed, electric motorized damper. Provide step-down transformer if required. Install and wire damper to open when fan runs.
- J. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods.
- K. Mill aluminum finish.
- L. Furnish permanently lubricated sealed ball type motor and drive shaft bearings. Motor and wheel supported by vibration isolators.
- M. Acceptable Manufacturers: Aerovent "FACX" Cook "ACE-D", Greenheck, ILG – CRD, ACME PX, Penn DX, or Carnes.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with cadmium plated lag screws to roof curb.
- C. If manufacturer has no recommendations, secure roof exhaust fans to curbs with 1/4" lag bolts on 8" maximum centers.
- D. MC shall install and wire factory provided damper to open when the fan runs if the manufacturer does not provide an option to pre-wire the damper.

END OF SECTION 23 34 23

## SECTION 23 37 00 - AIR INLETS AND OUTLETS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Grilles and Registers.
- B. Square Stepdown Cone Diffusers.
- C. Louvers.
- D. Roof Hoods.

## 1.2 QUALITY ASSURANCE

- A. Test and rate performance of air inlets and outlets per ASHRAE 70.
- B. Test and rate performance of louvers per AMCA 500L-99.
- C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

## 1.3 SUBMITTALS

- A. Submit product data under provisions of Section 23 05 00.
- B. Submit schedule of inlets and outlets indicating type, size, location, application, and noise level.
- C. Review requirements of inlets and outlets as to size, finish, and type of mounting prior to submitting product data and schedules of inlets and outlets.
- D. Submit manufacturer's installation instructions.

## 1.4 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

## PART 2 - PRODUCTS

## 2.1 GRILLES AND REGISTERS

- A. Reference to a grille means an air supply, exhaust or transfer device without a damper.
- B. Reference to a register means an air supply, exhaust or transfer device with a damper.
- C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.
- D. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents shall be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. The capacity and size of the unit shall be as shown on the drawings.
- F. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to  $10^{-12}$  watts with a 10 dB room effect.
- G. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.
- H. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.
- I. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.
- J. Where specified to serve registers, provide opposed blade volume dampers operable from the face of the register.
- K. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.
- L. Acceptable Manufacturers: Tuttle & Bailey, Titus, Price, Nailor, Carnes, or Krueger.

## 2.2 SQUARE STEPDOWN CONE DIFFUSERS

- A. Reference to a diffuser means an air supply device, ceiling mounted, that shall diffuse air uniformly throughout the conditioned space.
- B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule. Flat-oval inlets are not acceptable for connection to flexible ducts.
- C. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents should be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.
- D. The capacity and size of the unit shall be as shown on the drawings.
- E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to  $10^{-12}$  watts with a 10 dB room effect.
- F. Diffusers shall be drop face construction.
- G. Diffuser shall be entirely constructed of stamped panel and a minimum of three stepdown diffusion cones.
- H. Stepdown cones shall be mechanically fastened to panel with metal fasteners. Diffuser stepdown cones glued, fastened with plastic clips, or otherwise attached to face panel will not be acceptable.
- I. Each stepdown cone shall be one piece stamped construction. The cones shall be removable for cleaning.
- J. Diffusers shall be constructed of minimum 24 gauge steel.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

K. Acceptable Manufacturers: Tuttle & Bailey, Titus, Price, Nailor, Carnes, or Krueger.

## 2.3 LOUVERS - FIXED - ALUMINUM

- A. Louvers shall be minimum 4" deep and constructed of extruded aluminum. Blade, jamb and sill thickness shall be minimum 0.081". Blades shall be spaced at a maximum of 5.1" apart.
- B. Louvers shall be of the drainable blade design with water collected on the leading edge of the blade and diverted to the jamb.
- C. Louvers shall be furnished with aluminum bird screen mounted on the inside surface.
- D. Size, cfm, finish and pressure drop for louvers shall be as scheduled on the drawings.
- E. AMCA Certified performance for 48" x 48" samples with intake airflow of 8,000 cfm shall not exhibit more than 0.19" pressure drop. Maximum water penetration shall be 0.01 ounces per square foot at the scheduled intake velocity based on 15 minute test duration when subjected to a water flow rate of 0.25 gal/min as described under the Water Penetration Test in AMCA 500-L-07.
- F. Contractor shall provide the General Contractor with the correct sizes and locations of all louvers required in masonry walls.
- G. Louvers shall be sealed around perimeter to avoid moisture penetration between the louver frame and wall.
- H. Louvers shall be suitable for duct connection.
- I. Acceptable Manufacturers: Air Flow - "EA-403", Arrow - "EA-415-D", American Warming & Ventilating - "LE-21", Construction Specialties - "A4097", Dowco - "DBE-4", Louvers & Dampers, Inc. - "IL-23", Ruskin - "ELF375DX", Vent Products - "2760", Greenheck - "ESD-403", Pottorff - "EFD".

## 2.4 ROOF HOODS

- A. Hoods shall be constructed of all-welded aluminum.
- B. Curb cap shall be of 14 gauge formed aluminum with mitered corners continuously heliarc-welded. Hood shall be of the same material and cross-braced for added strength. Underside of hood shall be coated with insulating mastics.
- C. Hoods shall be furnished with aluminum bird screen.
- D. Hood and throat shall be reinforced with extruded aluminum angle and have a minimum snow load rating of 30 lbs. per square foot.
- E. Size, cfm, finish and pressure drop for hoods shall be as scheduled on the drawings.
- F. Inlet area shall be minimum 150% of throat area for intake hoods. Outlet area shall be minimum 125% of throat area for exhaust hoods and relief vents.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- G. Hoods shall be furnished with 12" high curb (above top of roof) and be of the size and type as shown on the drawings.
- H. Hood shall be furnished with motorized damper unless otherwise noted on the drawings.
- I. Acceptable Manufacturers: Ammerman, Carnes, Cook, Greenheck, ILG, Jenco Fan, Penn, Twin City Fan & Blower.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. General Installation Requirements:
  - 1. Install items in accordance with manufacturers' instructions.
  - 2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
  - 3. Install diffusers to ductwork with air tight connections.
  - 4. Flexible ducts shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required.
- B. Volume Damper:
  - 1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.
- C. Roof Hood:
  - 1. If manufacturer has no recommendations, secure roof hoods to curbs with 1/4" lag bolts on 8" maximum centers.
  - 2. Provide 20 gauge sheet metal duct blank-off behind louvers at unused portions of louver openings in exterior walls. Back with 2" rigid 3# density fiberglass board insulation with foil scrim facing the room. Seal watertight.

END OF SECTION 23 37 00

## SECTION 23 74 11 - PACKAGED ROOFTOP AIR CONDITIONING UNITS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Packaged Rooftop Unit.
- B. Unit Controls.
- C. Roof Mounting Frame and Base.

## 1.2 QUALITY ASSURANCE

- A. All insulation inside the unit and in the air stream must comply with the requirement of NFPA 90A (maximum flame spread of 25 and maximum smoke developed of 50).
- B. All units must be UL or ETL listed and must contain UL labeled components.
- C. Fans shall be tested and rated in cabinet in accordance with AMCA Standard 210. All fan assemblies shall be dynamically balanced in cabinet at final assembly.
- D. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

## 1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00.
- B. Indicate electrical service and duct connections on shop drawings or product data.
- C. Submit manufacturer's installation instructions.

## 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

## 1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

## 1.6 WARRANTY

- A. Provide five (5) year manufacturer's warranty for compressors.
- B. Provide five (5) year manufacturer's warranty for heat exchanger.
- C. Provide three (3) year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

## 1.7 MAINTENANCE SERVICE

- A. Furnish complete service and maintenance of packaged roof top units for one year from Date of Substantial Completion.
- B. Provide maintenance service with a two month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.
- C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibrations.
- D. Submit copy of service call work order or report, and include description of work performed.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. Greenheck.
- B. Trane.
- C. York.
- D. Aeon
- E. McQuay.
- F. Carrier.

## 2.2 MANUFACTURED UNITS

- A. Provide roof-mounted units having gas burner and electric refrigeration.
- B. Unit shall be self-contained, packaged, factory assembled, pre-wired and tested, consisting of cabinet and frame, supply fan, exhaust fan, heat exchanger and burner, controls, air filters, refrigerant cooling coil and compressor, condenser coil, condenser fan, and a full refrigerant charge.
- C. Unit shall be furnished with non-fused disconnect switch, short fuse protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection.

## 2.3 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels with quick fasteners screwdriver operated flush cam type. Access doors shall be provided at each section (e.g., filter section, supply fan section, etc.). All exterior access panels must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 18 gauge, with access doors or removable panels of minimum 20 gauge.
- B. Outside Air Intakes: The outside air intakes shall be located a minimum of 15 inches above the roof mounting curb to minimize the effect of heat pickup from the roof during the natural cooling cycle and the effects of snow on the roof during winter operation. Each air intake shall be furnished with rain eliminators.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Insulation: Minimum of 1" thick, 1.5 lb/cu.ft. density coated glass fiber insulation on surfaces where conditioned air is handled. Protect edges from erosion.
- D. Heat Exchangers: Stainless steel, of welded construction.
- E. Air Filters: Two inch thick glass fiber disposable media in metal frames.
- F. Roof Mounting Curb: Minimum 12 inches high, minimum 14 gauge galvanized steel, one piece construction, insulated, all welded, wood nailer.

## 2.4 FANS/MOTORS

- A. Supply and Exhaust Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor sheave, and rubber isolated hinge mounted motor or direct drive as indicated. Isolate complete fan assembly. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
- B. Belt drive fans must be within  $\pm 10\%$  of scheduled RPM.
- C. All fans must be statically and dynamically balanced.
- D. Belt drive fans shall have slide rails, adjusting screws, anchor bolts, and bedplates.
- E. Motors shall be open drip-proof with grease lubricated bearings.
- F. Motors shall be "variable frequency drive rated" when controlled by VFDs.
- G. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
- H. Units used with variable speed drives shall have fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
- I. No equipment shall be selected or operate above 90% of its motor nameplate rating.
- J. Motor shall have 1.15 service factor.

## 2.5 BURNER

- A. Gas Burner: Forced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot. Fully modulating gas valve with minimum 4:1 modulating turndown.
- B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.
- C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, or adjustable time delay relays with switch for continuous fan operation.

## 2.6 EVAPORATOR COIL

- A. Provide copper tube with aluminum fin coil assembly.
- B. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
- C. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

## 2.7 COMPRESSOR

- A. Provide hermetic or semi-hermetic compressors (quantity as scheduled on drawings), 3600 rev/min maximum, resiliently mounted with positive lubrication, crankcase heater for operation down to 0°F, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
- B. Five minute timed off circuit shall delay compressor start.
- C. Outdoor thermostat shall energize compressor above 50°F ambient.
- D. Provide step capacity control by cylinder unloading or cycling multi-speed compressors.
- E. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

## 2.8 CONDENSER

- A. Provide copper tube aluminum fin coil assembly with sub-cooling rows.
- B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor.
- C. Provide refrigerant pressure switches or outdoor thermostat to cycle condenser fans.
- D. Provide hail guards on all condenser coils.

## 2.9 MIXING SECTION

- A. Dampers: Provide outside, return and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper shall fail to closed position. Relief dampers may be gravity balanced.
- B. Gaskets: Provide tight fitting dampers with edge gaskets, maximum leakage 5 percent at 2 inches pressure differential. Gaskets must be mechanically fastened (use of adhesive alone shall not be acceptable).

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Damper Operator: 24 volt with gear train sealed in oil, with spring return on units 7.5 tons cooling capacity and larger.

## 2.10 ELECTRICAL

- A. Provide with single point power connection, disconnect, transformer, and convenience outlet. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect.
- B. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.
- C. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.
- D. All units shall include a transformer for controls and convenience outlet.
- E. Only one power cable connection to the unit shall be necessary.

## 2.11 OPERATING CONTROLS - SINGLE ZONE UNITS VARIABLE AIR VOLUME

- A. Electric solid state microcomputer based room thermostat, located as indicated in service area with remote sensor located as indicated.
- B. Room thermostat shall incorporate:
  - 1. Automatic switching from heating to cooling.
  - 2. Preferential rate control to minimize overshoot and deviation from set point.
  - 3. Set-up for four separate temperatures per day.
  - 4. Instant override of set point for continuous or timed period from one hour to 31 days.
  - 5. Short cycle protection.
  - 6. Seven days per week programming
  - 7. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.
- C. Room thermostat display shall include:
  - 1. Time of day.
  - 2. Actual room temperature.
  - 3. Programmed temperature.
  - 4. Programmed time.
  - 5. Duration of timed override.
  - 6. Day of week.
  - 7. System model indication: heating, cooling, auto, off, fan auto, fan on.
  - 8. Stage (heating or cooling) operation.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Provide low limit thermostat in supply air to close outside air dampers and stop supply fan.
- E. Control Sequence: Unit shall be provided with all necessary control programming, software, and accessories required to accomplish the following control sequence. RTU shall modulate supply fan airflow, cooling, and heating as needed to maintain adjustable room thermostat temperature of 75°F (adj.). Unit shall not allow simultaneous heating and cooling. Unit shall be capable of turning down to a minimum supply air 3500 cfm at any time during occupied mode. Fan shall modulate between 3500 cfm and 7000 cfm at any given time during occupied mode. During unoccupied mode unit may modulate below 3500 cfm. Programmable thermostat will allow the user to set temperature in room during unoccupied mode. Unit shall be provided with hot gas reheat for dehumidification purposes. Return air humidity shall be maintained at 50% RH.
- F. Outside Air Damper Control Sequence: Minimum outside air damper shall have two positions. Damper shall be set to 1000 cfm of outside air if the kitchen hood is not in operation. Damper shall be set to 3000 cfm of outside air if the kitchen hood is in operation. Mechanical contractor shall provide all necessary wiring and accessories to determine if hood is in operation. Outside air damper shall be fully modulating to allow for economizer control when outdoor air temperature can satisfy room thermostat temperature setpoint. During economizer operation in occupied mode the outside air damper shall not modulate below 3500 cfm.
- G. Relief/Exhaust Damper and Fan Control: Unit shall be provided with relief fan to control building pressure based on varying outside air rate. Unit manufacturer shall provide building pressure sensor to control fan. Building shall be maintained at a minimum of 0.01 inches W.G.
- H. Alarms: Unit shall be provided with the following alarms at a minimum; flame failure, low discharge air temperature, clogged filter, fire alarm shutdown, relief fan fault, supply fan VFD fault. RTU shall be supplied with relay to shutdown unit upon activation of the duct mounted smoke detector provided by electrical contractor. Coordinate requirements with E.C. RTU shall be capable of sending general alarm to owner via text, page, or other acceptable means to owner. Coordinate requirements with owner.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.
- B. Verify that proper power supply is available.

## 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork and utility services. Install roof mounting frame level.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. All field wiring shall be in accordance with the National Electrical Code.
- D. P-traps must be provided for all drain pans.
- E. Comb all coils to repair bent fins.
- F. Install on vibration isolation as scheduled on drawings.

## 3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide initial start-up and shutdown during first year of operation, including routine servicing and check-out.

END OF SECTION 23 74 11



## SECTION 23 74 23.13 - GAS FIRED MAKE-UP AIR UNITS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Packaged Makeup Air Unit.
- B. Unit Controls.
- C. Roof Mounting Frame and Base.

## 1.2 QUALITY ASSURANCE

- A. All insulation inside the unit and in the air stream must comply with the requirement of NFPA 90A (maximum flame spread of 25 and maximum smoke developed of 50).
- B. All units must be UL or ETL listed and must contain UL labeled components.
- C. Fans shall be tested and rated in cabinet in accordance with AMCA Standard 210. All fan assemblies shall be dynamically balanced in cabinet at final assembly.
- D. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

## 1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00.
- B. Indicate electrical service and duct connections on shop drawings or product data.
- C. Submit manufacturer's installation instructions.

## 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

## 1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

## 1.6 WARRANTY

- A. Provide five (5) year manufacturer's warranty for compressors.
- B. Provide five (5) year manufacturer's warranty for heat exchanger.
- C. Provide three (3) year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 1.7 MAINTENANCE SERVICE

- A. Furnish complete service and maintenance of packaged roof top units for one year from Date of Substantial Completion.
- B. Provide maintenance service with a two month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.
- C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibrations.
- D. Submit copy of service call work order or report, and include description of work performed.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. Greenheck.
- B. Trane.
- C. York.
- D. Aeon
- E. McQuay.
- F. Carrier.

## 2.2 MANUFACTURED UNITS

- A. Provide roof-mounted units having gas burner and electric refrigeration.
- B. Unit shall be self-contained, packaged, factory assembled, pre-wired and tested, consisting of cabinet and frame, supply fan, heat exchanger and burner, controls, air filters, refrigerant cooling coil and compressor, condenser coil, condenser fan, and a full refrigerant charge.
- C. Unit shall be furnished with non-fused disconnect switch, short fuse protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection.

## 2.3 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels with quick fasteners screwdriver operated flush cam type. Access doors shall be provided at each section (e.g., filter section, supply fan section, etc.). All exterior access panels must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 18 gauge, with access doors or removable panels of minimum 20 gauge.
- B. Outside Air Intakes: The outside air intakes shall be located a minimum of 15 inches above the roof mounting curb to minimize the effect of heat pickup from the roof during the natural cooling cycle and the effects of snow on the roof during winter operation. Each air intake shall be furnished with rain eliminators.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Insulation: Minimum of 1" thick, 1.5 lb/cu.ft. density coated glass fiber insulation on surfaces where conditioned air is handled. Protect edges from erosion.
- D. Heat Exchangers: Stainless steel, of welded construction.
- E. Air Filters: Two inch thick glass fiber disposable media in metal frames.
- F. Roof Mounting Curb: Minimum 12 inches high, minimum 14 gauge galvanized steel, one piece construction, insulated, all welded, wood nailer.

## 2.4 FANS/MOTORS

- A. Supply and Exhaust Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor sheave, and rubber isolated hinge mounted motor or direct drive as indicated. Isolate complete fan assembly. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
- B. Belt drive fans must be within  $\pm 10\%$  of scheduled RPM.
- C. All fans must be statically and dynamically balanced.
- D. Belt drive fans shall have slide rails, adjusting screws, anchor bolts, and bedplates.
- E. Motors shall be open drip-proof with grease lubricated bearings.
- F. Motors shall be "variable frequency drive rated" when controlled by VFDs.
- G. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
- H. Units used with variable speed drives shall have fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
- I. No equipment shall be selected or operate above 90% of its motor nameplate rating.
- J. Motor shall have 1.15 service factor.

## 2.5 BURNER

- A. Gas Burner: Forced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot. Fully modulating gas valve with minimum 4:1 modulating turndown.
- B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.
- C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, or adjustable time delay relays with switch for continuous fan operation.

## 2.6 EVAPORATOR COIL

- A. Provide copper tube with aluminum fin coil assembly.
- B. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
- C. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

## 2.7 COMPRESSOR

- A. Provide hermetic or semi-hermetic compressors (quantity as scheduled on drawings), 3600 rev/min maximum, resiliently mounted with positive lubrication, crankcase heater for operation down to 0°F, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
- B. Five minute timed off circuit shall delay compressor start.
- C. Outdoor thermostat shall energize compressor above 50°F ambient.
- D. Provide step capacity control by cylinder unloading or cycling multi-speed compressors.
- E. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

## 2.8 CONDENSER

- A. Provide copper tube aluminum fin coil assembly with sub-cooling rows.
- B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor.
- C. Provide refrigerant pressure switches or outdoor thermostat to cycle condenser fans.
- D. Provide hail guards on all condenser coils.

## 2.9 ELECTRICAL

- A. Provide with single point power connection, disconnect, transformer, and convenience outlet. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.
- C. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.
- D. All units shall include a transformer for controls and convenience outlet.
- E. Only one power cable connection to the unit shall be necessary.

## 2.10 OPERATING CONTROLS - SINGLE ZONE UNITS VARIABLE AIR VOLUME

- A. Electric solid state microcomputer based room thermostat, located as indicated in service area with remote sensor located as indicated.
- B. Room thermostat shall incorporate:
  - 1. Automatic switching from heating to cooling.
  - 2. Preferential rate control to minimize overshoot and deviation from set point.
  - 3. Set-up for four separate temperatures per day.
  - 4. Instant override of set point for continuous or timed period from one hour to 31 days.
  - 5. Short cycle protection.
  - 6. Seven days per week programming
  - 7. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.
- C. Room thermostat display shall include:
  - 1. Time of day.
  - 2. Actual room temperature.
  - 3. Programmed temperature.
  - 4. Programmed time.
  - 5. Duration of timed override.
  - 6. Day of week.
  - 7. System model indication: heating, cooling, auto, off, fan auto, fan on.
  - 8. Stage (heating or cooling) operation.
- D. Provide low limit thermostat in supply air to close outside air dampers and stop supply fan.
- E. Control Sequence: Unit shall be provided with all necessary control programming, software, and accessories required to accomplish the following control sequence. MAU shall be programmed for two modes of operation. Under normal operation MAU shall modulate supply fan airflow, cooling, and heating as needed to maintain adjustable room thermostat temperature of 75°F (adj.). During normal operation the unit shall be interlocked with the associated exhaust fan within the building to modulate the supply and exhaust fan in unison. MAU shall provide signal to exhaust fan VFD to vary the speed. The second mode of operation shall allow the user to manual switch the unit into

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

full airflow as scheduled on the drawings. The heating and cooling controls of the unit shall modulate to maintain a constant discharge air temperature of 75°F (adj.). During this operation the exhaust fan will be operate at its maximum airflow as schedule on the drawings.

- F. Alarms: Unit shall be provided with the following alarms at a minimum; flame failure, low discharge air temperature, clogged filter, supply fan VFD fault. RTU shall be capable of sending general alarm to owner via text, page, or other acceptable means to owner. Coordinate requirements with owner.

END OF SECTION 23 74 23.13

## SECTION 23 82 00 - TERMINAL HEAT TRANSFER UNITS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Cabinet Heaters.
- B. Electric Unit Heaters.
- C. Duct Free Split System.

## 1.2 QUALITY ASSURANCE

- A. All filters shall be UL listed Class 1 or Class 2.
- B. All electrical equipment shall have a UL label.
- C. All gas fired units shall be AGA approved or UL listed.
- D. All gas trains shall comply with utility company and code requirements.
- E. All louvers and dampers shall have AMCA certified ratings.
- F. Factory wired equipment shall conform to ANSI/NFPA 70.

## 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00.
- B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.
- C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.
- D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.
- E. Submit manufacturers' installation instructions.

## 1.4 DELIVERY, STORAGE AND HANDLING

- A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

## 1.5 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

## PART 2 - PRODUCTS

## 2.1 ELECTRIC CABINET HEATERS

- A. Forced air wall mounted heaters shall include cabinet, fan, motor, coil, inlet grille and discharge grille.
- B. Coil: Electric dual element with finned steel sheaths.
- C. Blower shall have a two-speed split capacitor motor and a concealed unit mounted "Off-Low-High" fan speed switch.
- D. Power connections, circuit breaker, or disconnect shall be provided by the E.C.
- E. Units shall have 1" disposable filters ahead of all coils.
- F. Cabinets shall have 16 gauge exposed surfaces, 18 gauge concealed surfaces, and no exposed plastic parts.
- G. Baked enamel finish. Color selected by Architect.
- H. Acceptable Manufacturers: Trane, Berko.

## 2.2 ELECTRIC UNIT HEATERS

- A. Horizontal or vertical discharge as scheduled on the drawings.
- B. Horizontal units shall have adjustable outlet louvers.
- C. Metal sheathed fin tube electric heating elements.
- D. Casing: Heavy gauge steel with baked enamel finish.
- E. Automatic reset thermal overload wired for instantaneous pilot operation of contactor holding coil.
- F. Motors shall be totally enclosed continuous duty with built-in thermal overload protection.
- G. Provide unit mounted and wired disconnect.
- H. Provide resiliently mounted fan guard/motor support.
- I. Fans: Direct drive propeller type, factory balanced.
- J. Acceptable Manufacturers: Trane, Modine, or Reznor.

## 2.3 DUCT FREE SPLIT SYSTEM

- A. Split system air-cooled terminal with wall mounted fan coil, electric refrigeration system, integral temperature controls, and remote mounted heat pump unit or condensing unit as scheduled.
- B. Warranty: Provide one-year manufacturer's warranty on parts and defects and six years on the compressor.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Cabinet: Wall mounted thermal plastic with integral finish. Fully insulated.
- D. Discharge Grille: Fan shall be tangential direct--drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor--driven vertical air sweep shall be provided standard.
- E. Indoor unit shall include:
  - 1. Direction expansion cooling coil.
  - 2. Expansion valve and reversing valve.
  - 3. Centrifugal forward curved evaporator fans with multi-speed split capacitor motors.
  - 4. Integral controls for temperature set point adjustment.
  - 5. Plastic drain pan formed to prevent ponding or water retention.
  - 6. Washable air filters.
- F. Outdoor unit shall include:
  - 1. Inverter type hermetically sealed rotary compressor with internal spring isolation, external isolation, permanent seal capacitor motor and overload protection.
  - 2. Condenser coil.
  - 3. Propeller type condenser fan with split capacitor motor.
  - 4. R-410a charged and insulated refrigerant line set sized for location shown.
- G. Performance shall be based on ARI 210 or ARI 240 test conditions.
- H. Coordinate installation of units with architectural and electrical work.
- I. Supply units fully charged with refrigerant and filled with oil.
- J. Approved Manufacturers: Sanyo, Mitsubishi, LG, or approved equal.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. General Installation Requirements:
  - 1. Install all products per manufacturers' instructions.
  - 2. Coordinate recess sizes for recessed equipment.
  - 3. Protect units with protective covers during construction.
  - 4. Comb all coils to repair bent fins.

## B. Unit Heater:

1. Hang unit heaters from building structure, not from piping. Mount as high as possible within manufacturer's recommended mounting height requirements. If unit heaters cannot be installed within manufacturer's recommended range, notify Architect/Engineer prior to mounting.

## 3.2 CLEANING

- A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.
- C. Install new filters.

END OF SECTION 23 82 00



## SECTION 23 83 00 - RADIANT FLOOR HEATING SYSTEMS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

## A. Description:

1. Furnish and install radiant floor heating system tubing, electric heater, distribution manifolds, manifold support brackets, manifold to tubing fittings, manifold end caps and bushings, circuit isolation and balancing valves, controls, and installation specialties, supervision and field engineering required for complete and proper function of the system. All indoor components shall be installed within a lockable cabinet.

## B. System Design:

1. Provide a system capable of delivering 45 BTU's per sq. ft for indoor applications and 150 BTU's per sq. ft for exterior snow melt systems in area shown on the drawings.

## 1.2 SUBMITTALS

- A. Provide submittals and shop drawings in accordance with the General Requirements and as specified herein.
- B. Submit shop drawings indicating detailed layout of system, including equipment, water heater, tubing locations, loop lengths, critical dimensions, tubing/slab penetration details, fittings, and details for protected exposed PEX tubing. Provide pressure drops at design flow rates for all equipment including loops, manifolds, isolation valves, and control valves. Provide detailed flow, pressure, and electrical power requirements of radiant system pump.
- C. Submit manufacturer's technical instructions including specific installation instructions for system installation in the specific construction of the radiant panel or slab. Include details at slab construction joints and expansion joints.
- D. Submit installer's certifications of training for installation of PEX floor heating systems.
- E. Submit data indicating tube sizing and panel performance at tube spacing and warm water temperatures selected.
- F. Submit independent certification results for the tubing systems from a recognized testing laboratory.
- G. Submit catalog data on all supports, tube guides, spacers, fittings, and associated items necessary for the installation of the tubing and manifolds.

## 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store tubing and specialties in shipping containers with labeling in place. Do not expose to ultraviolet light for more than 90 days.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Protect tubing and specialties from entry of contaminating material by installing tape or plugs in all open tube ends until installation and/or maintain tubing in the original shipping boxes or packaging until usage.
- C. Unprotected tubes shall not be dragged across the ground or concrete surfaces, and shall be stored on a flat surface with no sharp edges.
- D. Tube shall be protected from oil, grease, direct sunlight, paint, and other elements as recommended by manufacturer.

## 1.4 REGULATORY REQUIREMENTS

- A. Tubing shall conform to ASTM F876 and ASTM F877 (for Canada conform to CAN/CSA B137.5). Tubing oxygen permeation barrier shall conform to DIN 4726.
- B. Installer's Qualification: Installer's shall be qualified, in writing, as either being certified or certifiable prior to the commencement of the installation.

## 1.5 WARRANTY

- A. The radiant floor system component manufacturer shall warrant the tubing to be free from defects in material and workmanship for a period of twenty-five (25) years.
- B. All manifolds, pumps, and controls shall be warranted for 18 months and/or two heating seasons.

## PART 2 - PRODUCTS

## 2.1 SYSTEM COMPONENTS

- A. Tube:
  - 1. Tube shall be cross-linked polyethylene, aluminum core polyethylene, or multi-layer, elastomeric, industrial grade EPDM rubber hose with maximum working pressure/temperature of 160 psi @ 73.4°F, 100 psi @ 180°F, 80 psi @ 200°F.
  - 2. The tube shall be manufactured in accordance with ASTM standard specification F876. The tube shall be listed to ASTM by independent third party testing laboratory.
  - 3. The tube shall be of cross-linked polyethylene with a minimum degree of cross-linking of 80% or multi-layer, elastomeric, industrial grade EPDM rubber hose. The tube shall have an oxygen diffusion barrier capable of limiting oxygen diffusion through the tube to no greater than 0.10g/m<sup>3</sup>/day @ 104°F water temperature.
  - 4. The tube dimensions shall be: 5/8" nominal inside diameter (3/4" outside diameter), in accordance with ASTM standard specification, as pertaining to paragraph 2.
  - 5. The minimum bend radius for cold bending of the tube shall not be less than six (6) times the outside diameter. Bends with a radius less than stated shall require the use of a bend support as supplied by the tube manufacturer.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

6. All Components: Components of the buried tubing system shall be provided by one manufacturer, including; tube, fittings, manifolds, controls, and other ancillary items required for a complete installation.
- B. Manifolds:
1. Manifolds shall be of cast brass construction, manufactured of alloys to prevent dezincification, and shall have integral circuit balancing valves. Manifolds shall be able to vent air from the system, and shall be provided with support brackets and tube bend supports. Manifolds shall be isolated from supply and return tubing with valves that are suitable for isolation and balancing.
- C. Fittings:
1. Fittings shall be manufactured of dezincification resistant brass. These fittings must be supplied by the tube manufacturer. The fittings shall consist of a compression fitting with insert, compression ring and a compression nut.
- D. Water Heater: Refer to schedule for boiler requirements.
- E. Supply And Return Piping To Manifolds:
1. Piping shall be metal pipe or cross-linked polyethylene tube with an integral oxygen diffusion barrier. Cross-linked polyethylene tube should only be used when specifically approved by the local building inspector for supply and return piping applications.
  2. Fittings shall be compatible to the piping material used. Fittings used with the cross-linked polyethylene tube shall not permit excessive oxygen permeation.
- F. Acceptable Manufacturers: Uponor, Rehau, Kitec, Zurn, Watts Radiant.

## 2.2 CONTROLS

- A. Microprocessor controls shall be used to energize radiant loops based on outside air temperature. Zoning control shall allow user to energize each zone separately. Indoor systems controls shall include floor temperature sensor and allow the user to manually adjust the floor temperature setpoint. For systems the controls shall allow have slab temperature and moisture sensors to automatically turn on when snow is present. The controls for outdoor systems shall also allow the user manual control of the slabe temperature for each zone..
- B. Approved control component manufacturer: Uponor, Rehau, Kitec, Zurn, Watts Radiant.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Hydronic radiant heat tubing loops shall be installed in accordance with the manufacturer's recommendations and the details as shown on the contract drawings.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. All fittings should be accessible for maintenance. Tubing loops shall be installed without splices, as a minimum, from the point at which the tubing enters the panel to the point at which it exits the panel. No splices shall occur underground.
- C. Installation shall follow the shop drawings for tubing layout, tube spacing, manifold configuration, manifold location, and controls. All notes on the drawing shall be followed.
  - 1. The tubing system shall be pressurized, with water or air, in accordance, with applicable codes, or to a pressure of 60 psig 24 hours prior to encasement in the radiant panel. The tubing system shall remain at this pressure during the panel installation, and for a minimum of 24 hours thereafter to ensure system integrity. The Contractor shall provide the water or air for the pressurization of the tubing system. The Contractor assumes all liabilities for suitable safety precautions and testing, including the use of compressed air, when applicable.
- D. At start up time, the Contractor shall: follow the manufacturer's recommendations for system water and temperature balancing, record balance settings at each manifold location, and deliver to the Owner a complete record of these settings for inclusion in the operation and maintenance manuals.
- E. Set up controls to operate on a reset schedule based on the system manufacturer's recommendations.
- F. Glycol: Add 30% propylene glycol by weight.
- G. Any deviations from shop drawing layout must be accurately dimensioned for Owner's records.
- H. Provide warning labels in mechanical equipment spaces to alert future building remodelers of the presence of in-slab tubing.

END OF SECTION 23 83 00

## SECTION 26 05 00 - BASIC ELECTRICAL REQUIREMENTS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Interior Communications Pathways Section 27 05 28. This section is also applicable to Fire Alarm and Detection Systems Section 28 31 00.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced in each specification section.

## 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make his portion of the Electrical Work a finished and working system.
- C. Description of Systems shall be as follows:
  - 1. Electrical power system to and including light fixtures, equipment, motors, devices, etc.
  - 2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.
  - 3. Grounding system.
  - 4. Fire alarm system.
  - 5. Wiring of equipment furnished by others.
  - 6. Technology Systems as described in Division 27/28 and on the T-series documents as described in the Suggested Matrix of Scope Responsibility.
- D. Work Not Included:
  - 1. Telecommunications cabling will be by the Division 27 Contractor, in raceways and conduits furnished and installed as part of the Electrical work.
  - 2. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

## 1.3 ALTERNATES

- A. As identified on the bid form.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 1.4 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, AND CONTROL CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
  2. "Technology Contractors" refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.
  3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
  4. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
  5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
  6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
  7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
  8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

9. Low Voltage Technology Wiring: The wiring associated with the Technology Systems, used for analog or digital signals between equipment.
10. Telecommunications Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications information outlets.

## C. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
  - a. Lighting Fixtures
  - b. Gravity flow piping.
  - c. Sheet metal.
  - d. Other piping.
  - e. Conduits and wireway.

## D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Temperature Control Contractor's or Subcontractor's Responsibility:
1. Wiring of all devices needed to make the Temperature Control System functional.
  2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
  3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
- F. Electrical Contractor's Responsibility:
1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
  2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Contractor when such so noted on the Electrical Drawings.
  3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
  4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
  5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.
- G. General (Electrical/Technology):
1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".
  2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.
  3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

## H. Technology Contractor's Responsibility:

1. Assumes all responsibility for the Low Voltage Technology Wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility".
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined in here-in).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of Technology equipment which is required to be bonded to the telecommunications ground bar.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.5 QUALITY ASSURANCE

## A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor's risk.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## B. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.
2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

## C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Madison, Wisconsin Codes, Laws, Ordinances and other regulations having jurisdiction over this installation.
2. Conform to Wisconsin Building Code.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. If there are no local codes having jurisdiction, the current issue of the National Electrical Code shall be followed.

## D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.
- E. Utility Company Requirements:
1. Secure from the private or public utility company all applicable requirements.
  2. Comply with all utility company requirements.
  3. The Owner shall make application for and pay for new electrical service equipment and installation. The Contractor shall coordinate schedule and requirements with the Owner and Utility Company.
  4. Furnish the CT cabinet and meter base. Verify approved manufacturers and equipment with the Utility Company.
- F. Examination of Drawings:
1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
  2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways so as to best fit the layout of the job.
  3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
  4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
  5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
  6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
  7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better quality number shall govern.
  8. Where used in electrical documents the word "furnish" shall mean supply for use, the word "install" shall mean connect up complete and ready for operation, and the word "provide" shall mean to supply for use and connect up complete and ready for operation.
  9. Any item listed as furnished shall also be installed unless otherwise noted.
  10. Any item listed as installed shall also be furnished unless otherwise noted.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit MEP.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

## H. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, fittings, etc.

## 1.6 SUBMITTALS

## A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

## 1. Submittals list:

<u>Referenced Specification Section</u>	<u>Submittal Item</u>
26 24 16	Panelboards
26 24 19	Motor Control
26 28 16	Disconnect Switches
26 31 00	Solar Photovoltaic Systems
26 43 00	Surge Protection Devices
26 51 00	Lighting

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. In addition to the provisions of Division 1, the following provisions are required:
1. The Contractor shall submit either one electronic copy or four (4) paper copies of each shop drawing for review by the Architect/Engineer BEFORE releasing any equipment for manufacture or shipment.
  2. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. CONTRACTOR'S APPROVAL STAMP IS REQUIRED ON ALL SUBMITTALS. APPROVAL WILL INDICATE THE CONTRACTOR'S REVIEW of all material and a COMPLETE UNDERSTANDING OF EXACTLY WHAT IS TO BE FURNISHED. Contractor shall clearly mark all deviations from the contract documents on all submittals. IF THE CONTRACTOR DOES NOT MARK DEVIATIONS, THEN THE ITEM SHALL BE REQUIRED TO MEET ALL DRAWING AND SPECIFICATION REQUIREMENTS.
  3. Each data sheet shall clearly show at the top of the sheet what General Electrical Equipment Schedule symbol (and applicable variations and subscripts) that data sheet corresponds to.
  4. Each data sheet shall show the size, rating, style, finish, material, catalog number, manufacturer name and product photos for each item to ensure compliance with these specifications.
  5. Assemble all submittals in sets, such as panelboards, fire alarm, lighting, or motor control. All sets shall be identical and contain an index of the items enclosed with a general topic description on the cover.
  6. Bind each set in a manufacturer's folder or inside of a manila file folder.
  7. Where more than one model is shown on a manufacturer's sheet, clearly indicate exactly which item and which data is relevant to the work.
  8. Where the manufacturer lists multiple part numbers or options on a single data sheet, the part number and options to be used shall be clearly set apart from other part numbers shown on that sheet.
  9. Failure to comply with the above shall be reason to resubmit all shop drawings.
  10. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost to the Owner, for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
- C. Provide Schedule of Values:
1. Application forms: Use AIA Document Continuation Sheets G703 (or similar) as the form for application.
  2. Provide line items on the Schedule of Values including:
    - a. General Conditions (mobilization, bonds, insurance, etc.)

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- b. Lighting
- c. Power
- d. Fire Alarm

- 3. Change orders shall have schedule of values broken out as listed above submitted with each change order.
- 4. Coordinate with the Project Architect/Engineer the items included in the Schedule of Values. The intent is to not create schedules in addition to those the Electrical Contractor normally submits to the General Contractor for payment.

## 1.7 PRODUCT DELIVERY, STORAGE, HANDLING AND MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.
- B. Keep all materials clean, dry and free from damaging environments.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

## 1.8 WARRANTY

- A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

## 1.9 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

## 1.10 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis of design and establishes the quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fit in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on his part or on the part of other Contractors whose work is affected.
- E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

## PART 2 - PRODUCTS

## 2.1 GENERAL

- A. All items of material having a similar function (e.g., safety switches, panelboards, motor starters) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

## PART 3 - EXECUTION

## 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

shall be made additional insureds under the Contractor's general liability insurance policy.

## 3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

## A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with his work.

## B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Architect/Engineer or their representative, and do no further work until the Architect/Engineer or their representative gives further instructions.
9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.
10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.
  12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.
- C. Dewatering:
1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.
- D. Underground Obstructions:
1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.
  2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.
- E. Fill and Backfilling:
1. No rubbish or waste material is permitted for fill or backfill.
  2. Furnish all necessary sand for backfilling.
  3. Dispose of the excess excavated earth as directed.
  4. Backfill materials shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to rise in unbackfilled trenches.
  5. Backfill all trenches and excavations immediately after installing of conduit, or removing forms, unless other protection is directed.
  6. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Spread fill and backfill materials in 6" uniform horizontal layers with each layer compacted separately to required density.
  7. For conduits that are not concrete encased, lay all conduits on a compacted bed of sand at least 3" deep. Backfill around conduits with sand, in 6" layers and compact each layer.
  8. Conduits that are concrete encased or in a ductbank, conduit spacers, and cradles shall be installed on a bed of compacted CA-6 gravel. Refer to conduit section for backfilling and ductbank requirements.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

9. Backfill with sand up to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.
10. Place all backfill above the sand in uniform layers not exceeding 6" deep. Place then carefully and uniformly tamp each layer to eliminate lateral or vertical displacement.
11. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
12. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

## F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting and landscaping features removed or damaged to its original condition. At least 6" of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition. Broken edges shall be saw cut and repaired as directed by Architect/Engineer.

## 3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:
  1. Placing fill over underground and underslab utilities.
  2. Covering exterior walls, interior partitions and chases.
  3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer may review the installation and provide a written report noting deficiencies requiring correction. The contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation:
  1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    - a. All junction boxes are closed and identified in accordance with Section 26 05 53 Electrical Identification.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- b. Light fixtures, including ceiling-mounted exit and emergency lights, are installed and operational.
  - c. Light fixture whips are suspended above the ceiling.
  - d. Light fixtures are suspended independently of the ceiling system when required by these contract documents.
  - e. All wall penetrations have been sealed.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

## 3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
  2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
  3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.
- C. The following must be submitted before Architect/Engineer recommends final payment:
  1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including marked-up or reproducible drawings and specifications.
  3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed and submit receipt to Architect/Engineer.
5. Inspection and testing report by the fire alarm system manufacturer.
6. Start-up reports on all equipment requiring a factory installation or start-up.

## 3.5 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Submit three (3) properly indexed and bound copies; in “D” ring style notebooks, of the Operations and Maintenance Instructions to the Architect/Engineer. Make all corrections or additions required.
- B. Operation and Maintenance Instructions shall include:
  1. Notebooks shall be heavy duty locking three ring binders and incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. “Peel and stick” labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. Provide “Wilson-Jones” or equal, color black. Size notebooks a minimum of 1/2" thicker than material for future inserts. Label the spine and front cover of each notebook. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other forms of binding will be acceptable.
  2. Prepare binder covers (front and spine) with printed title “Operation and Maintenance Instructions”, title of project, and subject matter of binder when multiple binders are required.
  3. Title page with project title, Architect, Engineer, Contractor, and Subcontractor with addresses, telephone numbers, and contacts.
  4. Table of Contents describing all index tabs.
  5. Listing of all Subcontractors and major equipment suppliers with addresses, telephone numbers, and contacts.
  6. Index tabs dividing information by specification section, major equipment, or systems. All tab titles shall be clearly printed under reinforced plastic tabs. Label all equipment to match the identification in the construction documents.
  7. Copies of warranties.
  8. Copies of all final approved shop drawings and submittals. Copy of power system study and overcurrent protective device settings.
  9. Copies of all factory inspection and/or equipment start-up reports.
- C. Operation and maintenance data shall consist of written instructions for the care, maintenance, and operation of the equipment and systems. Instruction books, cards, manuals furnished with the equipment shall be included.

## 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
  - 1. Maintenance of equipment.
  - 2. Start-up procedures for all major equipment.
  - 3. Description of emergency system operation.
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to the Owner's representative so his representative can be present if desired.
- F. Minimum hours of instruction time for each item and/or system shall be as indicated in each individual specification section.
- G. Operating Instructions:
  - 1. Contractor is responsible for all instructions to the Owner's representatives for the electrical and specialized systems.
  - 2. If the Contractor does not have staff that can adequately provide the required instructions, he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

## 3.7 RECORD DOCUMENTS

- A. The following paragraphs supplement the requirements of Division 1.
- B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

## 3.8 PAINTING

- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.
- B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor. Painting shall be performed as described in project specifications.
- C. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chipping, etc. If color option is specified or is standard to the unit, verify with the Architect his color preference before ordering.

## 3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

## 3.10 SPECIAL REQUIREMENTS

- A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.
- B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.

## 3.11 SYSTEM COMMISSIONING

- A. The electrical systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.
1. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

## 3.12 FIELD QUALITY CONTROL

## A. General:

1. Conduct all tests required during and after construction.
2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
4. Any wiring device, electrical apparatus or lighting fixture, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than the National Electrical Code Standards. Take readings between conductors, and between conductors and ground.
6. If the results obtained in the tests are not satisfactory make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.

## B. Ground Resistance:

1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Architect/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)
2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. If the ground resistance value obtained is more than the value set forth in Section 26 05 26, the following shall be done to obtain the value given:
    - a. Verify that all connections in the service ground system are secure.
    - b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.
    - c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.
    - d. Review results with the Architect/Engineer.
  4. Before final payment is made to the Contractor submit a written report to the Architect/Engineer including the following:
    - a. Date of test.
    - b. Number of hours since the last rain.
    - c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.
    - d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.
    - e. Make, model, and calibration date of test equipment.
    - f. Tabulation of measurements taken and calculations made.
- C. Other Equipment:
1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.
- D. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.

END OF SECTION 26 05 00



READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

In order to prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations of fire-rated construction fire sealed in accordance with specifications.
2. Electrical panels have typed circuit identification.
3. Per Section 26 05 00, cable insulation test results have been submitted.
4. Per Section 26 05 00, ground resistance test results have been submitted.
5. Operation and Maintenance manuals have been submitted as per Section 26 05 00.
6. Bound copies of approved shop drawings have been submitted as per Section 26 05 00.
7. Report of instruction of Owner's representative has been submitted as per Section 26 05 00.
8. Fire alarm inspection and testing report has been submitted as per Sections 26 05 00 and 28 31 00.
9. Start-up reports from factory representative have been submitted as per Section 26 05 00.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

\* \* \* \* \*



## SECTION 26 05 13 - WIRE AND CABLE

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Building wire
- B. Remote control and signal cable

## PART 2 - PRODUCTS

## 2.1 BUILDING WIRE

- A. Feeders and Branch Circuits: Copper, stranded conductor, 600 volt insulation, THHN/THWN.
- B. Feeders and Branch Circuits in Underground Conduit: Copper, stranded conductor, 600 volt insulation, THWN.
- C. Control Circuits: Copper, stranded conductor 600 volt insulation, THHN/THWN.
- D. Aluminum conductors are not to be used.

## 2.2 REMOTE CONTROL AND SIGNAL CABLE

- A. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600 volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- B. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

## PART 3 - EXECUTION

## 3.1 WIRE AND CABLE INSTALLATION SCHEDULE

- A. Above Accessible Ceilings: Building wire in raceways. Low voltage cable (less than 100 volts) may be installed without conduit but shall be plenum rated.
- B. All Other Locations: Building wire in raceway.
- C. Above Grade: All conductors installed above grade shall be type "THHN".
- D. Underground or In Slab: All conductors shall be type "THWN".

### 3.2 WIRE FOR SPECIALIZED SYSTEMS

- A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed:
1. Fire alarm
  2. Low voltage switching

### 3.3 CONTRACTOR CHANGES

- A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.16. Service entrance conductors are based on copper conductor installed in underground electrical ducts, NEC Table B.310.15(B)(2)(7).
- B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.
- C. Underground electrical duct ampacity rating shall be in accordance with NEC Table B.310.15(B)(2)(7) or calculated in accordance with Annex B Application Information for Ampacity Calculation. The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.
- D. Record drawing shall include the calculations and sketches.

### 3.4 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.
- B. Use no wire smaller than 18 AWG for low voltage control wiring (<100 volts).
- C. Use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 75 feet.
- D. Use no wire smaller than 8 AWG for outdoor lighting circuits.
- E. The ampacity of multiple conductors in one conduit shall be derated per National Electrical Code, Article 310. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, etc.
- F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.
- G. Splice only in junction or outlet boxes.
- H. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- I. Make conductor lengths for parallel circuits equal.
- J. All conductors shall be continuous in conduit from last outlet to their termination.

- K. Terminate all spare conductors on terminal blocks, and label the spare conductors.

### 3.5 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially thru raceway.
- D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.
- E. Cables or wires shall not be laid out on the ground before pulling.
- F. Cables or wires shall not be dragged over earth or paving.
- G. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
- H. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.
- I. Only nylon rope shall be permitted to pull cables into conduit and ducts.
- J. At least six (6) inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.
- K. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.
- L. Completely and thoroughly swab raceway system before installing conductors.

### 3.6 CABLE INSTALLATION

- A. Provide protection for exposed cables where subject to damage.
- B. Use suitable cable fittings and connectors.
- C. Run all open cable in a neat and symmetrical manner. Follow the routing as illustrated on the drawings as closely as possible. If routing is not illustrated then the Contractor shall choose his own routing, but in any case it shall be run in a manner previously stated.
- D. Open cable shall be supported by the appropriate size bridle rings or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same bridle rings.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.
- F. Where open cables are grouped, they shall be neatly bundled and held together with nylon tie wraps placed every 2.5 ft. on the bundle. Where tie bundle passes through a bridle ring it shall be fastened to the ring with a tie wrap.
- G. Bridle ring supports shall be installed at a minimum of five foot (5') intervals. All rings shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc.
- H. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

## 3.7 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice and tap only in accessible junction boxes.
- B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for copper conductor terminations, 8 AWG and larger.
- C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.
- D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.
- E. Use copper, compression connectors applied with circumferential crimp for copper wire splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.
- I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, and the like, the connections to phase conductors are intended thus:
  - 1. Facing the front and operating side of the equipment, the phase identification shall be:
    - a. Left to Right - A-B-C
    - b. Top to Bottom - A-B-C
- J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

## 3.8 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Building Wire and Power Cable Testing: Test shall be made by means of an insulation testing device such as a "Megger" using not less than 500 volts D.C. test potential.
- C. Inspect wire and cable for physical damage and proper connection.
- D. Torque test conductor connections and terminations to manufacturers recommended values.
- E. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

END OF SECTION 26 05 13





## SECTION 26 05 26 - GROUNDING AND BONDING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Equipment grounding system
- B. Bonding system
- C. Grounding electrode system

## 1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 Grounding and Bonding Equipment.

## 1.3 SUMMARY

- A. This section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

## PART 2 - PRODUCTS

## 2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section 26 05 13 "Wire and Cable".
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Sizes and types below are typical. Adjust to suit Project conditions and requirements.
- F. Copper Bonding Conductors: As follows:
  - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
  - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
  - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

G. **[IBT]:** Intersystem Bonding Termination:

1. Copper bar, 1/4" x 2" x 2". Provide with wall mounting brackets, insulators and pre-tapped holes.
2. Approved Manufacturers: Harger GBI Series, Erico B544 Series.

## 2.2 CONNECTOR PRODUCTS

- A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Connectors: Hydraulic compression type or exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- C. Bolted Connectors: Bolted-pressure-type connectors.

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.
- B. Concrete-Encased Grounding Electrode (Ufer): Fabricate according to NFPA 70, Paragraph 52-(3), using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG or 20 feet (6.0 m) of 1/2" (13mm) steel reinforcing bar.

## PART 3 - EXECUTION

## 3.1 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
  2. Make connections with clean, bare metal at points of contact.
  3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.
- G. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

## 3.2 INSTALLATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.
- C. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.
- D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then use a bolted clamp. Bond straps directly to the basic structure, taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- E. In raceways, use insulated equipment grounding conductors.

### 3.3 EQUIPMENT GROUNDING SYSTEM

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.

### 3.4 BONDING SYSTEM

- A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.
- B. Isolated Equipment Enclosure: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment bonding conductor.
- C. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.
- D. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
- E. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.

### 3.5 GROUNDING ELECTRODE SYSTEM

- A. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.
- B. Provide bonding at Utility Company's metering equipment and pad mounted transformer.
- C. Ground Rods: Install at least two rods spaced at least 20 feet from each other and located at least the same distance from other grounding electrodes.
  - 1. Drive ground rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.
  - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- F. Concrete-Encased Grounding Electrode (Ufer): Install concrete-encased grounding electrode encased in at least 2 inches (50 mm) of concrete horizontally within the foundation that is in contact with the earth. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

## 3.6 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
  - 1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
  - 2. Testing: Perform the following field quality-control testing:
    - a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
    - b. Test completed grounding system at each location where a maximum ground-resistance level is specified and at service disconnect enclosure grounding terminal. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
    - c. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
      - 1) Equipment Rated 500 kVA and Less: 10 ohms.
    - d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26



## SECTION 26 05 27 - SUPPORTING DEVICES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Conduit and equipment supports
- B. Fastening hardware

## 1.2 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. Allied Support Systems
- B. Cooper B-Line
- C. Erico, Inc.
- D. Hilti
- E. Power Fasteners

## 2.2 MATERIAL

- A. Support Channel: Hot-dip galvanized for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.
- B. Hardware: Corrosion resistant.
- C. Anchorage and Structural Attachment Components:
  - 1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.
    - a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
  - 2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
  - 3. Welding Lugs: Comply with MSS-SP-69, Type 57.
  - 4. Beam clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## D. Conduit Sleeves and Lintels:

1. Each Contractor shall provide, to the General Contractor for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.
2. Refer to Structural plans and specifications for lintel requirements and sizes.
3. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Architect or Structural Engineer.
4. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable.
5. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
6. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
7. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
8. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
9. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
10. Size sleeves large enough to allow expansion and contraction movement.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.
- B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs.
- C. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Do not use powder-actuated anchors without specific permission.
- E. Do not drill structural steel members.
- F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- G. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting. Provide steel channel supports to stand surface-mounted panelboard or cabinet one inch off wall.
- H. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- I. Refer to Section 26 05 33 for special conduit supporting requirements.

## 3.2 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
- B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION 26 05 27



## SECTION 26 05 33 - CONDUIT AND BOXES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Rigid metallic conduit and fittings
- B. Electrical metallic tubing and fittings
- C. Flexible metallic conduit and fittings
- D. Liquidtight flexible metallic conduit and fittings
- E. Rigid non-metallic conduit and fittings
- F. Wall and ceiling outlet boxes
- G. Electrical connection
- H. Pull and junction boxes
- I. Accessories

## 1.2 REFERENCES

- A. Definitions:
  - 1. Fittings: Conduit connection or coupling.
  - 2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
  - 3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
  - 4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.
  - 5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
  - 6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
  - 7. Slab: Horizontal pour of concrete used for the purpose of a floor or sub-floor.

## PART 2 - PRODUCTS

## 2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

- A. Acceptable Manufacturers:
  - 1. Acceptable Manufacturers: Allied, LTV, Steelduct, Wheatland Tube Co, O-Z Gedney, or approved equal.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Acceptable Manufacturers of RMC Conduit Fittings: Appleton Electric, O-Z/Gedney Co., Electroline, Raco, Bridgeport, Midwest, Regal, Thomas & Betts, Crouse-Hinds, Killark, or approved equal.
- B. Fittings and Conduit Bodies:
1. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
  2. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
  3. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**
  4. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.
- C. PVC Externally Coated Conduit: NEMA RN 1; rigid steel conduit with external 40 mil PVC coating and internal galvanized surface. All fittings and conduit bodies shall be complete with coating. Acceptable Manufacturers: Robroy, Permacote, or approved equal.

## 2.2 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Acceptable Manufacturers of EMT Conduit: Allied, LTV, Steelduct, Wheatland Tube Co, or approved equal.
- B. Fittings and Conduit Bodies:
1. Compression or steel set screw type of steel designed for their specific application.
  2. Acceptable Manufacturers of EMT Conduit Fittings: Appleton Electric, O-Z/Gedney Co., Electroline, Raco, Bridgeport, Midwest, Regal, Thomas & Betts, or approved equal.

## 2.3 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

- A. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit with #12 AWG THHN conductors and an insulated ground wire.
- B. Acceptable Manufacturers: American Flex, Alflex, Electri-Flex Co, or approved equal.
- C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## D. Fittings and Conduit Bodies:

1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Acceptable Manufacturers: O-Z/Gedney Co., Thomas & Betts, Appleton Electric, Electroline, Bridgeport, Midwest, Regal, or approved equal.

## 2.4 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

- A. Acceptable Manufacturers: Anaconda Type UA, Electri-Flex Type LA, Alflex, Carlon (Lamson & Sessions), or approved equal.
- B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.
- C. Fittings and Conduit Bodies:
  1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
  2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
  3. Acceptable Manufacturers: Appleton Electric, O-Z/Gedney Co., Electroline, Bridgeport, Thomas & Betts, Midwest, Regal, Carlon (Lamson & Sessions), or approved equal.

## 2.5 RIGID NON-METALLIC CONDUIT (RNC) AND FITTINGS

- A. Acceptable Manufacturers: Carlon (Lamson & Sessions) Type 40, Cantex, J.M. Mfg., or approved equal.
- B. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.
- C. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
- D. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

## 2.6 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, minimum of 14 gauge, with 1/2 inch male fixture studs where required.
- B. Cast Boxes: NEMA FB1, Type FD, Aluminum or cast ferrous alloy, deep type, gasketed cover, threaded hubs.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.
- D. Switch outlet boxes for local light control switches and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.
- E. Receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.7 **[ECONN]: ELECTRICAL CONNECTION**

- A. Electrical connection to equipment and motors, sized per NEC. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.8 **[JB]: PULL AND JUNCTION BOXES**

- A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.
- C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

2.9 **ACCESSORIES**

- A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes. Kinetics Noise Control – IsoBacker Pad, SpecSeal – SSP Putty and Pads, 3M #MPP-4S or equal.

## PART 3 - EXECUTION

3.1 **CONDUIT SIZING**

- A. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to N.E.C. (Latest Edition). Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the National Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Minimum Conduit Size (Unless Noted Otherwise):
1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
  2. Below Grade 5' or less from Building Foundation: 1 inch.
  3. Below Grade More than 5' from Building Foundation: 1 inch.
  4. Telecommunication Conduit: 1 inch.
  5. Controls Conduit: 1/2 inch.
- C. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

## 3.2 CONDUIT ARRANGEMENT

- A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian traffic.
- B. Conduit shall not share the same cell as structural reinforcement in masonry walls.
- C. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.
- D. Contractor shall adapt his work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.
- E. Contractor shall cooperate with all Contractors on the project. He shall obtain details of other Contractor's work in order to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by him. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

## 3.3 CONDUIT SUPPORT

- A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.
- C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.
- D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1-1/2" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.
- F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.
- G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the National Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.
- J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.
- K. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.
- L. Finish:
  - 1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
  - 2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 3.4 CONDUIT INSTALLATION

## A. Conduit Connections:

1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

## B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

## C. Conduit Bends:

1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
2. All bends of rigid non-metallic conduit (RNC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.
4. Telecommunications conduits shall have no more than two (2) 90 degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.
  - a. A third bend is acceptable if:
    - 1) The total run is not longer than (33) feet.
    - 2) The conduit size is increased to the next trade size.
5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter into the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
6. Telecommunications conduit bend radius shall be six (6) times the diameter for conduits under 2" and ten (10) times the diameter for conduits over 2".

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

7. Rigid non-metallic conduit (RNC) runs longer than 100 feet or runs which have more than two 90° equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.
8. Use conduit bodies to make sharp changes in direction (i.e. around beams).

## D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets. All metallic conduits shall be bonded per the National Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. Seal penetrations with intumescent caulk, putty, or sheet installed per manufacturer's recommendations. All materials used to seal penetrations of firewalls and floors shall be tested and certified as a system per ASTM E814 Standard for fire tests or through-penetration fire stops as manufactured by 3M or approved equal.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, equal to O-Z/Gedney type EYD.
9. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.
10. Do not route conduits in slabs on grade, but under.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

11. Rigid non-metallic conduit (RNC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.
12. Where rigid non-metallic conduit (RNC) conduit is used below grade, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
13. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
14. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.
15. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3" above finished floor (AFF).
16. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4" below ceiling and as close to the wall as possible.
17. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4" above finished floor (AFF) and as close to the wall as possible.

## 3.5 CONDUIT TERMINATIONS

- A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, or approved equal.
- B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.
- C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.
- D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.
- E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the National Electrical Code, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.
- F. Rigid non-metallic conduit (RNC) conduit shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.

- G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of any and all foreign matter prior to any wires or pull cords being installed.

## 3.6 UNDERGROUND CONDUIT INSTALLATION

## A. Conduit Connections:

1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.

## B. Conduit Bends (Lateral):

1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.
2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.

## C. Conduit Elbows (vertical):

1. Minimum metal or RTRC elbow radiuses shall be 18 inches for secondary conduits (<600V). Increase radius, as required, based on pulling tension calculation requirements.

## D. Conduit Placement:

1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.
3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum  $f'c = 2500$  and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
4. Before the Contractor pulls any cables into the conduit he shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

5. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
  6. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
  7. All non-metallic conduit installed underground outside of a slab shall be rigid.
- E. Raceway Seal:
1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.
  2. All telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault with "JackMoon" or equivalent duct seal, capable of withstanding a 10 foot head of water (5 PSI).

## 3.7 CONDUIT INSTALLATION SCHEDULE

- A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If This Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the National Electrical Code shall be required.
- B. The following schedule shall be adhered to unless they constitute a violation of applicable codes or are noted otherwise on the drawings. The installation of RMC conduit will be permitted in place of any and all conduit specified in this schedule.
1. Exposed:
    - a. Panel feeders, etc.: EMT.
    - b. Branch Circuits (lighting, receptacles, controls, etc.): EMT.
    - c. Mechanical Equipment Feeders (pumps, AHU's, etc.): EMT.
    - d. Floor Mounted Pump Feeders: EMT with no more than 6' of PVC coated flexible metal conduit to pump.
    - e. Controls: EMT painted blue or dyed blue.
  2. Finished Spaces/Concealed: EMT.
  3. Wet or Damp Locations: RMC conduit, boxes and fittings, installed and equipped so as to prevent water from entering the conduit system.
  4. Corrosive Locations (Seal Building Life Safety Areas): PVC Coated Rigid Metal conduit, boxes and fittings installed and equipped so as to prevent water from entering the conduit system.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

5. Under Slabs on Grade or Site Conduits:
  - a. Within 5' from the Exterior Perimeter of a Building Foundation: RMC Concrete encased RNC conduit with a minimum of 3" thickness between the surface of the concrete and the nearest conduit. Concrete to be doweled into the foundation.
  - b. 5' or Greater from the Exterior Perimeter of a Building Foundation: RNC RMC.
6. Interior Locations:
  - a. Exposed: EMT.
  - b. Concealed: EMT.

## 3.8 BOX INSTALLATION SCHEDULE

- A. Galvanized steel boxes may be used except where cast boxes are required.
- B. Cast boxes shall be used in:
  1. Exterior locations.
  2. Wet locations.
  3. Kitchens when exposed on wall surface.

## 3.9 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.
- C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer and General Contractor.
- D. Locate and install to maintain headroom and to present a neat appearance.
- E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

## 3.10 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls.
  1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, install fire-rated moldable pads to all five sides of the back box to maintain the fire-rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire-rating.
- B. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)
- C. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.
- D. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- E. Provide knockout closures for unused openings.
- F. Support boxes independently of conduit.
- G. Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- H. Install boxes in walls without damaging wall insulation.
- I. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes.
- J. Position outlets to locate luminaires as shown on reflected ceiling drawings.
- K. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
- L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- N. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

## 3.11 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- B. Support pull and junction boxes independent of conduit.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Do not install boxes back-to-back in walls.
  - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
  - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, install fire-rated moldable pads to all five sides of the back box to maintain the fire-rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire-rating.

## 3.12 EXPOSED BOX INSTALLATION

- A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.
- B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.
- C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.
- D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.
- E. Wood, plastic, or fiber plugs shall not be used for fastenings.
- F. Explosive devices shall not be used unless specifically allowed.

END OF SECTION 26 05 33



## SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Nameplates and tape labels
- B. Wire and cable markers
- C. Conductor color coding
- D. Electrical gear labeling
- E. Power distribution equipment labeling

## PART 2 - PRODUCTS

## 2.1 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- B. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.
- C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- D. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F. Provide ties in specified colors when used for color coding.
- E. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.
- F. Aluminum, Wraparound Marker Bands: 1" in width, .014 inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- G. Brass or aluminum Tags: 2" by 2" by .05-inch metal tags with stamped legend, punched for fastener.
- H. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label, minimum of 3/4" high x 9/16" wide, with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 2.2 NAMEPLATES AND SIGNS

- A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners. Engraving legend shall be as follows:
  - 1. Black letters on white face for normal power.
- B. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- C. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with .0396 inch galvanized-steel backing; and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- D. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- E. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

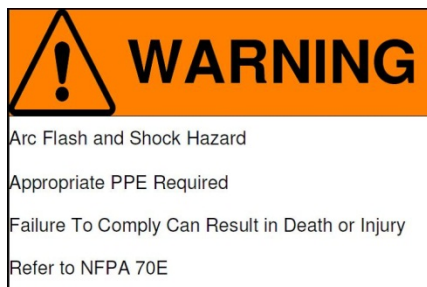
## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.
- B. Install identification devices in accordance with manufacturer's written instruction and requirements of NEC.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.
- D. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch Kroy tape or Brother self-laminating vinyl label, or permanent magic marker, neatly hand printed. In rooms that are painted out, provide labeling on inside of cover.
- E. Circuit Identification: Tag or label conductors as follows:
  - 1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
  - 2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- F. Apply warning, caution and instruction signs as follows:
1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
  2. Emergency Operating Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- G. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.
- H. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- I. Install ARC FLASH WARNING signs on all panelboards. Sign at a minimum shall contain:



- J. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single marker.

## 3.2 DEVICE COVER PLATES

- A. Provide identification on all device cover plates. Identification shall indicate source and circuit number serving the device (i.e. "S #24").

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-laminating vinyl label with black letters in normal size “Swiss 721 Bold” font. Letter and number size to 3/16-inch high. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the device openings.

## 3.3 BOX LABELING

- A. All junction, pull, and connection boxes shall be identified as follows:
  - 1. For power and lighting circuits, indicate system voltage and identity of contained circuits (“120V, B-3,5,7”).
  - 2. For other wiring, indicate system type and description of wiring (“FIRE ALARM NAC #1”).
- B. Box covers shall be painted to correspond with system type as follows:
  - 1. Fire Alarm: Red
  - 2. Temperature Control/Building Automation: Blue

## 3.4 CONDUCTOR COLOR CODING

- A. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.
- B. All wires and cables, 6 AWG or larger, shall be coded by the application of plastic tape. The tape shall be 3-M, Plymouth or Permacel, in colors specified below. The tape shall be applied at each conductor termination with two 1-inch tape bands at 6-inch centers. Contractor option to use colored cabling in lieu of the tape at each end for conductor 6 AWG to 500 KCM.
- C. Wire and cables smaller than 6 AWG shall be color coded by the manufacturer.
- D. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.
- E. Conductors shall be color coded as follows:
  - 1. 208Y/120 Volt, 4-Wire:
    - a. A-Phase – Black
    - b. B-Phase – Red
    - c. C-Phase – Blue
    - d. Neutral – White
    - e. Ground Bond – Green

## 3.5 CONTROL EQUIPMENT IDENTIFICATION

- A. Provide identification on the front of all control equipment, such as disconnect switches, starters, VFDs, etc. Nameplate text shall be a minimum of 1/4” high.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Labeling shall include:
1. Equipment type and contract documents designation of equipment being served.
  2. Location of equipment being served if it is not located within sight.
  3. Voltage and phase of circuit(s).
  4. Panel and circuit number(s) serving the equipment.

## 3.6 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

- A. Provide identification on the front of all power distribution equipment, such as panelboards, etc. The identification material shall be engraved plastic-laminated labels. Text shall be a minimum of 1/4" high, Swiss 721 Bold.
- B. Labeling shall include:
1. Equipment type and contract documents designation of equipment.
  2. Voltage of the equipment.
  3. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
- C. A separate nameplate for the service entrance equipment shall be labeled with the **MAXIMUM AVAILABLE FAULT CURRENT** and **DATE** of calculation given on the one-line diagram.
- D. Distribution panelboards shall have each overcurrent protection device identified with name and location of the load being served.
- E. Branch panelboards shall be provided with typed panel schedules upon completion of the project. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 26 05 00 for other requirements.

END OF SECTION 26 05 53



## SECTION 26 09 33 - LIGHTING CONTROL SYSTEMS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Time switches.

## PART 2 - PRODUCTS

## 2.1 TIME SWITCH

- A. **[TC-1]:** Time switch, 7 day astronomic, 1 channel, electronic, one SPDT 20 amp contact, LCD display, 12 or 24 hour format, minimum 100 hours carryover, UL listed.
  - 1. Approved Manufacturers: Paragon, Tork, Intermatic.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify that required utilities are available, in proper location, and ready for use.

## 3.2 INSTALLATION

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

END OF SECTION 26 09 33





## SECTION 26 20 00 - SERVICE ENTRANCE

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Arrangement with Utility Company for permanent electric service
- B. Underground service entrance

## 1.2 RELATED SECTIONS AND WORK

- A. Refer to the One-Line Diagram for additional information.

## 1.3 QUALITY ASSURANCE

- A. Utility Company: Madison Gas and Electric.
- B. Install service entrance in accordance with Utility Company's rules and regulations.

## 1.4 SYSTEM DESCRIPTION

- A. System Voltage: 208Y/120 volts, three phase, four-wire, 60 Hertz.

## PART 2 - PRODUCTS

## 2.1 METERING EQUIPMENT

- A. Meter: Furnished by the Utility Company.
- B. Meter Base: Furnished by the Contractor, as approved by the Utility Company.
- C. Exterior Mounted Metering Cabinets: Furnished and installed by the Contractor to Utility Company's specifications.

## 2.2 IDENTIFICATION

- A. Provide a permanent plaque or sign denoting all services, feeders, and branch circuits supplying the building or structure and the area served by each. Install plaque or sign at each service disconnecting means.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Make arrangements with Utility Company to obtain permanent electric service to the Project.
- B. Primary distribution equipment and pad-mounted transformers shall be furnished and installed by the Utility Company.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Primary conductors shall be furnished, installed, and terminated by the Utility Company. Primary conduit shall be furnished and installed by the Contractor, as needed, to the Utility Company's requirements.
- D. Concrete Pad for Transformer: Furnished and installed by the Utility Company.

END OF SECTION 26 20 00

## SECTION 26 24 16 - PANELBOARDS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Distribution panelboards: MDP-#
- B. Lighting and appliance branch circuit panelboards: [Panel '###']

## 1.2 RELATED SECTIONS AND WORK

- A. Refer to the One-Line Diagram and Panel Schedules for size, rating, and configuration.

## 1.3 SUBMITTALS

- A. Submit shop drawings for equipment and component devices under provisions of Section 26 05 00.
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.

## 1.4 SPARE PARTS

- A. Keys: Furnish four (4) each to the Owner.

## PART 2 - PRODUCTS

## 2.1 RATINGS

- A. Definitions:
  - 1. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.
- B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

## 2.2 DISTRIBUTION PANELBOARDS

- A. General
  - 1. Approved Manufacturers:
    - a. Square D, I-Line
    - b. General Electric Spectra ADS
    - c. Siemens F2, P4
    - d. Cutler Hammer PRL4, PRL5
- B. Panelboards: NEMA PB 1; type as shown on the drawings.
- C. Enclosure: NEMA PB 1; Type 1.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Provide cabinet front with front hinged to box and hinged door with flush lock. Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with aluminum or copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- F. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
- G. Suitable for use as service entrance equipment.

## 2.3 BRANCH CIRCUIT PANELBOARDS

- A. General
  - 1. Approved Manufacturers:
    - a. Square D NQ
    - b. General Electric AQ, AE
    - c. Siemens P1
    - d. Cutler Hammer PRL1, PRL2
- B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.
- C. Enclosure: NEMA PB 1; Type 1.
- D. Provide cabinet front with front hinged to box and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- F. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.
- G. Minimum Integrated Short Circuit Rating: As shown on the drawings.
- H. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.
- I. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Height: 6 feet to handle of highest device.
- C. Provide filler plates for unused spaces in panelboards.
- D. Provide typed circuit directory for each branch circuit panelboard. Label each circuit with the type of load and the name and number of the area served. Revise directory to reflect circuit changes required to balance phase loads.

## 3.2 FIELD QUALITY CONTROL

- A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

END OF SECTION 26 24 16



## SECTION 26 24 19 - MOTOR CONTROL

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Manual motor starters
- B. Magnetic motor starters
- C. Combination magnetic motor starters

## 1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule and One-Line Diagram for rating and configuration.

## 1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 26 05 00.
- B. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and over-current protective devices.
- C. Submit manufacturer's instructions under provisions of Section 26 05 00.

## 1.4 SPARE PARTS

- A. Fuses: Furnish three (3) spare fuses of each type and rating installed to the Owner.
- B. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 26 05 00.
- B. Deliver individually wrapped for protection, and mounted on shipping skids.
- C. Store and protect products under provisions of Section 26 05 00.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from fumes, dirt, water, construction debris, traffic, and physical damage.
- E. Handle in accordance with manufacturer's written instructions. Handle carefully to avoid damage to components, enclosure, and finish.

## 1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 26 05 00.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## PART 2 - PRODUCTS

## 2.1 MANUAL MOTOR STARTERS

- A. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, and toggle operator.

## 2.2 MAGNETIC MOTOR STARTERS

- A. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- B. Full Voltage Starting: Non-reversing type, unless otherwise indicated.
- C. Coil Operating Voltage: 120 volts, 60 Hertz, obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating, and control devices, plus 100% spare capacity.
- D. Size: NEMA ICS 2; size as shown on the drawings.
- E. Overload Relay:
  - 1. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- F. Enclosure: NEMA ICS 6; Type 1.
- G. Combination Motor Starters: Combine motor starters with disconnect switch in common enclosure. Provide with disconnecting means as indicated on drawings.
- H. Auxiliary Contacts: NEMA ICS 2; two normally open, field convertible contacts in addition to seal-in contact.
- I. Indicating Lights: NEMA ICS 2; RUN: red in front cover.
- J. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.
- K. Control Power Transformers: 120 volt fused secondary, fused primary, minimum VA as scheduled:  
Size 1 - 100 VA

## 2.3 CONTROLLER OVER-CURRENT PROTECTION AND DISCONNECTING MEANS

- A. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Provide with Class 'R' rejection clips. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory. Fuses to be 250 volt, Class RK-5.



## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions.
- B. Install fuses in fusible switches.
- C. Set field-adjustable overloads to match installed motor characteristics.
- D. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

END OF SECTION 26 24 19



## SECTION 26 27 26 - WIRING DEVICES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Device plates and box covers
- B. Receptacles including GFCI and/or weather resistant
- C. Wall switches
- D. Indoor occupancy sensors
- E. Cord and plug sets

## 1.2 QUALITY ASSURANCE

- A. Provide similar devices from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency to Authorities Having Jurisdiction and marked for intended use.
- C. Comply with NFPA 70.

## 1.3 COORDINATION

- A. Cord and Plug Sets: Match equipment requirements.

## PART 2 - PRODUCTS

## 2.1 DEVICE COLOR

- A. All switch, receptacle, and outlet colors shall be ivory, unless indicated otherwise.

## 2.2 COVERPLATES

- A. All switches, receptacles, and outlets shall be complete with the following:
  - 1. #302 stainless steel coverplates.
  - 2. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.
- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 26 05 53.
- D. Plate securing screws shall be metal with head color matching the wall plate finish.

## 2.3 RECEPTACLES

- A. Refer to Electrical Symbols List for device type.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. **[REC-DUP]:** NEMA 5-20R Duplex Receptacle:
1. 125 volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap.
  2. Approved Manufacturers: Hubbell 5352A, Leviton, 5362-S, Pass & Seymour 5362, Cooper 5352.
- C. **[REC-DUP-GFI]:** NEMA 5-20R Ground Fault Duplex Receptacle:
1. 125 volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.
  2. Approved Manufacturers: Hubbell GF20L, Leviton 7899, Pass & Seymour 2095, Cooper VGF20.
- D. **[REC-DUP-WP]:** NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:
1. 125 volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face. Provide NEMA 3R rated while-in-use cast aluminum cover.
  2. Approved Manufacturers: Hubbell GFTR20, Leviton W7899-TR, Pass & Seymour 2095TRWR, Cooper TWRVGF20.
- E. **[REC-SIM-530R]:** NEMA 5-30R Simplex Receptacle:
1. 125 volt, 30 amp, 3-wire grounding type, phenolic face.
  2. Approved Manufacturers: Hubbell HBL9308, Leviton 5371, Pass & Seymour 3802, Cooper 5716N.
- F. **[REC-SIM-650R]:** NEMA 6-50R Simplex Receptacle:
1. 250 volt, 50 amp, 2-pole, 3-wire grounding type with thermoplastic face.
  2. Approved Manufacturers: Hubbell HBL9367, Leviton 5374, Pass & Seymour 3804, Cooper 5709N.
  3. Provide matching cord and plug set.
- G. **[REC-SIM-L630R]:** NEMA L6-30R Locking Type Simplex Receptacle:
1. 250 volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
  2. Approved Manufacturers: Hubbell HBL2620, Leviton 2620, Pass & Seymour L630R, Cooper CWL630R.
- H. **[REC-SIM-L1430R]:** NEMA L14-30R Locking Type Simplex Receptacle:
1. 125/250 volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face.
  2. Approved Manufacturers: Hubbell HBL 2710, Leviton 2710, Pass & Seymour L1430R, Cooper CWL1430R.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. Provide matching cord and plug set.
- I. **[REC-QUAD]:** NEMA 5-20R Double Duplex Receptacle:
    1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.
    2. Approved manufacturers: Refer to Duplex Receptacle above.
  - J. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.
  - K. Side wired devices shall have four binding screws that are undercut for positive wire retention.
  - L. Ground Fault Circuit Interrupter (GFCI) receptacles shall comply with the 2006 edition of U.L. 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.

## 2.4 WALL SWITCHES

- A. Refer to Electrical Symbols List for device type.
- B. **[SW-1P]:** Single Pole Switch:
  1. Single throw, 120/277 volt, 20 amp maintained contact, 1 horsepower rated. Toggle handle, side and back wired.
  2. Approved Manufacturers: Hubbell HBL1221, Leviton 1221-2, Pass & Seymour PS20AC1, Cooper AH1221.
- C. **[SW-1P-ADJ]:** Local Timer Switch:
  1. User adjustable timeout, 120/277 volt, 800/1200 watt rating. No minimum load requirement. Flashes lights one minute before timeout.
  2. Approved Manufacturers: Watt Stopper TS-400, Hubbell Automation TD200.
- D. **[SW-1P-WP]:** Weatherproof Single Pole Switch:
  1. Single throw, 120/277 volt, 20 amp maintained contact. Toggle handle, side and back wired. Provide with weatherproof coverplate.
  2. Approved Manufacturers: Hubbell1221/HBL1795, Leviton 1221-2, Taymac MM180, Pass & Seymour PS20AC1/CA1-GL, Cooper 2221.
- E. **[SW-3W]:** Three-way Switch:
  1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
  2. Approved Manufacturers: Hubbell 1223, Leviton 1223-2, Pass & Seymour PS20AC3, Cooper AH1223.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- F. **[SW-3W-WP]:** Weatherproof Three-way Switch:
1. 120/277 volt, 20 amp. Toggle handle, side and back wired. Provide with weatherproof coverplate.
  2. Approved Manufacturers: Hubbell 1223, Leviton 1223-2, Pass & Seymour PS20AC3, Cooper AH1223.
- G. **[SW-4W-WP]:** Weatherproof Four-way Switch:
1. 120/277 volt, 20 amp. Toggle handle, side and back wired. Provide with weatherproof coverplate.
  2. Approved Manufacturers: Hubbell 1224, Leviton 1224-2, Pass & Seymour PS20AC4, Cooper AH1224.

## 2.5 LOCAL DAYLIGHTING CONTROLS

- A. Standalone photo cell.
- B. **[SW-LS-PC]:** Standalone Exterior Photo Sensors:
1. Sensor shall be within a weatherproof enclosure, with design operation in temperatures of -30°F to +130°F. Sensor shall have threaded stem for box mounting, with knuckle to permit aiming of receptor after installation. Sensor shall be mounted facing north.
  2. Sensor shall contain an integral switching contactor rated for 120 volt operation, with loads of up to 1,800 VA. Contacts shall be configured for zero-crossing closure to provide 100,000 cycle minimum operation.
  3. Sensor shall detect changes in daylight levels to provide triggering of exterior lighting equipment based on the sequence of operation.
  4. Sensor shall be field configurable at the device or via handheld wireless remote controller. Configurable settings shall include:
    - a. Ambient sensitivity range of 5 to 1,500 foot-candles.
    - b. Adjustable setpoint.
    - c. Deadband adjustment by percentage of setpoint.
    - d. Time delay of up to five minutes.
  5. Sensor shall be equipped with a lens cover that can be applied for system testing during daylight conditions.
  6. Approved Manufacturers: Paragon, Tork, Intermatic.

## 2.6 INDOOR OCCUPANCY

- A. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied, with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
  2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
  3. Relay Unit: Dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13 amp tungsten at 120 VAC, and for 1 hp at 120 VAC. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by NFPA 70.
  4. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.
    - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.
    - c. Time Delay and Sensitivity Adjustments: Recessed and concealed.
  5. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.
    - a. Bypass Switch: Override the on function in case of sensor failure.
    - b. Power Supply and Slave Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2" knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.
  6. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.
  7. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.
  8. Warranty: Five (5) year warranty.
- B. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. **[SW-OC-D]:** 360 Degree Coverage Pattern:
    - a. Frequency greater than 40 KHz. Dual sensing verifications (requires both technologies to activate), either technology maintains on status. Adjustable sensitivity and time delay. Sensor shall control all circuits in area, unless noted otherwise. Initial settings: 30 minutes.
    - b. Approved Manufacturers: Watt Stopper DT 300 Series, Hubbell OMNI-DT2000 or ATD2000C, Leviton OSC##-MOW.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Mask sensors where necessary to prevent nuisance switching from adjacent areas.
- D. PIR Type: Detect occupancy by sensing a combination of heat and movement in area of coverage.
  - 1. **[SW-OC-P-O]:** Wall Switch Occupancy Sensor:
    - a. Passive infrared, zero crossing circuitry, adjustable sensitivity and time delay, no minimum load requirements, manual or auto on operation, Initial settings: 10 minutes.
    - b. Approved Manufacturers: Watt Stopper PW-100 Series, Sensor Switch WSD, Hubbell LHIRS1 or AP1277, Leviton ODS15, Greengate OSW-P-0451.
  - 2. **[SW-OC-P-O2]:** Dual Wall Switch Occupancy Sensor:
    - a. Passive infrared, zero crossing circuitry. Switches control two separate circuits or relays. Adjustable sensitivity and time delay, no minimum load requirements, manual or auto on operation, Initial settings: 10 minutes.
    - b. Approved Manufacturers: Watt Stopper PW-200 Series, Sensor Switch WSD-2, Hubbell LHIRD2 or AP127712, Leviton ODS, Greengate OSW-P-0451.
- E. Ultrasonic Type: Ceiling mounting. Detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
  - 1. **[SW-OC-U]:** 360 Degree 20' x 20' Hand Motion Coverage Pattern:
    - a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise. Initial settings: 15 minutes.
    - b. Approved Manufacturers: Watt Stopper WT-1100 series, Hubbell OMNI-US or ATU series, Leviton OSC series, Greengate ODC-U series.

## 2.7 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
  - 1. Cord: Rubber-insulated, stranded copper conductors, with Type SOW-A jacket; with green insulated grounding conductor and equipment rating ampacity plus a minimum of 30 percent.
  - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection, FS/UL listed.



## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install light switches and convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.
- B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.
- C. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.
- D. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.
- E. Install devices and wall plates flush and level.
- F. Install nameplate identification to device cover plates. Identification shall identify panel name and circuit number. Refer to Specification Section 26 05 53 - Electrical Identification.
- G. Identify locations of power packs, control units, and relays above ceiling on record drawing.
- H. Test receptacles for proper polarity, ground continuity and compliance with requirements.

END OF SECTION 26 27 26



## SECTION 26 28 16 - DISCONNECT SWITCHES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Non-fusible switches
- B. Enclosures

## 1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule for rating and configuration.

## 1.3 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Product Data: For each type of enclosed switch, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.
- C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

## 1.4 COORDINATION

- A. Coordinate layout and installation of switches and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## PART 2 - PRODUCTS

## 2.1 NON-FUSIBLE SWITCHES

- A. **[DS-#]:** Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- B. Enclosures: Type as indicated on the disconnect schedule.
- C. Accessories: As indicated on the disconnect schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches where indicated on the drawings.

END OF SECTION 26 28 16

## SECTION 26 28 21 - CONTACTORS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. General-purpose contactors
- B. Lighting contactors
- C. Enclosures

## PART 2 - PRODUCTS

## 2.1 [C-1]: GENERAL-PURPOSE CONTACTORS

- A. Contactors: NEMA ICS 2 and UL 508; electrically held, 2-wire control.
- B. Coil Operating Voltage: 120 volts, 60 Hertz.
- C. Contacts: 6 pole, 30 AMP, 60 Hertz.
- D. Enclosure: ANSI/NEMA ICS 6; Type 1.
- E. Provide solderless pressure wire terminals.

## 2.2 [LC-1]: LIGHTING CONTACTORS

- A. Contactors: NEMA ICS 2 and UL 508; electrically held, 2-wire control.
- B. Coil Operating Voltage: 120 volts, 60 Hertz.
- C. Contacts: As indicated on the drawings.
- D. Enclosure: ANSI/NEMA ICS 6; Type 1.
- E. Provide solderless pressure wire terminals.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction boxes: and equipment enclosures.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

END OF SECTION 26 28 21

## SECTION 26 31 00 - SOLAR PHOTOVOLTAIC SYSTEMS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Photovoltaic Panels and Arrays
- B. Photovoltaic Inverter
- C. Combiner/Disconnect
- D. Photovoltaic Monitoring Equipment and Accessories
- E. Photovoltaic Mounting Systems

## 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in photovoltaic panel or inverter systems with five years documented experience.
- B. Installer: Equipment installer shall be NABCET certified, or be certified by photovoltaic inverter and panel manufacturers.
- C. Operate, commission, and demonstrate seven (7) days of complete photovoltaic system operation prior to turnover to the Owner.
  - 1. Refer to the Part 3 for system commissioning requirements.

## 1.3 SUBMITTALS

- A. Submit product data under provision of Section 26 05 00.
- B. Photovoltaic Panels: Include unit dimensions, weight, material construction, wattage, voltage, current, open circuit voltage, short circuit current, installation and maintenance information, and manufacturer voltage correction factor in information.
- C. Photovoltaic Inverter: Include unit dimensions, weight, installation and maintenance information. Also include the following:
  - 1. Input: DC voltage range, max current input.
  - 2. Output: AC voltage range, total harmonic distortion, power factor, efficiency, maximum current output.
  - 3. General: Power consumption, enclosure type, compliance with references.
  - 4. Environment: Ambient temperature rating, cooling requirements.
- D. Array Mounting frame:
  - 1. Calculations, drawings and installation details shall be designed and sealed by a Professional Engineer licensed in the state where the project is located experienced in solar mounting frame design and installation.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Design of support shall be performed for loading indicated in this specification and structural general notes.
  3. Coordination drawing drawn to scale and coordinating the photovoltaic array with other systems and equipment in the vicinity for use in the development and layout of the mounting frame.
  4. Clear indication of design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.
  5. Plan drawings and details shall be cross-referenced. Details provided are to clearly indicate attachment to structure, correctly representing the fastening requirements.
- E. Provide list of certified installers with proof of certification.
- 1.4 SPARE PARTS
- A. Provide spare parts under provisions of Section 26 05 00.
  - B. Provide three (3) additional fuses of each type and size installed.
  - C. Provide one (1) additional inverter convection cooling fan for each inverter module.
- 1.5 DELIVERY, STORAGE, HANDLING
- A. Store and protect products under provisions of Section 26 05 00.
  - B. Store in warm and dry location or per manufacturer's requirements.
  - C. Handle per manufacturer's requirements.
- 1.6 OPERATION AND MAINTENANCE DATA
- A. Submit data under provision of Section 26 05 00.
  - B. Include description of operation and servicing procedures, list of major components, recommended remedial and preventative maintenance procedures, and list of spare parts.
- 1.7 WARRANTY
- A. Photovoltaic Panels and Array: Provide 20-year warranty for power production under provisions of Section 26 05 00. Equipment shall maintain minimum 80% of the manufacturer-published wattage output rating for 20 years. Provide 5-year workmanship warranty.
  - B. Photovoltaic Inverter: Provide 20-year warranty of equipment and installation.
  - C. Include coverage for travel, parts, and service.



## 1.8 SYSTEM DESCRIPTION

- A. Complete photovoltaic system rated 2 kW DC at STC including photovoltaic panels, inverter system, combiner/disconnects, metering, and reporting equipment. Systems shall be configured to produce 208Y/120 3 phase 4 wire 60 Hz power.
- B. The photovoltaic system shall include a metering system for total system power production and a reporting system to monitor individual components.
- C. The photovoltaic system and inverter shall be configured as a grid inter-tie solar photovoltaic system. The individual inverters shall automatically de-energize their output to the building electrical system and disconnect from the photovoltaic panels upon loss of the utility electrical service. The photovoltaic inverter system shall remain disconnected until the electrical utility voltage has been restored.
- D. Equipment shall be identified for use in solar photovoltaic systems.
- E. Equipment including wiring, fuses, circuit breakers, etc. used in any DC portion of the photovoltaic power system shall be listed for use in DC circuits.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE PHOTOVOLTAIC PANEL MANUFACTURERS

- A. SolarWorld Model SW235 (basis of design)
- B. Kyocera Model KD235GX

## 2.2 PHOTOVOLTAIC PANELS AND ARRAYS

- A. Equipment Ratings:
  - 1. Maximum Rated Power (STC) Pmax: 235 watts
  - 2. Operating Power Point Voltage Umpp: 30 VDC
  - 3. Maximum Power Point Current Impp: 7.89 A
  - 4. Maximum Open Circuit Voltage Uoc: 37.0 VDC
  - 5. Maximum Short Circuit Current Isc: 8.55 A
  - 6. Nominal Operating Cell Temperature Conditions (NOCT) Pmax: 166 watts
- B. Operating Environment Conditions:
  - 1. Operating Temperature: -40 to 90°C
  - 2. Wet location listed
- C. Cell Material: Silicon-based solar cell construction with UV stabilized polymer. Provide with bypass diode technology for partial shading operation.
- D. Panel Construction: Anodized aluminum frame with ground point and tempered glass cover.
- E. Dimensions: 39.4" wide x 1.84" deep x 66" long.
  - 1. Maximum Weight: 47 lbs.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## F. Panel Connections and Terminations:

1. Provide manufacturer's wiring and quick-connect terminations for series creation of module-strings installation of panels.
2. Provide manufacturer wiring to combiner boxes for parallel grouping of module-strings.
3. All exterior wire and terminations shall be listed sunlight resistant.

## 2.3 COMBINER/DISCONNECT

- A. Combination of combiner box and solar array disconnect in a single enclosure.
- B. Load break switch rated 600 VDC maximum with lockout provisions.
- C. Fuse holders rated 30 amp maximum. Terminal blocks for each PV string.
- D. Enclosure: NEMA 4X.

## 2.4 PHOTOVOLTAIC INVERTERS

## A. Acceptable Inverter Manufacturers:

1. SMA America, LLC Model Sunny Boy (basis of design)
2. Xantrex Technology Inc.
3. Fronius USA, LLC Model IG Plus

## B. Equipment Ratings:

1. AC Output Power Rating for Each Inverter: 2,000 watt
2. Output Voltage: 208V, 3 phase
3. Power Factor: 1.0
4. Minimum CEC Efficiency: 95.5%
5. DC Voltage Input Range: 300 to 600 VDC
6. Maximum Array Input per Inverter: 2,500 watt
7. Maximum AC Output Current per Inverter: 3.4 amps
8. Maximum DC Input Current: 30 amps
9. Total Harmonic Distortion: Less than 10%
10. DC Voltage Ripple: Less than 5%
11. Enclosure: NEMA 3R

## C. Operating Environment Condition:

1. Maximum ambient temperature: 113 °F
2. Wet location listed

## D. Inverter Technology: Full DC/AC rectification, real sine-wave output with high frequency pulse width modulation PWM.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Internal Protection: Inverter shall measure utility voltage, current, and impedance. Loss of utility power shall cause inverter to shut down and disconnect its output to the AC bus and input from the DC bus. Inverter shall automatically reconnect to AC output bus and DC input bus upon return of utility source.
- F. The inverter shall be constructed to not allow backfeeding from the electrical utility to the photovoltaic panels or DC input bus.
- G. The inverter shall have integral AC and DC disconnects.
- H. The inverter shall be cooled via a forced air cooling fan.
- I. Inverters shall be provided with Ethernet connection for metering and recording system outputs. Provide communication gateway device(s) as required to connect inverter system to the Owner's LAN or network router.

## 2.5 METERING AND REPORT

- A. Personal Computer Software: Provide manufacturer's software for metering and reporting on personal computer. The Electrical Contractor shall install and provide provision for custom initialization of the photovoltaic system software package.
- B. Displayed and Recorded Data:
  - 1. The following data shall be provided for each photovoltaic inverter and updated every 10 seconds.
    - a. Power
    - b. kWh today
    - c. Total kWh
    - d. Date
    - e. Time
  - 2. The following data shall be provided for the entire photovoltaic system:
    - a. Power
    - b. kWh today
    - c. Total kWh
    - d. Date
    - e. Time
    - f. kWh to utility today
    - g. Total kWh to utility
  - 3. The above information shall be recorded, logged, and compiled by the personal computer software for production and performance evaluation purposes.
  - 4. Provide data reporting and recording of all manufacturers' standard reporting functions and data acquisition reporting.

## 2.6 ARRAY MOUNTING

- A. Basis of design is given so integrator can provide design and installation of an equivalent system that is compatible with the provided modules and structure. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
1. UNIRAC Large Array (U-LA) (Basis of Design)
  2. DPW Direct Power and Water
  3. PROSOLAR
- B. Mounting system requirements Roof mounting system :
1. 35 degree tilt angle.
  2. Wind load requirements: 100 mph and class for the particular application.
  3. 30 pound per square foot snow load.
  4. Total System Weight: 5 lbs/sf.
  5. Provides four mounting supports for each panel in accordance with manufacturer's requirements.
  6. Coordinate final dimensions with architectural drawings and existing conditions.
  7. Structural aluminum members to be mill finish. All brackets and connections to be stainless steel.
  8. Connect mounting system to electrode grounding system.
- C. Provide complete solar array mounting system including rails, splices, fasteners, legs, clamps, standoffs, feet, and anchors.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Photovoltaic cabling shall be installed in raceways separate from other building system cabling. Photovoltaic cabling shall be installed in conduit when located interior to the building.
- B. The photovoltaic panels and arrays shall be configured in an open circuit, short circuit, or provided with an opaque covering to disable the array from producing electrical power during installation. Refer to the manufacturer's information for additional disabling requirements during installation.
- C. Install fuses in all fuse holders and disconnects. Provide a label on the inside of each disconnect identifying the size, type, and model of each fuse installed.
- D. Provide provisions to seal all exterior penetrations. All photovoltaic system roof penetrations shall be sealed by the roofing contractor at the expense of the photovoltaic system contractor.
- E. Wire and Cable Schedule:
1. These requirements are in addition to the requirements of Section 26 05 13.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. DC Distribution System:
  - a. Exterior: Photovoltaic panel manufacturer-supplied cabling with quick connects.
  - b. Interior: Copper, stranded conductor, 600 volt insulation, THHN/THWN.
  - c. Wet Locations: Copper, stranded conductor 600 volt insulation THWN.
  - d. Conductors shall be color coded as follows:
    - 1) PV-: Black
    - 2) PV+: Red
    - 3) Ground Bond: Green
3. AC Distribution System:
  - a. Refer to Section 26 05 13.
4. Use no wire smaller than 10 AWG for 600 VDC wiring of the photovoltaic system.
5. Use 8 AWG for 600 VDC wiring of photovoltaic systems with distances between the photovoltaic panel and photovoltaic inverter greater than 100 feet.
- F. Interconnect photovoltaic inverters and/or communications gateway to each other and to the facility's local area network patch panel using Category 6 cable or other cable as directed by the inverter manufacturer.
- G. Provide provisions for programming and initializing the system metering and reporting software per the Owner's requirements. The Contractor shall organize a meeting with the Owner to finalize the programming and user interfaces of the program software.
- H. Install equipment per the manufacturer's recommendations.

## 3.2 LABELING

- A. Refer to Section 26 05 53 for product requirements.
- B. Label all photovoltaic system equipment as required by code.
- C. Label ground fault indicators:
  1. "IN THE EVENT OF A GROUND FAULT INDICATION – THE NORMALLY GROUNDED CONDUCTORS MAY BE ENERGIZED AND UNDERGROUNDED"

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Label all AC-alternating current and DC-direct current disconnects of the photovoltaic power system.
1. “---PHOTOVOLTAIC SYSTEM DISCONNECT---WARNING. ELECTRIC SHOCK HAZARD. DO NOT TOUCH TERMINALS. TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION’
- E. The AC disconnecting means for each photovoltaic inverter shall be labeled with the following:
1. Operating Current:
  2. Operating Voltage:
  3. Maximum System Voltage:
- F. Short Circuit Current: The interactive system point of interconnection shall be labeled at the disconnecting means with the following:
1. Maximum AC Output Operating Current:
  2. Operating AC Voltage:
- G. The building service entrance disconnect shall be clearly labeled to identify there is a photovoltaic system interconnection. The location of the interactive system disconnect shall be identified with a plaque reading: “WARNING – PHOTOVOLTAIC SYSTEM DISCONNECT LOCATED AT \_\_\_\_\_.”

## 3.3 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Section 26 05 00.
- B. Check for damage and tight connections prior to allowing the photovoltaic panels to begin power generation.
- C. Check for damage and proper operation of the photovoltaic inverters.
- D. Verify operation of the metering and reporting system components. Adjust and update the graphical user interface for project specific conditions.

## 3.4 SYSTEM COMMISSIONING

- A. Provide system commissioning report under provisions of Section 26 05 00.
- B. Notify Architect/Engineer seven days prior to beginning final witness testing of the photovoltaic system.
1. The Electrical Contractor shall fully test the complete photovoltaic system prior to notifying the Architect/Engineer for final witness testing.
- C. Test, measure, and record the following system values:
1. Date:
  2. Time of test:
  3. Testers:

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

4. Sun overcast conditions (full sun) (scattered clouds) (full cloud coverage).
5. Inverter:
  - a. DC input current:
  - b. DC input voltage:
  - c. AC output current:
  - d. AC output voltage:
  - e. Output power:

## D. Performance Test of Interactive Inverter System:

1. Verify proper operation of the photovoltaic system. Verify the photovoltaic system is producing power and delivering it to the building electrical distribution system.
2. Simulate power outage of electrical utility by switching the main electrical service disconnect from “closed” to “open”.
3. Verify that each individual photovoltaic inverter has stopped producing electrical energy and has disconnected itself from the photovoltaic panels and building electrical distribution system.
4. Simulate return of utility electrical power by switching the main electrical service disconnect from “open” to “closed”.
5. Verify each photovoltaic inverter has reconnected to the photovoltaic panels and building electrical distribution system. Verify power delivery from the photovoltaic inverters to the building electrical distribution system.
6. Document any test failure, including reason for failure and corrective actions. Retest the photovoltaic system to complete satisfactory operation.

## 3.5 OWNER TRAINING

- A. Provide Owner training under provisions of Section 26 05 00.
- B. Provide complete overview of the photovoltaic system to the Owner including:
  1. System overview
  2. System operation
  3. Manufacturer maintenance instructions
  4. System component locations
  5. Operation of the metering and reporting components and software
- C. Minimum Training Time:
  1. Eight hours includes:
    - a. Four hours system components.
    - b. Four hours computer software operation.

END OF SECTION 26 31 00





## SECTION 26 43 00 - SURGE PROTECTION DEVICES

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. This section describes materials and installation requirements for low voltage surge protection devices (SPD) for the protection of all AC electrical circuits. SPD equipment to be installed at service entrance equipment.

## 1.2 QUALITY ASSURANCE

- A. The specified unit shall be designed, manufactured, tested and installed in compliance with the above references. The unit shall be "Listed by Underwriters Laboratories" to UL 1449.
- B. Each unit shall be designed and manufactured by a qualified manufacturer of power conditioning equipment. The qualified manufacturer must have been engaged in the design and manufacturer of such products for a minimum of five years.

## 1.3 SUBMITTALS

- A. Shop Drawings: Should include device dimensions, mounting requirements including wire size and over-current protection device rating, nameplate nomenclature, electrical ratings, short circuit current rating, and test results as indicated below under "Testing, Warranty and Life Expectancy" as provided by an independent test lab or a UL certified test lab for the category(ies) of suppression device(s) specified using the appropriate IEEE test wave. Product data sheets with installation instructions for each size and type of device are required. Shop drawings submitted without the testing data as required by section this section will be rejected.
- B. Fuse information: Provide fuse information if required for operation. Include size, manufacturer, time-current chart responses to UL 1449 testing requirements, maximum surge protection capability per mode and phase as limited by the fuse, and verification of repetitive surge protection device operation without system degeneration greater than 10%.

## 1.4 SPARE PARTS

- A. Fuses: Furnish to the Owner 3 spare fuses of each type and rating installed.

## 1.5 TESTING, WARRANTY AND LIFE EXPECTANCY

- A. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.
  - 1. Single pulse surge current capacity: Single pulse surge current tested in a mode at rated surge currents.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Single pulse surge current capacity test: An initial UL 1449 defined 1.2 x 50 $\mu$ s, 6000V open circuit voltage waveform and an 8 x 20 $\mu$ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage (VPR).
  3. A single 8 x 20 $\mu$ s waveform pulse of maximum rated surge current per mode shall then be applied. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.
- B. Minimum Repetitive Surge Current Capacity:
1. Service entrance suppressor units should be tested repetitively at an independent lab to verify repetitive capacity.
  2. Minimum Repetitive Surge Current Capacity Test:
    - a. An initial UL 1449 surge defined as 1.2 x 50 $\mu$ s, 6000V open circuit voltage waveform and an 8 x 20 $\mu$ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage.
    - b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges, defined as a 1.2 x 50 $\mu$ s 10kV or 20kV open circuit voltage waveform and an 8 x 20 $\mu$ s 10,000A short circuit current waveform, shall then be applied at one-minute intervals.
    - c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.
  3. Survival is achieved if the suppression voltage (VPR) does not vary by more than 10%.
  4. Proof of such testing shall be the test log generated by the surge generator.
- C. Provide UL 1449 classification white sheet pages indicating the VPR (voltage protection rating) for each SPD unit submitted for this product using the 6kV/3kA combination wave surge.
- D. Warranty: Ten (10) years. Includes workmanship, installation and programming.
- E. No scheduled parts replacement or preventative maintenance shall be required.

## PART 2 - PRODUCTS

## 2.1 DESCRIPTION

- A. General: The unit shall provide transient voltage suppression, surge current diversion and high-frequency noise attenuation, when connected in parallel to the facilities distribution system. The unit MCOV shall not be less than 115% of the nominal system voltage. Operating frequency shall be for a 60 Hz system. The unit shall provide protection in all normal modes for "wye" and "delta" systems. The short circuit current rating shall be the larger of the listed value on the drawings or as required by the equipment protected.

## 2.2 RATINGS

A. **SPD:** Service Entrance Suppressors – NonModular:

1. For 120/208 volt, 3 phase, 4 wire, type 2, category C3 unit.
  - a. Surge current capacity: 80,000/160,000 amps per protection mode/phase
  - b. Nominal Discharge Current: 20 kA.
  - c. Mounting: Refer to the drawings.
  - d. Voltage Protection Rating: Refer to requirements below.
  - e. Components: Minimum component size of 20mm metal oxide varistors (MOV).
2. Approved Manufacturers:
  - a. Square D Surelogic Series
  - b. Siemens/APT TE Series
  - c. Cutler Hammer/Tycor CPS Series
  - d. General Electric Tranquell Series
  - e. Current Tech Current Guard Plus
  - f. Liebert ACVII Series
  - g. LEA International LSS Series

## B. Voltage Protection Rating:

1. Protection modes and UL 1449 voltage protection rating for surge suppression units per each mode (L-N, L-L, L-G, and N-G as appropriate).
  - a. 120/208 Volt, 3 phase, 4 wire. 700 Volt L-N, L-G, N-G and 1200 Volt L-L

## C. EMI/RFI Noise Rejection or Filtering:

1. Each unit shall include a UL1283 first order, high-frequency filter for noise filtering between 10 KHz and 100 MHz.

## D. Indication:

1. Each unit shall include solid-state indicators with externally mounted LED visual status indicators that indicate on-line status of each protection mode of the unit.
2. Each unit shall include an audible alarm with silencing switch to indicate when protection has failed.
3. Provide each unit with a transient counter.
4. Each unit shall contain form "C" contacts for remote indication of an alarm status.

- E. Fuses:
1. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit.
  2. Fuses shall be rated 200, 000 AIC minimum interrupting capacity.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine equipment for size and type of surge protection device to be used to ensure physical compatibility.
- B. Inspect surge protection device for any signs of physical damage due to shipping or handling before installing surge protection device.

#### 3.2 INSTALLATION

- A. Mounting Location:
1. The unit shall be installed as close as practical to the panel secondary lugs in accordance with applicable national/Local Electrical Codes and the manufacturer's recommended installation instructions. Connect the unit to the panel using a conduit nipple.
- B. Connections:
1. Conductors from the protected bus to the unit shall not be any longer than necessary avoiding unnecessary bends. The conductor leads shall be twisted together and as short as possible. Connection shall be with mechanical lugs for each phase, neutral, and ground if applicable. Contractor shall provide wire and circuit breakers sized per the approved manufacturer's requirements. Maximum lead length from protected bus to surge protection device shall be per manufacturer's requirements, but no greater than 5'-0".
  2. Neutral and ground shall not be bonded together at secondary panelboard locations.
- C. General:
1. Check unit for proper operation of protection and indication under start-up.
  2. Check unit to ensure all MOVs for each mode of protection are operational. Verify integral fuse links are operational and have not melted.
  3. Surge suppression devices shall not be installed ahead of the main service disconnect(s).

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

4. Install fuses in all fuse holders internal to the surge protection unit. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit. External fusing of the surge protection device is not allowed.
5. Coordinate location of surge protection device to allow adequate clearances for maintenance.

END OF SECTION 26 43 00



## SECTION 26 51 00 - LIGHTING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Interior luminaires and accessories
- B. Exterior luminaires and accessories
- C. Lamps
- D. Ballasts
- E. Poles

## 1.2 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Submit product data sheets for luminaires, lamps, ballasts, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with fixtures listed in ascending order, and with each luminaire's associated lamp, ballast, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.
- C. Submit lens product data, dimensions and weights if not included in product data sheet submittal.
- D. Include outline drawings, support points, weights, and accessory information for each luminaire type.
- E. Submit utility rebate forms, where offered at project location, with rebate items completed.
- F. LED luminaire submittals shall include photometric report per IESNA LM-79-08 for the latest generation system being furnished, including independent testing laboratory name, report number, date, luminaire model number, input wattage, luminaire, and light source specifications. Manufacturer origin of LED chipset and driver shall be submitted.
- G. For all LED luminaires specified as dimmer controlled, submit dimmer device data that is approved by manufacturer of submitted luminaire and that Contractor proposes to furnish and install. Contractor is responsible for verifying that installed dimming controls are compatible with and approved by the luminaire manufacturer.

## 1.3 EXTRA STOCK

- A. Provide extra stock under provisions of Section 26 05 00.
- B. Fluorescent Lamps: Five (5) percent of quantity installed. Minimum of two (2) of each size and type, and maximum of one (1) case (30 lamps).
- C. LED Light Engines or Modules: Five (5) percent of quantity installed, minimum of one (1) of each size and type.
- D. Lenses: Three (3) percent of quantity installed, minimum of one (1) of each size and type.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Ballasts and LED Drivers: Three (3) percent of quantity installed, minimum of one (1) of each size and type.

## 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site. Store and protect under provisions of Section 26 05 00.
- B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.
- C. Handle site lighting poles carefully to prevent breakage and damage to finish.

## 1.5 WARRANTY

- A. Fluorescent ballasts shall carry a three-year warranty from date of Substantial Completion.
- B. Emergency fluorescent ballast shall have a three-year warranty from date of substantial completion.
- C. Fluorescent lamps shall carry a two-year warranty from date of Substantial Completion.
- D. Light emitting diode (LED) light engines and drivers shall have a five-year warranty from date of Substantial Completion.

## PART 2 - PRODUCTS

## 2.1 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Lensed Fluorescent Troffers: Provide hinged frames with latches and 0.125 inch thick virgin acrylic lenses.
- B. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system.
- C. Self-Powered Exit Signs: Stencil face, 6 inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings. One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- D. Painted reflector surfaces shall have a minimum reflectance of 90%.

## 2.2 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Listed for wet or damp location as scheduled. Fountain and pool luminaires shall be listed for submersible location to meet depth specified.
- B. Provide low temperature LED drivers, with reliable starting to -20°F.



## 2.3 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

- A. Light emitting diodes used in interior applications shall have a minimum color rendering index (CRI) of 80. Light emitting diodes used in exterior applications shall have a minimum color rendering index (CRI) of 70. Color temperature of the luminaires shall be as noted on the luminaire schedule.
- B. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.
- C. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.
- D. LED Driver:
  - 1. Solid state driver with integral heat sink. Driver shall have overheat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 20%. Surge suppression device for all exterior luminaires.
  - 2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type.
  - 3. Driver shall have a minimum of 50,000 hours rated life.

## 2.4 ACCEPTABLE MANUFACTURERS – LAMPS

MANUFACTURER	FLUORESCENT
Philips Lighting Company	X
Osram Sylvania	X
GE Lighting	X
USHIO America, Inc.	X

## 2.5 FLUORESCENT LAMPS

- A. T-8 Type: Correlated color temperature (CCT) and Color Rendering Index (CRI) as scheduled on the drawings. Lamps shall be reduced mercury type having credentials that pass the EPA 1990 Toxic Characteristics. Four-foot, 32-watt lamps shall be 3100 lumen extended performance type, with minimum 30,000-hour lamp life at three-hour starts.

## 2.6 FLUORESCENT BALLASTS - GENERAL

- A. All ballasts shall have a Class A sound rating, or better.
- B. Ballast shall comply with EMI and RFI limits set by FCC (CFR 47 Part 18).
- C. Linear fluorescent ballasts shall operate parallel circuit lamps that allow remaining lamps to maintain full output if companion lamps fail.
- D. All fluorescent ballasts designed for operation of double-ended lamps or integral to a luminaire supplied by multi-wire branch circuits shall comply with disconnecting means as specified in NEC Article 410 and amendments thereto.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 2.7 ACCEPTABLE MANUFACTURERS - FLUORESCENT ELECTRONIC BALLASTS

- A. Advance: IOP
- B. GE: UltraStart
- C. MegnaTek/Universal: AccuStart, Ultim8
- D. Osram/Sylvania: QuickTronic

## 2.8 FLUORESCENT ELECTRONIC BALLAST

- A. Fluorescent Ballast: Shall meet UL Standard 935. Ballasts shall be PROGRAM RAPID START (PRS) type.
- B. Ballasts shall meet applicable ANSI and IEEE standards regarding harmonic distortion and surge protection. The input current 3rd harmonic content shall not exceed 13% of the input current. The total harmonic distortion shall not exceed 10%.
- C. Fluorescent ballasts shall conform to the performance criteria listed below:
  - 1. Ballast factor as indicated on luminaire schedule.
  - 2. Mean System Efficacy:
    - a. Program Start:  $\geq 88$  MLPW(T8);  $\geq 87$  MLPW(T5);  $\geq 85$  MLPW(T5HO)
- D. Luminaires designed as multi-level switching shall have combination of 1, 2 or 3 lamp ballasts configured to allow switching of all inboard lamps as a group separate from outboard lamps in the room. Master/slave luminaire arrangement is preferred where practical. The Contractor shall verify ballast configuration to achieve switching shown.
- E. The ballast must maintain constant high output through input voltage ranges of 90 to 145 volts for a 120V ballast (+/- 25%).
- F. Ballast Requirements:
  - 1. Current crest factor shall be no greater than 1.7.
  - 2. The operating ambient temperature range shall be 50°F to 105°F.
  - 3. Fluorescent ballasts shall operate at 20KHZ or higher, with no detectable lamp flicker.
  - 4. Ballasts shall not be affected by lamp failure and shall yield normal lamp life.
  - 5. Ballast power factor shall be greater than 90%.
  - 6. Ballast shall be rated Class P and shall be thermally protected.
  - 7. Program rapid start ballasts shall heat the filament prior to applying the starting voltage to the lamp, then remove lamp cathode heat in a sequence consistent with ANSI standard C82.11.

## 2.9 FLUORESCENT EMERGENCY BATTERY BALLASTS

- A. One-piece, self-contained unit with high-temperature, maintenance-free nickel cadmium battery, charger, and electronic circuitry.
- B. Charging indicator light to monitor charger and battery. Test switch and installation hardware.
- C. UL listed for installation inside or on top of luminaire.
- D. Minimum lumen output and number of lamps served as indicated on luminaire schedule.

## 2.10 ACCEPTABLE MANUFACTURERS - POLES

- A. Manufacturer of Luminaire.
- B. Valmont Poles.
- C. U. S. Pole Company.
- D. KW Industries

## 2.11 LIGHTING POLES

- A. Metal Poles: Square straight steel lighting pole with anchor base.
- B. Wind Load: 100 MPH velocity, with 1.3 gust factor with luminaires and brackets mounted.
- C. Hand Hole: 2 x 4 inches with removable weatherproof cover installed at manufacturer's standard location. Provide matching gasketed cover plate.
- D. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole. Grout between anchor plate and concrete base with non-shrink grout after pole is plumbed.
- E. Vibration Damper: Canister or snake type second mode vibration damper internal to the pole as recommended by pole manufacturer. Provide additional pole top damper for first mode vibration on single-head poles where recommended by manufacturer.
- F. Receptacle mounting location opposite hand hole.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Securely fasten luminaires to the ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members.
- B. Install lamps in lamp holders of luminaires.
- C. Support surface-mounted luminaires directly from building structure. Install luminaires larger than eight square feet (8 ft<sup>2</sup>) or weighing more than 30 pounds independent of ceiling framing.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Install recessed luminaires to permit removal from below. Use plaster frames or install grid clips. Support luminaires independent of ceiling grid with a minimum of two (2) #12 gauge wires located on diagonal corners.
- E. Optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.
- F. Luminaire Pole Bases: Sized and constructed as indicated on the drawings. Project anchor bolts 2 inches minimum above base. Install poles plumb with double nuts for adjustment. Grout around pole anchor base.
- G. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

## 3.2 LAMP SEASONING

- A. Operate all fluorescent lamps for 100 hours prior to requesting final observation. Operate lamps for minimum 8 hour intervals during seasoning.

## 3.3 RELAMPING

- A. Replace failed lamps at completion of work. Replacement of lamp burnouts after the warranty period starts shall be the responsibility of the final user.

## 3.4 ADJUSTING AND CLEANING

- A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.
- B. Touch up luminaire and pole finish at completion of work.

## 3.5 UTILITY REBATE

- A. Submit utility rebate form to Owner with each rebate item information completed. Include all invoices and information required by utility.

END OF SECTION 26 51 00

## SECTION 27 05 00 - BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Basic Communications Systems Requirements specifically applicable to Division 27 sections, in addition to Division 1 - General Requirements.

## 1.2 SCOPE OF WORK

- A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing, and placing into satisfactory operation the Communications Systems as shown on the drawings and specified herein.
- B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make their portion of the Communications Systems a finished and working system.
- C. Description of Systems include but are not limited to the following:
  - 1. Complete Structured Cabling System including, but not limited to:
    - a. Voice and data backbone cabling and terminations
    - b. Voice and data horizontal cabling and terminations
    - c. Information outlets (IO's) including faceplates, jacks, and labeling
    - d. Equipment racks, cabinets, cable management, and equipment
    - e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks
    - f. Cabling pathways
    - g. Grounding and Bonding
    - h. Testing
  - 2. All associated electrical backboxes, conduit, and miscellaneous cabling required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
  - 3. Firestopping of penetrations as described in Section 27 05 03.

## 1.3 OWNER FURNISHED PRODUCTS

- A. Fiber Optic Patch Cables.
- B. UTP Copper Patch Cables.

## 1.4 ALTERNATES

- A. Alternate Bid 7 - Lump Sum: Seal Exhibit
  - 1. Deduct price for deleting the following: seal exhibit pool, seal LSS pumps and filters and associated piping work, seal underwater viewing shelter, and finishes in seal holding; all as indicated on drawings.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 1.5 WORK SEQUENCE

- A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.
- B. Successful Bidders shall itemize all work and list associated hours and pay scale for each item.

## 1.6 DIVISION OF WORK BETWEEN ELECTRICAL AND COMMUNICATIONS CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
  - 1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
  - 2. "Electrical Contractor" shall also refer to the Contractor listed in Division 27 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
  - 3. "Communications Contractor" as referred to herein refer to the Contractors listed in Division 27 of this Specification.
  - 4. Low Voltage Communications Wiring: The wiring (less than 120VAC) associated with the Communications Systems, used for analog and/or digital signals between equipment.
  - 5. Telecommunications Rough-in: Relates specifically to the backboxes, necessary plaster rings, and other miscellaneous hardware required for the installation and mounting of the telecommunications information outlet. Rough-in shall include conduit from the information outlet backbox to above the nearest accessible ceiling in buildings with accessible ceilings, and to the equipment rack enclosure in buildings without accessible ceilings. Where surface mounted backboxes are required, conduit shall be routed from the information outlet backbox to above the nearest accessible ceiling in buildings with accessible ceilings, and to the equipment rack enclosure in buildings without accessible ceilings.
- C. General:
  - 1. The purpose of these Specifications is to outline typical Electrical and Communications Contractor's work responsibilities as related to Communications

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

Systems including Telecommunications rough-in, conduit, and Low Voltage Communications Wiring. The prime contractor is responsible for all divisions of work.

2. Where the Electrical Contractor is required to install conduit and/or conduit sleeves in support of Communications systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Communications Contractor has convened to determine the exact location and requirements of the installation.
3. This Contractor shall establish Electrical and Communications utility elevations prior to fabrication and installation. The Communications Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
  - a. Lighting Fixtures
  - b. Gravity Flow Piping, including Steam and Condensate
  - c. Sheet Metal
  - d. Electrical Busduct
  - e. Sprinkler Piping and other Piping
  - f. Conduit and Wireway
  - g. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Responsible for Communications Systems grounding and bonding.
3. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Communications Contractor's Responsibility:

1. Assumes all responsibility for the Low Voltage Communications Wiring, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes and conduit not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined in here-in).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of Communications equipment which is required to be bonded to the Communications ground system.

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5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.7 COORDINATION DRAWINGS

## A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

## B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.



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- a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
  3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. KJWW will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by KJWW. KJWW will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
    - a. Scale of drawings:
      - 1) General plans: 1/4 Inch = 1'-0" (minimum).
      - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
      - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
      - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
      - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
    2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
    3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
    4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.
- D. General:
1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
  2. A plotted set of coordination drawings shall be available at the project site.
  3. Coordination drawings are not shop drawings and shall not be submitted as such.
  4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in

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his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings, or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.8 QUALITY ASSURANCE

### A. Telecommunications Structured Cabling System Standards:

1. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:

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- a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling
  - b. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises
    - 1) C.1 - Commercial Building Telecommunications Standard
    - 2) C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard
    - 3) C.3 - Optical Fiber Cabling Components Standard
    - 4) C.4 - Broadband Coaxial Cabling and Components Standard
  - c. ANSI/TIA-569-C - Telecommunications Pathways and Spaces
  - d. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure
  - e. ANSI/TIA-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  - f. ANSI/TIA-758-B - Customer-Owned Outside Plant Telecommunications Standard
  - g. ANSI/TIA-942-A - Telecommunications Infrastructure Standard for Data Centers
  - h. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
  - i. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding
  - j. NFPA 70 (NEC) - National Electrical Code (Current Edition)
  - k. UL 444 - Standard for Safety for Communications Cable
- B. Refer to individual sections for additional Quality Assurance requirements.
- C. Qualifications:
1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
  2. The installing Contractor shall be certified by the manufacturer of the structured cabling system. Certification of Contractor shall have been in place for a minimum of one (1) year prior to bidding this project. Documentation of certification is required at the time of bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.

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3. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.
4. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
5. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.
6. The Contractor must have a RCDD (Registered Communications Distribution Designer) on-staff serving as a project manager or obtain the services of a RCDD (Registered Communications Distribution Designer) for the project. The RCDD shall perform the following tasks on the project:
  - a. Review contractor's submittals and stamp the submittals with a current RCDD stamp stating the submittals compliance with the contract documents.
  - b. Provide written and dated confirmation of an observation of the contractor's installation activities no less than every 2 weeks during the construction period.
  - c. Provide a final written and dated confirmation of a final construction review prior to testing.
  - d. Review final testing of system and provide current RCDD stamp on the documented results or transmittal of the results stating the test results compliance with the contract documents.
7. The Contractor shall have certified BICSI installation technicians on staff to perform the following tasks on the project:
  - a. Act as the field superintendent or job foreman with the responsibility of monitoring the daily work of each technician.
  - b. Oversee all testing and termination of cabling.
8. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
  - a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.
  - b. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
  - c. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic systems on the project.

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- d. A technical resume of experience for the Contractor's project manager and on-site installation supervisor assigned to this project.
- e. Resume and certification of the RCDD for the project as required by the form at the end of this specification section.
- f. Resume and certification of the BICSI installation technician for the project.

## D. Compliance with Codes, Laws, Ordinances:

1. This Contractor shall conform to all requirements of the City of Madison, Wisconsin Codes, Laws, Ordinances and other regulations having jurisdiction over this installation.
2. This Contractor shall also conform to all published standards of Dane County, Wisconsin.
3. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
4. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, the codes and regulations shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.
6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

## E. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal, and/or other regulatory bodies.
5. Pay all charges arising out of required inspections due to codes, permits, licenses, or as otherwise may be required by an authorized body.

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6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. Pay any charges by the service provider related to the service or change in service to the project.
8. All equipment and materials shall be as approved or listed by the following (unless approval or listing is not applicable to an item by all acceptable manufacturers):
  - a. Factory Mutual
  - b. Underwriters' Laboratories, Inc.

## F. Examination of Drawings:

1. The drawings for the Communications Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling so as to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications, or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but, where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install, terminate, and make completely ready for operation, the items mentioned.

## G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit 2014.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.

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4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

## H. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.
2. Field conditions that will result in telecommunications drops that exceed the length limitations identified in the contract documents shall be brought to the attention of the Architect/Engineer prior to installation. The cost of reworking cabling that is too long that was not brought to the written attention of the Architect/Engineer prior to installation will be borne entirely by the Contractor.

## 1.9 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

<b><u>Referenced Specification Section</u></b>	<b><u>Submittal Item</u></b>
27 05 00	Basic Communications Systems Requirements
27 05 03	Through Penetration Firestopping
27 05 26	Communications Bonding
27 05 28	Interior Communications Pathways
27 05 43	Exterior Communications Pathways
27 05 53	Identification and Administration
27 11 00	Communication Equipment Rooms
27 13 00	Backbone Cabling Requirements
27 15 00	Horizontal Cabling Requirements
27 17 10	Testing

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- B. In addition to the provisions of Division 1, the following is required:
1. Submittals shall include all layout drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring diagrams; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment, or systems and the location thereof conform to the requirements of the contract documents.
  2. The Contractor shall submit either one electronic copy or three (3) paper copies of each shop drawing for review by the Architect/Engineer BEFORE releasing any equipment for manufacture or shipment.
  3. Shop drawings which are larger than 11" x 17" or are plan size layout drawings, such as wiring diagrams and cable tray drawings, shall be submitted on reproducible media. Submit one reproducible and one print of each drawing or plan. All Contractor approval stamps shall be made on the reproducible. The Architect/Engineer will return the reproducible copy of the shop drawings, complete with comments. This Contractor shall copy and distribute these reviewed shop drawings as required. All costs for copying and distribution of reproducible shop drawings shall be included by This Contractor in their bid.
  4. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. **CONTRACTOR'S APPROVAL STAMP IS REQUIRED ON ALL SUBMITTALS. APPROVAL WILL INDICATE THE CONTRACTOR'S REVIEW of all material and a COMPLETE UNDERSTANDING OF EXACTLY WHAT IS TO BE FURNISHED.** Contractor shall clearly mark all deviations from the contract documents on all submittals. **IF DEVIATIONS ARE NOT MARKED BY THE CONTRACTOR, THEN THE ITEM SHALL BE REQUIRED TO MEET ALL DRAWING AND SPECIFICATION REQUIREMENTS.**
  5. The Contractor shall provide RCDD stamp on each submittal.
  6. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  7. The Contractor shall clearly indicate the size, finish, material, etc.
  8. All submittals shall be assembled in sets by Specification Section and by system.
  9. Each set shall be bound in a manufacturer's folder or inside of a manila file folder.
  10. Each set shall contain an index of the items enclosed with a general topic description on the cover.
  11. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is relevant to the work.
  12. Failure to comply with the above shall be reason to resubmit all shop drawing submittals.



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13. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
  14. Provide documentation of all warranties required by the contract documents.
  15. Submit copy of the Contractor certification form contained at the end of this Specification Section.
- C. Provide Schedule of Values for Technology Work:
1. Application forms: Use AIA Document Continuation Sheets G703 (or similar) as the form for application.
  2. Provide line items on the Schedule of Values including:
    - a. Structured Cabling
  3. Change orders shall have schedule of values broken out as listed above submitted with each change order.
  4. Coordinate with the Project Architect/Engineer the items included in the Schedule of Values. The intent is to not create schedules in addition to those the Technology Contractor normally submits to the General Contractor for payment.

## 1.10 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
1. Firestopping, including mechanical firestop systems.

## 1.11 PRODUCT DELIVERY, STORAGE, HANDLING &amp; MAINTENANCE

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment, and materials.
- B. Store materials on the site so as to prevent damage.
- C. Keep fixtures, equipment, and materials clean, dry, and free from deleterious conditions.

## 1.12 WARRANTY

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 27 may require additional warranty requirements for specific equipment or systems.
- B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the

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benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system, or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.

- C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation or of normal wear as determined by the Architect/Engineer.

## 1.13 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

## 1.14 MATERIAL

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used in this contract.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article, or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article, or equipment identified by the drawings and specifications may be used if approval is secured **in writing** from the Architect/Engineer not later than ten (10) days prior to the bid opening date. The Contractor bears full responsibility for the unnamed manufacturer's equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment, or installation method.
- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article, or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

## PART 2 - PRODUCTS

## 2.1 REFER TO INDIVIDUAL SECTIONS

## PART 3 - EXECUTION

## 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties, and responsibilities including, but not limited to, construction means, methods, sequence, techniques, or procedures necessary for performing, superintending, or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

## 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 05 33. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.
- C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including, but not limited to, damage to walls, flooring, ceiling, and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.
- D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

## 3.3 FIELD QUALITY CONTROL

- A. General:
1. Refer to specific Division 27 sections for further requirements.
  2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.

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3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements, and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
5. All telecommunications tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.
2. Application of foreign materials of any kind on any cable, cable jacket, or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

### 3.4 PROJECT CLOSEOUT

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
  2. Refer to the end of this specification section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."

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3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.
- C. Before final payment will be authorized, this Contractor must have completed the following:
1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
  2. Submitted bound copies of approved shop drawings.
  3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
  4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
  5. Submitted testing reports for all systems requiring final testing as described herein.
  6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
  7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site (Henry Vilas Zoo, 702 South Randall Avenue, Madison, Wisconsin 53715); submit receipt to Architect/Engineer prior to final payment being approved.

## 3.5 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Submit three (3) properly indexed and bound copies; in "D" ring style notebooks, of the Operations and Maintenance Instructions to the Architect/Engineer for approval. Make all corrections or additions required.
- B. Operation and Maintenance Instructions shall include:
1. Notebooks shall be heavy duty locking three ring binders and incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. Provide "Wilson-Jones" or equal, color black. Size notebooks a minimum of 1/2" thicker than material for future inserts. Label the spine and front cover of each notebook. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other forms of binding will be acceptable.
  2. Prepare binder covers (front and spine) with printed title "Operation and Maintenance Instructions", title of project, and subject matter of binder when multiple binders are required.

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3. Title page with project title, Architect, Engineer, Contractor, and Subcontractor with addresses, telephone numbers, and contacts.
4. Table of Contents describing all index tabs.
5. Listing of all Subcontractors and major equipment suppliers with addresses, telephone numbers, and contacts.
6. Index tabs dividing information by specification section, major equipment, or systems. All tab titles shall be clearly printed under reinforced plastic tags.
7. Copies of warranties.
8. Copies of all final approved shop drawings and submittals.
9. Copies of all factory inspection and/or equipment start-up reports.
10. Schematic wiring diagrams of the equipment which have been updated for field conditions. Field wiring shall have label numbers to match drawings.
11. Dimensional drawings of equipment.
12. Detailed parts list with list of suppliers.
13. Operating procedures for each system.
14. Maintenance schedule and procedures. Include maintenance chart that lists routine maintenance requirements and frequency over one year time period.
15. Repair procedures for major components.
16. Replacement parts and service material requirements for each system and the frequency of service required.
17. Instruction books, cards, and manuals furnished with the equipment.

## 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.
- E. Refer to the individual specification sections for minimum hours of instruction time for each system.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- F. Operating Instructions:
1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the Communications Systems.
  2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

## 3.7 SYSTEM COMMISSIONING

- A. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.
- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.
- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to insure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

## 3.8 RECORD DOCUMENTS

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- C. This Contractor shall maintain at the job site, a separate and complete set of Communications Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Communications Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

- D. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- E. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

## 3.9 ADJUST AND CLEAN

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

END OF SECTION 27 05 00



**STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION**

In order to assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

1. All cabling pathways (cable tray, ladder rack, conduit sleeves, etc) are installed and all cabling has been pulled through them.
2. All mechanical firestop products are installed and all other penetrations have been sealed.
3. All telecommunications jacks are installed in the faceplates.
4. All telecommunications cabling is pulled and at least 75% of all jacks have been terminated at the jack and at the telecom room.
5. Telecommunications testing is in progress and at least 25% of testing has been completed.
6. Telecommunications labeling has been provided on at least 25% of each type of component requiring a label.
7. All telecommunications related grounding is complete.
8. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.

The project will be ready for final jobsite observation prior to the requested date of the observation, according to the above list of requirement.

Prime Contractor: \_\_\_\_\_ By: \_\_\_\_\_

Requested Observation Date \_\_\_\_\_ Today's Date: \_\_\_\_\_

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.



**TELECOMMUNICATIONS – PROOF OF CERTIFICATION**

There are specific Contractor qualification requirements for this project as defined in Section 27 05 00, which may include Manufacturer Certification and RCDD credentials. This Proof of Certification document and the supporting documentation require herein, is required to be submitted at the time of bid to show compliance with the requirements of 27 05 00.

**Statement of Compliance:**

The named Contractor's base bid is a structured cabling solution from the connectivity manufacturer \_\_\_\_\_. Named Contractor is trained and certified, under the named manufacturer's formal certification program to provide and install all materials and work required by this project. Further, said Contractor is authorized, by the named manufacturer, to offer all product and labor warranties required for this project by these contract documents.

The certification of this named manufacturer is valid, current and in effect as of the bid day of this project, the \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_.

The named Contractor is not employing any other sub-contractor on the telecommunications portion of this project that does not also meet this certification requirement.

Contractor Company Name: \_\_\_\_\_

Authorized Representative: (print) \_\_\_\_\_

Date: \_\_\_\_\_ Manufacturer Certification Number (if any): \_\_\_\_\_

If this project requires RCDD certification, complete the following:

RCDD Name: \_\_\_\_\_ RCDD #: \_\_\_\_\_ Expiration: \_\_\_\_\_

Submit the following with the bid:

- This form.
- Proof of Manufacturer Certification indicated above.
- Proof of RCDD status.



## SECTION 27 05 03 - THROUGH PENETRATION FIRESTOPPING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

## 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

## 1.3 REFERENCES

- A. UL 723 - Surface Burning Characteristics of Building Materials
- B. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- C. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- D. Warnock Hersey - Directory of Listed Products
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- F. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- G. The Building Officials and Code Administrators National Building Code
- H. Wisconsin Administrative Code
- I. NFPA 5000 – Building Construction Safety Code

## 1.4 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 27 05 00.
- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Warnock Hersey Assembly number.
- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
  - 1. Types of penetrating items.
  - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
  - 3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
  - 4. F and T ratings for each firestop system.
- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

## 1.6 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
  - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
  - 2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings:
    - a. Floor penetrations located outside wall cavities.
    - b. Floor penetrations located outside fire-resistance-rated shaft enclosures.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.7 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the Construction Manager, General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

1. Review foreseeable methods related to firestopping work.
2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

## 1.8 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
  1. 3M; Fire Protection Produces Division.
  2. Hilti, Inc.
  3. RectorSeal Corporation, Metacaulk.
  4. Tremco; Sealant/Weatherproofing Division.
  5. Johns-Manville.
  6. Specified Technologies Inc. (S.T.I.)
  7. Spec Seal Firestop Products
  8. AD Firebarrier Protection Systems
  9. Wiremold/Legrand: FlameStopper

## 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- E. Provide firestopping systems allowing continuous insulation for all insulated pipes.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- F. Provide firestopping systems classified by UL or listed by Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated  
 F Rating = Floor/Wall Rating  
 T Rating = Floor/Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated  
 F Rating = Wall Rating  
 T Rating = 0

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated  
 F Rating = Wall/Floor Rating  
 T Rating (Floors) = Floor Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- G. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- H. Any openings in floors or walls not described in the UL or listed by Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

## 3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

## 3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

## 3.4 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
  - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Firestop System Supplier; UL or listed by Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

## 3.5 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION 27 05 03

## SECTION 27 05 26 - COMMUNICATIONS BONDING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Bonding Conductors
- B. Bonding Connectors
- C. Grounding Busbar (TMGB)
- D. Rack-mount Telecommunications Grounding Busbar

## 1.2 RELATED WORK

- A. Section 26 05 33 – Conduit
- B. Section 26 05 13 – Wire and Cable
- C. Section 26 05 26 – Grounding and Bonding
- D. Section 26 41 00 – Lightning Protection Systems
- E. Section 27 05 00 – Basic Communications Systems Requirements
- F. Section 27 05 03 – Through Penetration Firestopping
- G. Section 27 11 00 – Communication Equipment Rooms
- H. Section 27 05 28 – Interior Communication Pathways
- I. Section 27 05 53 – Identification and Administration

## 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.
- B. Communications bonding system component, device, equipment, and material manufacturer(s) shall have a minimum of five (5) years documented experience in the manufacture of communications bonding products.
- C. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be listed by Underwriters' Laboratories, Inc.

## 1.4 REFERENCES

- A. ANSI/IEEE 1100 – Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
- B. ANSI/TIA/EIA 568-C – Commercial Building Telecommunications Cabling Standard
- C. ANSI/TIA/EIA 569-A – Commercial Building Standard for Telecommunications Pathways and Spaces
- D. ANSI/TIA/EIA 606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- E. ANSI/TIA/EIA 758 – Customer Owned Outside Plant
- F. ANSI-J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- G. IEEE 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
- H. IEEE 837 – IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
- I. NFPA 70 – National Electrical Code
- J. NFPA 780 – Standard for the Installation of Lightning Protection Systems
- K. UL 96 – Lightning Protection Components
- L. UL 96A – Installation Requirements for Lightning Protection Systems
- M. UL 467 – Grounding and Bonding Equipment

## 1.5 SUBMITTALS

- A. Submit product data and shop drawings under provisions of Section 27 05 00 and Division 1.
- B. Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
  - 1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item, including construction, materials, ratings, and all other parameters identified in Part 2 - Products.
  - 2. Manufacturer's installation instructions indicating application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- C. Provide CAD-generated, project-specific system shop drawings as follows:
  - 1. Provide a system block diagram indicating system configuration, system components, interconnection between components, and conductor routing. The diagram shall clearly indicate all wiring and connections required in the system. When multiple devices or pieces of equipment are required in the exact same configuration (e.g., multiple identical equipment racks or sections of ladder tray), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where system equipment will be located.
  - 2. Installation details for all system components.
- D. Provide system checkout test procedure to be performed at acceptance.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under the provisions of Section 27 05 00.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Store and protect products under the provisions of Section 27 05 00.
- C. Contractor shall exercise care to prevent corrosion of any products prior to installation. Corroded products shall not be acceptable for use on this project.

## 1.7 SYSTEM DESCRIPTION

- A. This section describes the requirements for the furnishing, installation, adjusting, and testing of a complete turnkey communications bonding system, including connection to the electrical ground grid.
- B. Performance Statement: This specification section and the accompanying drawings are performance based, describing the minimum material quality, required features, operational requirements, and performance of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made, or every feature and function that must be configured. Based on the equipment constraints described and the performance required of the system as presented in these documents, the Contractor is solely responsible for determining all components, devices, equipment, wiring, connections, and terminations required for a complete and operational system that provides the required performance.
- C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor.
- D. Basic System Requirements:
  - 1. A complete communications bonding infrastructure is required for this project. Refer to the drawings and the requirements of ANSI-J-STD-607-A and NFPA 70 for complete information.
  - 2. The bonding system shall include, but not be limited to, the following major components:
    - a. Bonding Conductor for Telecommunications (BCT)
    - b. Telecommunications Main Grounding Busbar (TMGB)
    - c. Rack mount Telecommunications Grounding Busbar(s)
    - d. Bonding Conductor(s) (BC)
    - e. Bonding Connectors
    - f. Bonding system labeling and administration as defined in Section 27 05 53.

## 1.8 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 27 05 00.
- B. Provide final system block diagram showing any deviations from approved shop drawing submittal.
- C. Provide floor plans that document the following:
  - 1. Actual locations of system components, devices, and equipment.
  - 2. Actual conductor routing.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. Actual system component, device, equipment, and conductor labels.
- D. Provide statement that system checkout test, as outlined in the approved shop drawing submittal, is complete and test results were satisfactory.
- E. Complete all operation and maintenance manuals as described below.

## 1.9 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 27 05 00.
- B. Submitted data shall include:
  1. Approved shop drawings.
  2. Descriptions of recommended system maintenance procedures, including:
    - a. Inspection
    - b. Periodic preventive maintenance
    - c. Fault diagnosis
    - d. Repair or replacement of defective components

## PART 2 - PRODUCTS

## 2.1 BONDING CONDUCTORS

- A. Bare Copper:
  1. Annealed uncoated stranded conductor.
  2. Minimum size 6 AWG.
- B. Insulated Copper:
  1. Annealed uncoated stranded conductor.
  2. Insulation:
    - a. PVC insulation with nylon outer jacket.
    - b. Rated  $\geq$  600 volts.
    - c. Green.
  3. Minimum size 6 AWG.
- C. All bonding conductors shall be listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose and for installation in the space in which they are installed.
- D. Bonding Conductor Sizing
  1. All Communications bonding system conductors shall be sized by length as follows:

Length Linear ft (m)	Size (AWG)
Less than 13 (4)	6
14 - 20 (4 - 6)	4
21 - 26 (6 - 8)	3
27 - 33 (8 - 10)	2
34 - 41 (10 - 13)	1
42 - 52 (13 - 16)	1/0
53 - 66 (16 - 20)	2/0
Greater than 66 (20)	3/0

## 2.2 BONDING CONNECTORS

### A. Acceptable Types:

1. Two-hole compression lug
2. Exothermic weld
3. Irreversible compression

B. Connectors shall be provided in kit form and selected per manufacturer's written instructions.

C. Connectors shall comply with IEEE 837 and UL 467 and be listed for use for specific types, sizes, and combinations of conductors and connected items.

## 2.3 GROUNDING BUSBAR (TMGB)

### A. Features:

1. Wall-mount configuration.
2. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
3. Hole patterns compliant with BICSI recommendations and ANSI-J-STD-607-A standards.
4. Predrilled holes.
5. Integral insulators.
6. Stainless steel offset mounting brackets.

### B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 1/4" thick x 4" high x 12" long.
  - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
3. Hole pattern shall include:
  - a. A minimum of 15 sets of 5/16" holes, 5/8" on center, to accommodate "A" spaced 2-hole compression lugs.

- b. A minimum of three (3) sets of 7/16" holes, 1" on center, to accommodate "C" spaced 2-hole compression lugs.

#### 2.4 RACK-MOUNT TELECOMMUNICATIONS GROUNDING BUSBAR

##### A. Features:

1. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
2. Predrilled holes.
3. Mounts in a standard 19" equipment rack.

##### B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 3/16" thick x 3/4" high x 19" long.
  - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
3. Hole pattern shall include:
  - a. A minimum of eight (8) 6-32 tapped lug mounting holes on 1" centers.
  - b. A minimum of two (2) pairs of 5/16" diameter holes spaced 3/4" apart.

- C. Rack-Mount Telecommunications Grounding Busbars may function as TMGBs in Horizontal Cross-Connects that consist ONLY of a wall-mounted equipment rack enclosure. Refer to plans for additional information.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

##### A. General Bonding Requirements:

1. The communications bonding system shall be a complete system. Contractor shall furnish and install all necessary miscellaneous components, devices, equipment, material, and hardware, including, but not limited to, lock washers, paint-piercing washers, hex nuts, compression lugs, insulators, mounting screws, lugs, etc., to provide a complete system.
2. A licensed electrician shall perform all bonding.
3. Comply with the manufacturer's instructions and recommendations for installation of all products.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Main Cross Connect and Service Entrance Room Bonding Requirements:
1. Locate the TMGB in the service entrance room unless otherwise noted on the drawings.
  2. The location of the TMGB shall be the shortest practical distance from the telecommunications primary lightning protection devices.
  3. Bond the telecommunications primary protectors to the TMGB. Maintain a minimum 1 foot (300 mm) separation of the bonding conductor from all DC power cables, switchboard cable, and high frequency cable.
- C. Where the service entrance cable contains a shield, the shield(s) shall be bonded to the TMGB using manufacturer-approved hardware.
- D. Wall-Mounted Telecommunications Main Ground Bar (TMGB) Requirements:
1. Install TMGB such that it is insulated from its support with a minimum 2” standoff.
  2. Bond the TMGB to the electrical service ground via the BCT.
    - a. A minimum of 1 foot (300 mm) separation shall be maintained between the BCT and any DC power cables, switchboard cable, or high frequency cables.
  3. Where backbone or horizontal cabling contains a shield, the shield(s) shall be bonded to the TMGB.
  4. TMGB shall be bonded to all electrical panels located in the same room or space as the TMGB or in an immediately adjacent space within 20 linear feet of the TMGB. TMGB shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TMGB.
  5. TMGB shall be bonded to accessible metallic building structure located within the same room or space as the TMGB.
  6. All metallic continuous cable pathways, including, but not limited to, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TMGB, shall be bonded to the TMGB.
  7. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TMGB, shall be bonded to the TMGB.
- E. Rack-mount Telecommunications Ground Bar Requirements (RTGB):
1. Provide a rack-mount telecommunications ground bar in each equipment rack and equipment rack enclosure.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Install RTGB such that it is electrically bonded to the rack. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between RTGB and equipment rack.
  3. Bond each RTGB to the TGB via a BC.
  4. If more than one (1) RTGB is provided within the same room or space, they shall all be bonded together via a BC.
  5. All contractor-furnished and/or contractor-installed metallic communications equipment, including, but not limited to patch panels, fiber optic distribution enclosures, splice enclosures, active electronics, uninterruptible power supplies, etc., mounted within the same equipment rack as the RTGB, shall be bonded to the RTGB. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between equipment rack and installed metallic communications equipment. Active electronics and uninterruptible power supplies shall be bonded to the RTGB via a dedicated BC for each device.
- F. Metallic Interior Communication Pathway Bonding Requirements:
1. All metallic interior continuous communication cable pathways, including, but not limited to, conduit, conduit sleeves, fire-rated cable pathway devices, cable tray, basket tray, and ladder rack, shall be bonded to the communications bonding system.
- G. Bonding Conductor Requirements:
1. Bonding conductors shall be green or marked with a distinctive green color.
  2. Bonding conductors shall be routed parallel and perpendicular to building structure along shortest and straightest paths possible. Number of bends and changes in direction should be minimized. Install and secure conductors in a manner that protects the conductors from impact and from physical or mechanical strain or damage.
  3. Bonding conductors shall not be installed in metallic conduit.
  4. All conductors, including, but not limited, to the BCT and BC(s), shall be installed splice-free. If the Contractor believes that site conditions do not allow a splice-free installation, the Contractor may request permission from the Architect/Engineer to splice a specific communications bonding system conductor.
    - a. Where documented permission to splice a conductor is granted:
      - 1) The number of splices shall be limited to as few as possible.
      - 2) Splices shall be made using exothermic welding or irreversible compression-type connections only. Splice hardware shall be listed for grounding and bonding. Solder is not an acceptable means of splicing conductors.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- 3) Splices shall be made in telecommunications spaces in accessible locations to facilitate future inspection and maintenance.
  - 4) Splices shall be adequately supported and protected from impact and from physical or mechanical strain or damage.
5. All bonding conductors shall be labeled in accordance with the requirements of Section 27 05 53. In addition to the requirements of Section 27 05 53:
- a. Labels shall be nonmetallic.
  - b. Labels shall be printer-generated.
  - c. Labels shall be located on conductors as close as is practical to their point of termination in a readable position.
  - d. Additionally, conductors shall be labeled as follows:
    - 1) “IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER.”
6. Interior water piping is not acceptable for use as a communications bonding system bonding conductor.
7. Metallic cable shields are not acceptable for use as communications bonding system bonding conductors.
- H. Bonding Connection Requirements:
1. Make all connections in accessible locations to facilitate future inspection and maintenance.
  2. Communications bonding system connections shall be made using exothermic welding, two-hole compression lugs, or other irreversible compression-type connections. The use of 1-hole lugs is prohibited, except for connections to a rack-mount telecommunications ground bar. Connection hardware shall be listed for grounding and bonding. Sheet metal screws shall not be used to make communications bonding system connections.
  3. Thoroughly clean conductors before installing lugs and connectors.
  4. Install and tighten all connectors in accordance with manufacturer’s instructions, using the appropriate purpose-designed tool(s) recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer’s recommendations.
  5. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond at all connections.
  6. All bonding connections shall be coated in anti-oxidant joint compound that is purpose-designed and purpose-manufactured for that use. Anti-oxidant joint compound shall be applied in accordance with manufacturer’s recommendations and instructions.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

7. All installed connectors on conductors installed in damp locations shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against moisture ingress. Applied heat shrink tubing shall overlap conductor's outer jacket a minimum of four (4) inches past connector and be installed in accordance with manufacturer's recommendations and instructions.

## 3.2 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 27 05 00.
- B. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product from a reputable manufacturer that meets the requirements of the specifications.
- C. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

## 3.3 ADJUSTING

- A. Adjust work under provisions of Section 27 05 00.
- B. Contractor shall make any and all adjustments to the communications bonding system necessary to ensure that the installed system meets all requirements listed herein. Modifications necessary to comply with listed requirements or to provide specified performance shall be completed by the Contractor at no additional cost to the Owner.

## 3.4 TESTING

- A. Test installed system under provisions of Section 27 17 10.
- B. Measure and document resistance to ground at each TMGB, each RTGB, and each electrical distribution panel bonded to the TMGB.
  1. Measurements shall be made not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage, and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
  2. Measured resistance to ground at TMGB, each TGB, and each RTGB must not exceed 5 ohms.
  3. Under no circumstances shall any point in the communications bonding system have a lower resistance to ground than that of nearby electrical distribution system components that it is bonded to.
- C. Include measurement documentation in test data submitted at completion of project under provisions of Section 27 17 10.

## 3.5 SYSTEM TRAINING

- A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.
  - 1. Provide two week's advanced notice of training to the Owner and Architect/Engineer.
  - 2. The Architect/Engineer shall be presented with the option to attend the training.
  - 3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- B. At a minimum, the following training shall be conducted:
  - 1. A course detailing the system functions and operations that a technical user will encounter. Provide training on all aspects of using the system, including making new bonding connections to the TMGB or RTGB. Provide training on all recommended inspection, maintenance, and repair procedures for the system.
- C. Minimum on-site training times shall be:
  - 1. Technical user: One (1) hour.

END OF SECTION 27 05 26



## SECTION 27 05 28 - INTERIOR COMMUNICATION PATHWAYS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests, and services to install complete conduits, sleeves, innerduct, cable hanger and support routes, etc. for an interior cabling plant as shown on the drawings.

## 1.2 RELATED WORK

- A. Section 26 05 33 - Conduit
- B. Section 27 05 00 - Basic Communications Systems Requirements
- C. Section 27 05 26 - Communications Bonding

## 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for requirements.

## 1.4 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code

## 1.5 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.
- B. Coordination Drawings:
  - 1. Include conduit sleeve and cable hanger and support route layout in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

## 1.6 DRAWINGS

- A. The drawings, which constitute a part of these specifications, indicate the general route of the conduit, sleeves, etc. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

## PART 2 - PRODUCTS

## 2.1 CONDUIT

- A. Refer to Section 26 05 33 for conduit requirements for this project.

## 2.2 CABLE HANGERS AND SUPPORTS

- A. Provide a non-continuous cable support system suitable for use with open cable.
- B. Cable Hooks:
  - 1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.
  - 2. All cable hook mounting hardware shall be recessed to prevent damage to cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.
  - 3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use.
- C. Cable Hangers:
  - 1. Adjustable, non-continuous cable support slings for use with low voltage cabling.
  - 2. Steel and woven laminate construction, rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.
  - 3. Sling length shall be adjustable to a capacity of 425 4-pair UTP cables.
  - 4. Cabling hanger load limit shall be 100 lbs per foot.
  - 5. Manufacturer: Erico Caddy, CableCat CAT425, Arlington Fittings TI Series or approved equal.

## 2.3 INNERDUCT – CORRUGATED

- A. Fabricated from self-extinguishing high-impact polyvinyl chloride (PVC), orange in color.
- B. Fittings and accessories fabricated from same material as conduit and usable with rigid nonmetallic conduit.
- C. Solvent-cement type joints as recommended by manufacturer.
- D. Inside diameter not less than that of rigid steel conduit.
- E. Dielectric strength a minimum of 400 volts per mil.
- F. Corrugated wall construction.
- G. Pull rope pre-installed by manufacturer.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- H. Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all of the above General requirements plus:
  - 1. Be fabricated of flame-retardant materials (plenum rated) suitable for installation in such environments.
  - 2. Meet or exceed all requirements for flame resistant duct as required by Bellcore TR-NWT-000356 (Section 4.33).
- I. Innerduct installed within building riser shafts shall meet all of the above general requirements plus:
  - 1. Be fabricated of flame-retardant materials suitable for installation in such environment.
- J. Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

## PART 3 - EXECUTION

## 3.1 CONDUIT

- A. Refer to specification section 26 05 03 for additional requirements.
- B. All conduits shall be reamed and shall be installed with a nylon bushing.
- C. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.
- D. No conduit or sleeve containing more than two (2) cables shall exceed 40% fill ratio, regardless of length.
- E. Any conduit exceeding 90' in length or containing more than two (2) 90-degree bends shall contain a pull box sized per ANSI/TIA/EIA 569 requirements.
  - 1. A separate pull box is required for each 90' (or greater) length section.
  - 2. A separate pull box is required after any two (2) consecutive 90-degree bends.
  - 3. Pull box shall be located in an area that maintains accessibility of box, including the ability to remove box lid without removal or relocation of any other materials.
- F. Any conduit with bends totaling 90 degrees or more shall have the fill capacity derated by 15% for each 90 degrees of cumulative bend.
- G. Cables installed in any conduits that do not meet the above requirements shall be replaced at the Contractor's expense, after the conduit condition has been remedied.

### 3.2 CABLE HOOK SUPPORT SYSTEM

- A. In areas where cabling is not supported by ladder rack or installed in conduit, such cabling shall be supported by an approved cable hook support system.
- B. Refer to manufacturer's requirements for allowable fill capacity for selected cable hook. In no case shall a 40% fill capacity be exceeded.
- C. Cable hooks shall be securely mounted per manufacturer's instructions. In no case shall the side-to-side travel of any cable hook exceed 6".
- D. Cable hooks shall be selected based on the contractor's cable routing. Hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.
- E. Support spans shall be based on the manufacturer's load ratings. In no case shall a 4 foot span be exceeded.
- F. The resting and supporting of cabling on structural members shall not meet the requirements for cabling support specified herein.
- G. The use of tie-wraps or hook and loop type fasteners is specifically prohibited as a substitute for cable hooks specified herein.

### 3.3 INNER DUCT INSTALLATION REQUIREMENTS

- A. Inner duct shall be riser or plenum rated as required by the installation environment. At minimum, inner duct should extend to the ladder rack above the termination enclosure at system endpoints. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.
- B. All exposed inner duct is to be labeled at 35-foot (10 meter minimum) intervals with tags indicating ownership, the cable type (e.g., "Fiber Optic Cable") and the cables it contains (e.g., MA-CS or FS-CS).
- C. Where exposed, fiber optic cable shall be installed in protective inner duct.
- D. Contractor shall determine optimum size and quantity to satisfy the requirements of the installation and to ensure that the mechanical limitations, including minimum bend radius of the cable, are considered.
- E. The inner duct should extend into the termination enclosure at system endpoints.
- F. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

### 3.4 ATTACHMENT TO METAL DECKING

- A. Where supports for cable trays and cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center. This 25 lb. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

END OF SECTION 27 05 28

## SECTION 27 05 43 - EXTERIOR COMMUNICATION PATHWAYS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing exterior racks, ladders, conduits, sleeves, innerduct, etc. for an exterior cabling plant.

## 1.2 REFERENCES

- A. NFPA 70 (NEC) – National Electrical Code
- B. Section 27 05 00 – Basic Communications Systems Requirements.
- C. AASHTO HS-20 - Standard Specification for Highway Bridges.
- D. ANSI/ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- E. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
- F. ASTM A48 - Gray Iron Castings.
- G. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.

## 1.3 RELATED SECTIONS

- A. Section 26 05 33 - Conduit and Boxes

## 1.4 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.
- B. Handhole Manufacturer: Company specializing in premade handholes with minimum three (3) years documented experience.

## 1.5 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.
- B. Handhole submittal: Indicate material specifications, dimensions, capacities, size and location of openings, reinforcing details, and accessory locations.
  - 1. Provide product data for manhole accessories.

- C. Submit shop drawings and product data under provisions of Section 27 05 00.
- D. Submit manufacturer's installation instructions under provisions of Section 27 05 00.

#### 1.6 REGULATORY REQUIREMENTS

- A. Equipment and material shall be UL (Underwriters Laboratory) listed and labeled.

### PART 2 - PRODUCTS

#### 2.1 REFER TO SECTION 26 05 33 FOR CONDUIT REQUIREMENTS

#### 2.2 HAND-HOLES

- A. Features:
  - 1. Frost-heave-resistant design
  - 2. Gasketed cover, secured with bolts
  - 3. Cover shall be engraved with lettering, "ZOO TELECOMMUNICATIONS".
- B. Specifications:
  - 1. Material: Polymer concrete (enclosure and cover)
  - 2. Dimensions: As noted on drawings
  - 3. Rating: ANSI/SCTE 77 Tier 15 compliant
- C. Manufacturers:
  - 1. Basis of Design
    - A. Quazite
  - 2. Acceptable Alternates
    - a. Highline Products
    - b. Synertech

#### 2.3 INNERDUCT – CORRUGATED

- A. Fabricated from self-extinguishing high-impact polyvinyl chloride (PVC), orange in color.
- B. Fittings and accessories fabricated from same material as conduit and usable with rigid nonmetallic conduit.
- C. Solvent-cement type joints as recommended by manufacturer.
- D. Inside diameter not less than that of rigid steel conduit.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Minimum 1" diameter. Provide innerduct of sufficient size and quantity to accommodate associated fiber optic cables at a maximum 40% fill rate.
- F. Dielectric strength a minimum of 400 volts per mil.
- G. Corrugated wall construction.
- H. Pull rope pre-installed by manufacturer.
- I. Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

## PART 3 - EXECUTION

## 3.1 INSTALLATION – CONDUIT

- A. Where exterior buried conduit runs route in to a building, slope conduits away from building.
- B. All buried telecommunications conduits shall be installed at minimum depth(s) required by NEC. Where NEC published minimum depth requirements differ from those listed in the project documents, the deeper installation depth shall govern.
- C. Any bends in telecommunications conduits shall be made with a radius greater than or equal to ten times the outside diameter of the conduit.
- D. All metallic raceways shall be bonded and grounded in accordance with ANSI/TIA/EIA J-STD-607-A.

## 3.2 INSTALLATION – HANDHOLES

- A. Excavate, install base material, and compact base material in accordance with manufacturer's instructions. At a minimum, handholes shall be placed on a minimum 12" washed stone base extending a minimum 6" beyond outer dimensions of handhole.
- B. Install handholes plumb.
- C. Final elevation of installed handhole cover shall match elevation of final finished elevation of surrounding landscaping.

## 3.3 EXCAVATION, FILL, BACKFILL, COMPACTION

- A. General:
  - 1. The Contractor shall do all necessary excavating, securing, filling, backfilling, compacting, and restoration in connection with their work.
- B. Excavation:
  - 1. Excavations for trenches shall be excavated to proper dimensions to permit installation and inspection of work.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Where excavations are carried in error below indicated levels, thoroughly compacted sand-gravel fill, shall be placed in such excess excavations.
  3. Excavations shall be protected against frost action and freezing. Horizontal conduits shall be installed no less than 6" below frost line.
  4. Care shall be exercised in excavating so as to not damage surrounding structures, equipment, and buried utilities. In no case shall any major structural footing or foundation be undermined.
  5. Excavation shall be performed in all ground characteristics, including rock, if encountered. Each bidder shall visit the premises and determine, by actual observations, borings, or other means, the nature of the soil conditions. The cost of all such inspections, borings, etc., shall be borne by the bidder.
  6. In the case where the trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
  7. Where satisfactory bearing soil is not found at the indicated levels, the CO or their representative shall be notified immediately and no further work shall be done until further instructions are given.
  8. Mechanical excavation of the trench to line and grade of the conduit, unless otherwise indicated on the drawings.
- C. Dewatering:
1. The Contractor shall be responsible for the furnishing, installation, operation and removal of all dewatering pumps and lines necessary to keep the excavation free of water at all times.
- D. Underground Obstructions:
1. The Contractor is responsible for obtaining all utility locates for all trades on the project to determine obstructions indicated. The Contractor shall use great care in installing in the vicinity of underground obstruction.
- E. Fill and Backfilling:
1. No rubbish or waste material shall be permitted in excavations for trench fill and backfill.
  2. The Contractor shall provide the necessary sand for backfilling.
  3. Dispose of the excess excavated earth as directed.
  4. Soils for backfill shall be suitable for required stability and compaction, clean and free from perishable materials, frozen earth, debris or earth with an exceptionally high void content, and free from stones greater than 4 inches in diameter. Under no circumstances shall water be permitted to rise in unbackfilled trenches after installation has been placed.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

5. All trenches shall be backfilled immediately after installation of conduit, unless other protection is directed.
6. All conduit shall be laid on a compacted bed of sand at least 3" deep. Backfill around the conduit with sand, spread in 6" layers, then compact each layer.
7. Use sand for backfill up to grade for all conduit located under building slabs or paved areas. All other conduit shall have sand backfill to 6" above the top of the conduit.
8. The backfilling above the sand shall be placed in uniform layers not exceeding 6" in depth. Each layer shall be placed, then carefully and uniformly tamped, so as to limit the possibility of lateral or vertical displacement.
9. Where the fill and backfilling will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
10. Contractor shall install non-biodegradable warning tape 18" above horizontal conduits, over the entire length of the conduits, during backfilling.
11. Contractor shall install (1) 12-AWG insulated copper wire in one conduit of each buried conduit run for future locating purposes. Provide a minimum of 10 feet of slack in each handhole, pull point, and junction box. Wire shall be labeled, "LOCATOR WIRE" on each end and at each handhole, pull point, and junction box.
12. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

END OF SECTION 27 05 43





## SECTION 27 05 53 - IDENTIFICATION AND ADMINISTRATION

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. This section describes the execution and administration requirements relating to the structured cabling system and its termination components and related subsystems.
- B. Identification and labeling.

## 1.2 RELATED WORK

- A. Section 27 05 00 – Basic Communications Systems Requirements

## 1.3 QUALITY ASSURANCE

- A. Refer to section 27 05 00 for relevant standards.

## 1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Documentation of labeling scheme.

## PART 2 - PRODUCTS

## 2.1 LABELING

- A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.
- B. Insert labels shall meet the requirements of UL 969 for legibility, defacement and general exposure.
- C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, and typeface an attachment method.
- D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.
  - 1. All Code 39 bar codes shall have a ratio between 2.5:1 and 3.0:1. Provide a minimum “quite zone” of 0.25” on each side of the bar code.
  - 2. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.
- E. Color Code: Observe the following requirements for color coding:
  - 1. Labels on each end of a cable shall be the same color for each termination.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Labels for cross-connects shall be two different colors at each termination fields, representative of the color of that field.
  3. Orange (Pantone 15C) shall be used for the demarcation point.
  4. Green (Pantone 353C) shall be used for the termination point of network connection on the facility side of the demarc.
  5. Purple (Pantone 264C) shall be used to identify the termination of cables from common equipment (PBX, computers, LANS, etc.)
  6. White shall be used to identify the first-level backbone termination in the main cross-connect.
  7. Gray (Pantone 422C) shall be used to identify the second-level backbone termination in the main cross-connect.
  8. Blue (Pantone 291C) shall be used to identify the termination of station cabling at the telecommunications closet and/or equipment room end of the cable.
  9. Brown (Pantone 465C) shall be used to identify the termination of the interbuilding backbone cable terminations.
  10. Yellow (Pantone 101C) shall be used to identify the termination of auxiliary circuits, alarms, maintenance, security, etc.
  11. Red (Pantone 184C) shall be used to identify the termination of key telephone systems.
  12. In facilities that do not contain a main cross-connect, the color white may be used to identify second-level backbone terminations.
- F. Tag all CAT 3, CAT 5E, CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system:
1. (Telecom Room Number) – (Patch Panel Letter) – (Patch Panel Port Number).
  2. “Telecom Room Number” shall be as indicated on the drawings.
  3. “Patch Panel Letter” shall start with ‘A’ for the top modular patch panel, increasing sequentially from top to bottom across the equipment rack.
  4. “Patch Panel Port Number” shall start with ‘1’ for the upper left port in each modular patch panel, increasing sequentially from left to right and top to bottom across the modular patch panel face.
  5. Example #1: HC1-A3 indicates the third modular patch panel port in modular patch panel ‘A’ in Horizontal Cross-Connect 1.
  6. Example #2: HC/2-C39 indicates the thirty-ninth modular patch panel port in modular patch panel C in Horizontal Cross-Connect 2.

## 2.2 DOCUMENTATION/AS-BUILTS/RECORDS

## A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 27 05 00 and Division 1. Documentation shall include the items detailed in the subsections below.
2. All documentation, including hard copy and electronic forms shall become the property of the Owner.

## B. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

## PART 3 - EXECUTION

## 3.1 IDENTIFICATION AND LABELING

## A. Cable Labeling: Backbone and horizontal cables shall be labeled at each end.

1. Provide additional cable labeling at each manhole and pull box.
2. Cables that are routed through multiple pathway segments shall contain reference to all pathway segments in the pathway linkage field.
3. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color, may include blue with a white stripe to indicate the higher performance class station cabling.

## B. Information Outlet Labeling: Tag all voice and data jacks as defined herein.

## C. Termination Hardware Labeling:

1. An identifier shall be provided at each termination hardware location or its label.

## D. Grounding/Bonding Labeling:

1. The TMGB shall be labeled "TMGB." There shall be only one TMGB in the facility.
2. Label all TBB conductors connecting to the TMGB with a unique label, located at both ends of the TBB.
3. Each TGB shall be labeled with a unique label.
4. All TBB conductors connecting to the TGB shall be labeled uniquely at each end of the cable.

END OF SECTION 27 05 53



## SECTION 27 11 00 - COMMUNICATION EQUIPMENT ROOMS (CER)

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements related to furnishing and installing equipment for Communication Equipment Rooms. Communication Equipment Rooms include rooms for the Horizontal Cross Connects (HCs).
- B. Definitions:
  - 1. Horizontal Cross Connect (HC): Cross connect location between the horizontal cabling and the backbone cabling.
- C. Refer to Specification Section 27 05 28 for cable pathway and support requirements.

## 1.2 RELATED WORK

- A. Section 27 05 00 - Basic Communications Systems Requirements
- B. Section 27 05 26 - Communications Bonding
- C. Section 27 05 28 - Interior Communication Pathways
- D. Section 27 15 00 - Horizontal Cabling Requirements

## 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for applicable standards.

## 1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.
- B. Coordination Drawings:
  - 1. Include ladder racking, equipment racks, and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

## PART 2 - PRODUCTS

## 2.1 EQUIPMENT GROUNDING

- A. Refer to specification section 27 05 26 for grounding requirements.
- B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

## 2.2 EQUIPMENT RACKS AND CABINETS

- A. Where identified on the drawings in Communication Equipment Rooms, equipment racks and/or equipment cabinets shall be furnished and installed by the Contractor to house cable termination components (e.g., copper and optical fiber) and Owner's network electronics.
- B. The equipment rack shall conform to the following requirements:
1. Standard TIA/EIA 19" Two-Post Floor Rack:
    - a. Equipment rack shall be 84" in height, self-supporting and provide a useable mounting height of 45 rack units (RU) (1 RU = 1 ¾").
    - b. Channel uprights shall be spaced to accommodate industry standard 19" mounting.
    - c. Equipment rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per TIA/EIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
    - d. Each equipment rack shall be provided with a supply of spare screws (minimum of 24).
    - e. Equipment racks shall be provided with a ground bar and minimum #6 AWG ground lug. Refer to specification section 27 05 26 for grounding conductor sizing requirements.
    - f. Provide all mounting hardware and accessories as required for a complete installation.
  2. Standard TIA/EIA 19" Four-Post Floor Rack:
    - a. Equipment rack shall be 96" in height, self-supporting and provide a useable mounting height of 51 rack units (RU) (1 RU = 1 ¾").
    - b. Channel uprights shall be spaced to accommodate industry standard 19" mounting.
    - c. Equipment rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per TIA/EIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
    - d. Each equipment rack shall be provided with a supply of spare screws (minimum of 24).
    - e. Equipment racks shall be provided with a ground bar and minimum #6 AWG ground lug. Refer to specification section 27 05 26 for grounding conductor sizing requirements.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- f. Provide all mounting hardware and accessories as required for a complete installation.
3. Standard TIA/EIA 19" Wall Cabinet:
    - a. The equipment cabinets shall be constructed of painted steel and offer a minimum usable vertical rack mounting capacity of 19 RU. Racks shall be a minimum of 26 inches deep. Access to the rear of the cabinet-mounted equipment shall be by a hinged arrangement.
    - b. The equipment cabinet shall be equipped with a lockable steel front door and furnished with two (2) keys that shall be usable on all cabinets furnished under this Contract.
    - c. The equipment cabinet shall be configured to allow for adjustment of the channel uprights (front to rear) in 1-inch increments and be spaced to accommodate industry standard 19-inch mounting. Hole pattern on channel uprights shall be per TIA/EIA specifications (5/8"-5/8"-1/2").
    - d. The equipment cabinet shall be vented to allow for airflow through the cabinet.
    - e. Each equipment rack shall be provided with a supply of spare screws (minimum of 24).
    - f. Equipment racks shall be provided with a ground bar and minimum #6 AWG ground lug. Refer to specification section 27 05 26 for grounding conductor sizing requirements.
    - g. Provide all mounting hardware and accessories as required for a complete installation.

## 2.3 CABLE MANAGEMENT – VERTICAL AND HORIZONTAL

## A. Equipment Racks:

1. Two-Post and Four-Post Floor Racks shall be equipped with vertical and horizontal cable management hardware to facilitate an orderly, hidden routing of copper and optical fiber patch cables from the modular patch panels and/or 110-type termination blocks to the customer provided network electronics. Vertical and horizontal cable management hardware shall be as follows:
  - a. Horizontal cable management hardware shall be duct-style with flexible fingers, be two-sided to provide cable management at front and rear, have a minimum capacity of 3" x 3" at the front and 2" x 5" at the rear, and incorporate removable front and rear covers designed to conceal and protect cable.
  - b. At a minimum, horizontal cable management hardware shall be positioned above and below (a) each grouping of two rows of jacks on modular patch panels and (b) above and below each optical fiber patch panel in floor racks.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- c. Vertical cable management hardware shall be duct-style with flexible fingers, be two-sided to provide cable management at front and rear, have a minimum capacity of 6" x 6" at the front and rear, and incorporate removable front and rear covers designed to conceal and protect cable. Vertical cable management hardware shall mount on spacers attached to the rack uprights and not on the upright itself. Where multiple equipment racks are to be installed, this hardware shall be mounted between the uprights of adjacent equipment racks. Equipment rack uprights and the spacers shall be secured together per manufacturer's recommendations.
  2. Each equipment rack shall be supplied with a minimum of 12 releasable (e.g., "hook and loop") cable support ties.
- B. Equipment Cabinets
1. Equipment Cabinets shall be equipped with horizontal cable management hardware to facilitate an orderly, hidden routing of copper and optical fiber patch cables from the modular patch panels and/or 110-type termination blocks to the customer provided network electronics. Horizontal cable management hardware shall be as follows:
    - a. Horizontal cable management hardware shall be duct-style with flexible fingers, be two-sided to provide cable management at front and rear, have a minimum capacity of 3" x 3" at the front and 2" x 5" at the rear, and incorporate removable front and rear covers designed to conceal and protect cable.
    - b. At a minimum, horizontal cable management hardware shall be positioned below (a) each grouping of two rows of jacks on modular patch panels and (b) below each optical fiber patch panel in wall cabinets.
- C. 110-type Termination Blocks:
1. Horizontal troughs incorporating plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Horizontal troughs shall be positioned below each 100-pair 110-type termination block.
  2. Vertical troughs incorporating metal distribution rings shall be provided for vertical routing of jumper and/or cross-connect wire.

## 2.4 PATCH PANELS

- A. Where identified on the drawings in Communication Equipment Rooms, modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.
- B. Copper cabling shall be terminated in Communication Equipment Rooms on modular patch panels consisting of a modular connector system incorporating modular jacks meeting the specifications for the jacks detailed in Section 27 15 00.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Modular patch panel configuration shall be 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks). High-density modular patch panels will not be accepted.
- D. The modular patch panel blocks shall have the ability to seat and cut eight (8) conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated solid and stranded copper conductors. Modular patch panel blocks shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.
- E. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturer's minimum bend radius specifications are adhered to.

## 2.5 OPTICAL FIBER PANELS

- A. All terminated optical fibers shall be mated to duplex LC-type couplings mounted on enclosed fiber distribution cabinets. Couplings shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g., "FDDI Connector"), Biconic, FC, and MT-RJ by changing panels on which connector couplings are mounted. Refer to Section 27 15 00 for coupling requirements.
- B. The fiber distribution cabinet shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings, including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor.
- C. The fiber distribution cabinet shall be an enclosed assembly affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to conceal and protect the optical fiber couplings, connectors, and cable.
- D. Access to the inside of the fiber distribution cabinet's enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the fiber distribution cabinet to gain entry will not be accepted.
- E. The fiber distribution cabinet's enclosure shall provide for strain relief of incoming optical fiber cables and shall incorporate radius control mechanisms to limit bending of the optical fiber to the manufacturer's recommended minimums or 1/2", whichever is larger.
- F. All fiber distribution cabinets shall provide protection to both the "facilities" and "user" side of the coupling. The fiber distribution cabinet's enclosure shall be configured to require front access only when patching. The incoming optical fiber cables (e.g., backbone, riser, horizontal, etc.) shall not be accessible from the patching area of the panel. The fiber distribution cabinet's enclosure shall provide a physical barrier to access such optical fiber cables.
- G. Where "Loose Buffered" cables are installed, the 250  $\mu$ m coated optical fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtailed") or (2) the use of a "fan-out" kit. In the latter approach, individual

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

fibers are to be secured in a protective covering, an Aramid (e.g., Kevlar™) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the “fusion” method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250 µm coated optical fibers shall not be permitted.

## 2.6 TERMINATION BLOCKS

- A. Where identified on the drawings in Communication Equipment Rooms, 110-type termination blocks shall be furnished and installed by the Contractor for termination of copper cable.
- B. Each horizontal row of the 110-type termination block must be capable of terminating one (1) 25-pair binder group (backbone cables).
- C. The Mechanical Termination Shall:
  - 1. Have the ability of terminating 22 - 26 AWG plastic insulated solid and stranded copper conductors.
  - 2. Provide a direct connection between the cable and jumper wires.
  - 3. Have less than 0.2 dB of attenuation from 1-16 MHz.
  - 4. Have less than 100 mW of DC resistance.
  - 5. Have less than 5 mw of resistance imbalance.
  - 6. Have minimal signal impairments at all frequencies up to 16 MHz.
- D. The 110-type termination block shall identify pair position by a color designation - Blue, Orange, Green, Brown, and Slate (backbone only).
- E. The 110-type termination block shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.

## 2.7 LADDER RACK

- A. Provide complete ladder rack system including metallic ladder rack, splice connectors, fastening hardware and other miscellaneous materials as required for a complete installation per manufacturer's recommendations.
- B. Steel Stringer Style Ladder Rack:
  - 1. Steel siderail stringer, 1.5” stringer height, 12” spaced welded rungs.
  - 2. Steel shall meet the requirements of ASTM A1011 SS Grade 33.
  - 3. Loading limits shall be 132 lbs/ft for 5 ft spans.
- C. Ladder rack finish shall be flat black powder coat.

## 2.8 D-RINGS

- A. Rounded edge D-rings for support of cabling in vertical and horizontal configurations.
- B. EIA 310D compliant, manufactured from materials meeting UL94-V0 specifications.
- C. Provide ¼” screw holes for wall mounting.
- D. Sized to accommodate associated cabling plus 50% growth at a maximum 40% fill rate.

## 2.9 POWER STRIPS

- A. Provide power strips on all equipment racks, unless noted otherwise. These power strips shall have the following characteristics:
  - 1. Standard Rack Mount:
    - a. TIA/EIA 19” equipment rack mountable.
    - b. Compliant with UL-1449 Second Edition and UL-497A.
    - c. Provide transient suppression to 13,000-A. Protection shall be in all three modes (line-neutral, line-ground and neutral-ground).
    - d. Shall meet or exceed ANSI C62 Category A3 requirements.
    - e. Provide high-frequency noise suppression as follows:
      - >20-dB @ 50 kHz
      - >40-dB @ 150 kHz
      - >80-dB @ 1 MHz
      - >30-dB @ 6 to 1000 MHz
    - f. Provide a minimum of 720 joules of AC energy absorption.
    - g. Be equipped with a 15-foot power cord.

## 2.10 COPPER PATCH CORDS

- A. By Owner.

## 2.11 FIBER PATCH CORDS

- A. By Owner.

## 2.12 LIGHTNING PROTECTION

- A. Contractor shall provide multipair protector panel(s), including mounting and termination hardware. The multipair protector panel(s) shall be UL listed.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. For small pair count applications (less than or equal to 200-pairs), the multipair protector panel shall consist of a mounting panel for a series of solid-state gas-tube protector units and 110-type termination blocks for input and output connections. Insertion of the protector units into the mounting panel will complete the circuit. The multipair protector panel(s) shall be available in 25- and 100-pair counts.
- C. Gas-tube Protection Units:
  - 1. DC Breakdown Voltage (at 2 KV/sec): 265-425V.
  - 2. Surger Breakdown Voltage (at 100 V/ $\mu$ sec): 200-800V.
  - 3. Insulation Resistance: 100 Mohms.
  - 4. Vented Breakdown Voltage: Less than 1,000V.
  - 5. DC Arc Voltage: 20V (typical).
  - 6. Capacitance: Less than 100 pf.
  - 7. Rated Impulse Discharge: 200A.
  - 8. AC Discharge: 65A (11 cycles at 60 Hz).
  - 9. Maximum Impulse Discharge: 20 KA.

## PART 3 - EXECUTION

## 3.1 EQUIPMENT RACKS

- A. Equipment racks shall be furnished and installed as shown on the drawings.
- B. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. The rack shall be stabilized by extending a brace to the wall. Alternately, overhead ladder rack by which the cabling accesses the equipment rack(s) may provide this function.
- C. A space between the rack upright and the wall (approximately 6") should be provided to allow for cabling in that area. The rear of the rack should be approximately 42" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 42" workspace in front of the rack is also required. Locations where these guidelines cannot be followed should be brought to the attention of the Architect/Engineer for resolution prior to installation.
- D. All positioning of hardware and equipment is to be reviewed and approved by the Owner prior to installation.

## 3.2 LADDER RACK

- A. Provide support for ladder rack on 4 ft centers.
- B. Maintain a 1.5 safety factor on all load limits specified herein.
- C. Ladder rack support shall be by minimum 5/8" diameter threaded rod when ceiling mounted. Ladder rack requiring wall mounting shall utilize accessories supplied by the ladder rack manufacturer specifically for the purpose of wall mounting ladder rack.

## 3.3 D-RINGS

- A. Provide D-rings for cable routing and management in all areas where open cabling is routed along the wall in an Equipment Room.
- B. Locate D-rings on maximum 12" centers vertically and horizontally.
- C. Securely attach D-rings to the wall as required by the manufacturer.

## 3.4 GROUNDING

- A. Provide a complete grounding system in accordance with the requirements of Section 27 05 26.

## 3.5 CABLE INSTALLATION

- A. Bend radius of copper cable shall not exceed 4 times the outside cable diameter or manufacturer's recommendation, whichever is less. Bend radius of fiber optic cable shall not exceed 10 times the outside cable diameter or manufacturer's recommendation, whichever is less.
- B. Cables shall be neatly bundled and dressed to their respective panels and/or blocks. Each shall be fed by an individual bundle separated and dressed to the point of cable entrance into the rack and/or frame.
- C. The cable jacket shall be maintained as close as possible to the termination point.
- D. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that is visible without removing the bundle support. Refer to 27 05 53 for labeling requirements.

## 3.6 OPTICAL FIBER TERMINATION

- A. All fiber slack shall be neatly coiled within fiber splice enclosures or splice trays. No slack loops shall be allowed external to the enclosure.
- B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.
- C. Each cable shall be clearly labeled at the entrance to all enclosures.
- D. A maximum of 12 strands shall be spliced in any tray.

## 3.7 CONDUIT AND CABLE ROUTING

- A. Refer to Section 26 05 33 for additional requirements.
- B. Where conduits enter a telecommunications room, conduits shall be terminated on the wall where shown on the contract documents. Conduits entering the room from the floor shall extend 3" above the floor slab.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Where cabling rises vertically in a telecommunications room, provide vertical cable management to support the cabling from floor to ceiling level.
- D. All conduits shall be reamed and shall be installed with nylon bushings at each end.
- E. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter. Refer to 27 05 28 for additional requirements.

END OF SECTION 27 11 00

## SECTION 27 13 00 - BACKBONE CABLING REQUIREMENTS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing backbone communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of both optical fiber and copper cabling.

## 1.2 RELATED WORK

- A. Section 27 05 00 – Basic Technology Systems Requirements.
- B. Section 27 15 00 - Horizontal Cabling Requirements.
- C. Section 27 17 20 - Support and Warranty.

## 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.

## 1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.

## PART 2 - PRODUCTS

- 2.1 The basis of design is listed herein. Refer to Section 27 17 20 for additional acceptable manufacturers.

## 2.2 COPPER BACKBONE – INSIDE PLANT

- A. CAT 3 Backbone Cable:
  - 1. The CAT 3 backbone cable shall link Communication Equipment Rooms serving the building. These CAT 3 backbone cables shall be terminated on cable pair protectors and rack-mounted 110-type termination blocks.
  - 2. CAT 3 backbone cable shall incorporate 24 AWG solid annealed copper conductors insulated with a polyvinyl chloride (PVC) CMR skin. Conductors shall be twisted to form pairs and be fully color-coded.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. Conductors shall be identified by the insulation color of each conductor. The color code shall follow the industry standard composed of 10 distinctive colors to identify 25-pairs in accordance with ICEA publication S-80-576-1988. Marking of each mate of the primary conductor in a pair with the color of that primary conductor is optional.
4. CAT 3 backbone cable shall meet the TIA/EIA Category 3 performance requirements.
5. Basis of Design:
  - a. 25-pair: Superior Essex 18-499-33.

## 2.3 COPPER BACKBONE – OUTSIDE PLANT

## A. CAT 3 Backbone Cable:

1. CAT 3 backbone cable shall incorporate 24 AWG solid, annealed, bare copper conductors. All conductors shall be continuous and splice free. Bridge taps shall not be allowed.
2. Conductors shall be insulated with a thermoplastic skin. Maximum diameter of the insulated conductor shall be 0.048 in (1.22 mm). Insulated conductors shall be stranded into pairs of varying lengths to minimize crosstalk.
3. Conductors shall be identified by the insulation color of each conductor. The color code shall follow the industry standard composed of 10 distinctive colors to identify 25-pairs in accordance with ICEA publication S-80-576-1988. Marking of each mate of the primary conductor in a pair with the color of that primary conductor is optional.
4. CAT 3 backbone cable shall meet the physical and electrical requirements of 100 Ohm “Backbone Cable” as defined by the ANSI/TIA/EIA-568 Standard for Commercial Building Wiring and shall conform to Category 3 performance specifications or better. Measurements should be in accordance with ASTM D 4566 (ref. B.17).
5. CAT 3 backbone cable shall be UL listed and be compliant with Article 800 (Communications Circuits) of the National Electrical Code (NEC) and be suitable for installation in underground duct or direct burial (REA PE-89).
6. A flooding compound shall be applied over the core and to all surfaces of the shield/armor to resist moisture entry and to inhibit corrosion.
7. The CAT 3 backbone cable core shall be filled with a waterproofing compound and wrapped with a non-hydroscopic core tape.
8. CAT 3 backbone cable shall contain an overall corrugated, coated aluminum shield, which is electrically continuous over its entire length.
9. CAT 3 backbone cable shall be finished with a black polyethylene jacket, which is sequentially printed with a footage marker at regular intervals.



10. Basis of Design:
  - a. 25-pair: Superior Essex 09-097-77.

#### 2.4 OPTICAL FIBER BACKBONE – OUTSIDE PLANT

##### A. Duct Bank (Multimode/Singlemode):

1. This optical fiber cable shall be suitable for installation in underground duct and in innerduct.
2. Optical fiber cable materials shall be all dielectric (no conductive materials).
3. Optical fiber cable shall be filled with a water-blocking material.
4. Outer Sheath: Polyethylene (PE). The outer sheath shall be marked with the manufacturer's name, words identifying the cable type (e.g., "Optical Fiber Cable" or "Fiber Optic Cable"), year of manufacture, and sequential length markings. The actual length of the optical fiber cable shall be within -0/+1% of the length markings. The marking shall be in a contrasting color to the cable jacket.
5. Temperature Range:
  - a. Storage: -40°C to +70°C (no irreversible change in attenuation).
  - b. Operating: -40°C to +70°C.
6. Humidity Range: 0% to 100%.
7. Maximum Tensile Strength:
  - a. During Installation: 2700 Newton (600 lb. force) (no irreversible change in attenuation).
  - b. Long Term: 890 N (200 lb. force).
8. Crush Resistance: 250 lbf/in (44 N/mm)
9. Bending Radius:
  - a. During Installation: 20 times cable diameter.
  - b. No Load: 10 times cable diameter.

##### B. Basis of Design (Multimode):

1. 24-strand: CommScope D-024-LN-5K-FSUNS.

##### C. Basis of Design (Singlemode):

1. 24-strand: CommScope D-024-LN-8W-FSUNS.

## 2.5 OPTICAL FIBER BACKBONE PERFORMANCE

## A. OM4 Multimode (MM):

1. Fiber Type: Multimode; doped silica core surrounded by a concentric glass cladding.
2. Index Profile: Graded Index.
3. Transmission Windows: 850-nm and 1300-nm.
4. Core Diameter (nom): 50- $\mu$ m (microns)  $\pm$  2.5.
5. Cladding Diameter: 125- $\mu$ m  $\pm$  1.
6. Core-clad Concentricity:  $\leq$  1.0- $\mu$ m.
7. Cladding Non-circularity:  $\leq$  1.0%.
8. Fiber Coating Diameter:
  - a. 245- $\mu$ m  $\pm$  10 (primary coating).
  - b. 900- $\mu$ m (nominal) secondary coating (tight buffer)
  - c. All coatings shall be mechanically strippable without damaging the optical fiber.
9. Attenuation (maximum @ 23  $\pm$  5°C; backbone):
  - a. @ 850-nm: 3.0 dB/km.
  - b. @ 1300-nm: 1.0 dB/km.
  - c. @1300-nm thru 1380-nm: 1.5dB/km

When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation over the rated temperature range of the optical cable shall not exceed 0.50 dB/km with 80% of the measured fibers not exceeding 0.25 dB/km.

## 10. Bandwidth

- a. EMB, minimum:
  - 1) @ 850-nm: 4700 MHz/km.
- b. OFL, minimum:
  - 1) @ 850-nm: 3500 MHz/km.
  - 2) @ 1300-nm: 500 MHz/km.
11. No optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## B. OS2 Singlemode (SM):

1. Fiber Type: Singlemode; doped silica core surrounded by a concentric glass cladding.
2. Core Diameter: 8 to 9  $\mu\text{m}$ . All optical fibers shall be of the same nominal core diameter and profile.
3. Cladding Diameter:  $125 \pm 1.0\mu\text{m}$ .
4. Cladding Non-circularity:  $\leq 1\%$ .
5. Core to Cladding Offset:  $\leq 0.8 \mu\text{m}$ .
6. Fiber Coating Diameter:
  - a.  $245 \pm 15\mu\text{m}$  (primary coating).
  - b. 900-nm (nominal) secondary coating (tight buffer).
  - c. All coatings shall be mechanically strippable without damaging the optical fiber.
7. Cut-off Wavelength (cabled fiber;  $\lambda_{\text{cef}}$ )  $\leq 1260\text{-nm}$ .
8. Mode Field Diameter: 8.3 to 9.8  $\mu\text{m}$  at 1300-nm;  $10.5 \pm 1.0 \mu\text{m}$  at 1550-nm.
9. Zero Dispersion Wavelength ( $\lambda_0$ ):  $1301.5 \text{ nm} \leq \lambda_0 \leq 1321.5 \text{ nm}$ .
10. Zero Dispersion Slope ( $S_0$ ):  $\leq 0.092 \text{ ps/nm}^2\cdot\text{km}$ .
11. Fiber Attenuation (maximum @  $23 \pm 5^\circ\text{C}$ ; Backbone):
  - a. @ 1300-nm: 2.0 dB/km
  - b. @ 1550-nm: 1.75 dB/km

When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation over the rated temperature range of the optical fiber cable shall not exceed 0.05 dB/km at 1550-nm. The magnitude of the maximum attenuation change of each individual optical fiber shall not be greater than 0.15 dB/km at 1550-nm.
12. Fiber Dispersion (maximum):
  - a. @ 1285 to 1330-nm: 3.5-ps/nm\*km
  - b. @ 1550-nm: 18-ps/nm\*km
13. No optical fiber shall show a point discontinuity greater than 0.1 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

## PART 3 - EXECUTION

## 3.1 CABLE INSTALLATION REQUIREMENTS

- A. Cable slack shall be provided in each backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure.
- B. A minimum of 5 meters (approximately 15 feet) of slack cable (each cable if applicable) shall be coiled and secured at both ends located in the entrance room, Telecommunications Room, or main equipment room, for backbone and intra-building cable. This slack shall be stored inside a wall-mounted protective storage enclosure.
- C. Where exposed, all backbone fiber optic cable shall be installed in protective inner duct. This includes areas where the cable is routed in cable tray and where making a transition between paths (e.g., between conduit and cable tray or into equipment racks). The inner duct should extend into the termination and/or storage enclosure(s) at system endpoints.

## 3.2 CROSS-CONNECTS

- A. The Owner will be responsible for all cross-connects between the data backbone cabling and network electronics and between the data network electronics and horizontal cabling.
- B. The Owner shall be responsible for the cross-connect wiring between the horizontal and backbone voice cabling.
- C. This Contractor shall not be responsible for cross-connects between the cabling terminations at the Entrance Room and the telephone utility network point-of-presence. It shall be the responsibility of the Contractor, to work with the Owner and provide the necessary assistance to allow Owner and/or telephone company personnel to make the necessary connections to establish service on the new cable system. These activities include, but are not limited to cross-connect documentation, general wiring overview and cable pair identification.

END OF SECTION 27 13 00

## SECTION 27 15 00 - HORIZONTAL CABLING REQUIREMENTS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The horizontal cabling plant consists of copper cabling.

## 1.2 RELATED WORK

- A. Section 27 05 00 - Basic Communications Systems Requirements

## 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.
- B. The channel shall be required to meet the performance requirements indicated herein. The manufacturer shall warranty the performance of their system to the required performance.
- C. Specific components of the channel shall be required, at a minimum, to meet the Standard component requirements for that particular component.
- D. The installing contractor must be certified by the manufacturer of the structured cabling system.

## 1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.

## PART 2 - PRODUCTS

## 2.1 HORIZONTAL CABLE

- A. CAT 6 Cable:
  - 1. The horizontal cable requirements must be met, as well as the following channel requirements.
  - 2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective Communication Equipment Room as indicated on the drawings.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. Performance tests shall be conducted at a maximum discrete test frequency of 250 MHz for the channel. All numbers given are dB per 100 meters.
4. Channel Requirements:

Insertion Loss:	250 MHz	35.8 dB
NEXT:	250 MHz	33.1 dB
PS NEXT:	250 MHz	30.2 dB
ACR:	250 MHz	1.5 dB
PS ACR:	250 MHz	-5.7 dB
ELFEXT	250 MHz	18.8 dB
PS ELFEXT:	250 MHz	12.3 dB
Return Loss:	250 MHz	10.0 dB

5. The jacket color for all CAT 6 cable shall be blue.
6. Provide cable with plenum-rated jacket (CMP) in areas where cable will be installed free-air in spaces used as return air plenums. Provide cable with riser-rated jacket (CMR) in areas where cable will be installed in conduit and/or in areas where cable will not be installed free air in spaces used as return air plenums. Refer to floor plans for additional information.
7. Basis of Design:
  - a. Plenum: CommScope 6504+
  - b. Nonplenum: CommScope 65N4+

## 2.2 CONNECTORS/COUPLERS/ADAPTERS

## A. Optical Fiber Connectors (LC-type) (Multimode/Singlemode):

1. LC-type optical fiber connector plugs shall be used to terminate optical fiber patch cords in Communication Equipment Rooms.
2. LC-type optical fiber connector plugs shall be snap-type with an integrated pull-proof design.
3. LC-type optical fiber connector plugs shall incorporate domed zirconia ferrule and shall utilize a factory pre-polish end face to ensure fiber-to-fiber physical contact for low loss and reflections.
4. LC-type optical fiber connector plugs shall accept 1.6mm – 2.0mm and 3.0mm outside diameter fiber.
5. The average insertion loss is .3db for multi-mode and single mode connectors.
6. LC-type optical fiber connector plugs shall meet the following performance criteria:

<u>Test Procedure</u>	<u>Maximum Attenuation Change</u>
Cable Retention (FOTP-6)	0.2 dB

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

<u>Test Procedure</u>	<u>Maximum Attenuation Change</u>
Durability (FOTP-21)	0.2 dB
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

## 7. Additional Performance Requirements:

- a. Length: 2.23 inches
- b. Operating Temperature: -40 to 85 degrees C

## 8. Basis of Design:

- a. Multimode: CommScope MFC-LCR-09-BG
- b. Singlemode: CommScope SFC-LCR-09-BL

## B. Optical Fiber Couplings (LC-type) (Multimode/Singlemode):

1. LC-type optical fiber couplings shall be used to terminate optical fiber backbone cable on fiber distribution cabinet panels in Communication Equipment Rooms. Horizontal optical fiber cables shall also be terminated using optical fiber couplings at their designated work area locations on information outlet faceplates for "fiber to the desk."
2. LC-type optical fiber couplings shall be snap-type.
3. LC-type optical fiber couplings shall incorporate domed zirconia ferrule and shall utilize a PC polish to ensure fiber-to-fiber physical contact for low loss and reflections.
4. LC-type optical fiber connector plugs shall accept 1.6mm – 2.0mm and 3.0mm outside diameter fiber.
5. The average insertion loss is .3db for multi-mode and single mode connectors.
6. SC-type optical fiber couplings shall meet the following performance criteria:

<u>Test Procedure</u>	<u>Maximum Attenuation Change</u>
Cable Retention (FOTP-6)	0.2 dB
Durability (FOTP-21)	0.2 dB
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

## 7. Additional Performance Requirements:

- a. Length: 2 inches (5.08cm)
- b. Operating Temperature: -40 to 85 degrees C

## 8. Basis of Design:

- a. Multimode: CommScope RFE-PNL-012-MFA-LC12-BK/4U-AQ
- b. Singlemode: CommScope RFE-PNL-012-SFA-LC12-BK/4U

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 2.3 FACEPLATES/JACKS

## A. CAT 6 Jacks:

1. CAT 6 horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.
2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.
3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
4. Where standalone CAT 6 only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.
5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.
6. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall (1) match the faceplate color used for other utilities in the building or (2) when installed in surface raceway (if applicable), match the color of that raceway.
7. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.
8. The CAT 6 modular jacks shall be non-keyed 8-pin modular jacks.
9. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.
10. CAT 6 modular jacks shall be pinned per TIA-568B.
11. CAT 6 termination hardware shall, as a minimum, meet all of the mechanical and electrical performance requirements of the following standards:
  - a. ANSI/TIA/EIA-568-A-5
  - b. ANSI/TIA/EIA-568A
  - c. ISO/IEC 11801
  - d. IEC 603-7
  - e. FCC PART 68 SUBPART F



12. The color for CAT 6 jacks shall be orange.

#### 2.4 WORK AREA PATCH CORDS

- A. By Owner.

### PART 3 - EXECUTION

#### 3.1 CABLE INSTALLATION REQUIREMENTS

- A. Horizontal Cabling:

1. The maximum horizontal cable drop length for Data UTP shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing horizontal cabling in a fashion so as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Architect/Engineer prior to installation. Changes to the contract documents shall be approved by the Architect/Engineer.
2. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellems-style grips may be used to spread the strain over a longer length of cable.
3. Manufacturer's minimum bend radius specifications shall be observed in all instances.
4. Horizontal cabling installed as open cabling shall be supported at a maximum of 4' between supports. Refer to specification section 27 05 28 for cable pathway requirements.
5. The maximum conduit fill for horizontal cabling shall not exceed 40% regardless of conduit length.
6. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.
7. A coil of 3 feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook, bridle ring, etc.) before the cables enter a fishable wall, conduit, surface raceway, or box. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
8. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:
  - a. Twelve (12) inches from power lines of <5-kVa.
  - b. Eighteen (18) inches from high-voltage lighting (including fluorescent).
  - c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
  - d. Thirty-nine (39) inches from transformers and motors.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

9. Information outlets shown on floor plans with the subscript “W” are intended to be used for wall mounted telephones. Back boxes for wall mounted telephones shall not be located within 12” vertically, or horizontally, from any light switches, power receptacles, nurse call devices, thermostats, countertop, counter backsplash, or any other architectural element that would otherwise prevent the installation of a wall mounted telephone on the mating lugs.

## 3.2 CABLE TERMINATION REQUIREMENTS

## A. Cable Termination – CAT 3 Voice Horizontal Cabling:

1. Voice pairs shall terminate on wall-mounted 110-type termination blocks at the entrance room, main equipment room and/or telecommunications rooms.
2. If the “last” Horizontal termination block is greater than 50% utilized, one additional block shall be provided for future use. Provide additional horizontal termination blocks to accommodate a minimum of 25% additional drops.
3. The Contractor shall furnish and install cable management hardware (e.g., D-rings and cable guides) to neatly and securely route the cable from the nearest cable tray to the cable termination hardware.
4. The height of the voice termination field shall not exceed 6 feet (72 inches) above floor level to facilitate cable maintenance.
5. Termination blocks on which the backbone and horizontal cabling are terminated shall be positioned in separate columns. Backbone cabling should be positioned to the left; horizontal cabling to the right and be in close proximity to simplify installation and subsequent tracing of cross-connect wiring. Where new cabling is to be integrated with existing cabling at the building entrance, it will be the responsibility of the Contractor, in cooperation with the Owner, to coordinate placement of voice termination hardware of the local exchange carrier(s) serving the site.
6. Cables shall be fed from below the termination hardware in a manner that will facilitate growth.
7. Horizontal troughs incorporating split plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers at wall-mounted 110-blocks. Troughs shall be positioned at the top of and between each column of termination blocks. Rings shall be positioned between the backbone and horizontal blocks for vertical routing of jumpers and/or cross-connect wiring.
8. Termination of backbone voice cabling shall be accomplished by using 5-pair (e.g., C5-type) clips.
9. The Contractor shall ensure that the twists in each cable pair are preserved to within 1.0 inch of the termination for all voice UTP cables. The cable jacket shall be removed only to the extent required to make the termination.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## B. Cable Terminations - Data UTP:

1. Modular patch panels shall be designed and installed in a fashion as to allow future horizontal cabling to be terminated on the panel without disruption to existing connections.
2. If the "last" patch panel (per rack) is greater than 50% utilized, one additional patch panel shall be provided for future use. Modular patch panels shall be sized to accommodate a minimum of 25% additional drops.
3. At information outlets and modular patch panels, the Contractor shall ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for data cables. The cable jacket shall be removed only to the extent required to make the termination.

## C. Cable Terminations - Fiber Optic:

1. ALL fibers shall be terminated using the specified connector type.
2. All terminated fibers at the telecommunications rooms shall be mated to couplings mounted on panels. Couplings shall be mounted on a panel that, in turn, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting access to the fiber optic cable from the front of the housing.
3. All couplings shall be fitted with a dust cap.
4. Fibers from multiple locations may share a common enclosure; however, they must be segregated on the connector panels and clearly identified. Fibers from multiple destinations may be secured in a common enclosure provided that they are clearly identified as such. Fibers from different locations shall NOT share a common connector panel (e.g., "insert").
5. Slack in each fiber shall be provided to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30" high workbench positioned adjacent to the termination enclosure(s). A minimum of 1 meter (approximately 39") of slack shall be retained regardless of panel position relative to the potential work area.

END OF SECTION 27 15 00



## SECTION 27 17 10 - TESTING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. This section describes the testing requirements relating to the structured cabling system and its termination components and related subsystems.

## 1.2 RELATED WORK

- A. Section 27 05 00 – Basic Communications Systems Requirements

## 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.

## 1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work, the Contractor shall submit:
  - 1. Complete information on testing procedure as described herein.

## PART 2 - PRODUCTS

## 2.1 TESTING COPPER

- A. General Requirements:
  - 1. The Contractor is responsible to perform acceptance tests as indicated below for each sub-system (e.g., backbone, horizontal, etc.) as it is completed.
  - 2. The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor should provide a summary of the proposed test plan for each cable type including equipment to be used, setup, test frequencies or wavelengths, results format, etc. The method of testing shall be approved by the Architect/Engineer.
  - 3. The Contractor shall visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. The Contractor shall provide the Architect/Engineer with a written certification that this inspection has been made.
  - 4. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove the wiring connections are correct.
6. The Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Architect/Engineer, the Contractor shall provide copies of the original test results.
7. All cabling shall be 100% fault-free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
  - a. CAT 3 Backbone Cable:
    - 1) Backbone CAT 3 copper cable shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the termination blocks (e.g., 110). Any mis-positioned pairs must be identified and corrected. The percentage of "bad" pairs shall not exceed 3% in any backbone (riser or tie) cable based on total pair count. All bad pairs must be identified and documented.
  - b. CAT 6 Cable:
    - 1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.
    - 2) Horizontal cable shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.
    - 3) CAT 6 horizontal cable shall also be tested to 250 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Basic Link" including cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:
      - a) Wire Map
      - b) Length
      - c) NEXT Loss (Pair-to-Pair)

- d) NEXT (Power Sum)
  - e) ELFEXT (Pair-to-Pair)
  - f) ELFEXT (Power Sum)
  - g) Return Loss
  - h) Attenuation
  - i) Propagation Delay
  - j) Delay Skew
- 4) The maximum length of horizontal cable shall not exceed 295 feet (90m), which allows 33 feet (10 m) for technology equipment and modular patch cords.
- 5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.
- 6) CAT 6 horizontal cable testing shall be performed using a test instrument designed for testing to 250 MHz or higher. Test records shall verify, "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS\*, FAIL\*, or FAIL result for any of the parameters will not be accepted.
- 7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

## 2.2 TESTING FIBER

### A. General Requirements:

1. The Contractor is responsible to perform acceptance tests as indicated below for each optical fiber sub-system (e.g., backbone, horizontal, etc.) as it is completed.
2. The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor should provide a summary of the proposed test plan for each optical fiber cable type including equipment to be used, setup, test frequencies or wavelengths, results format, etc. The method of testing shall be approved by the Architect/Engineer.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. The Contractor shall visually inspect all optical fiber cabling and termination points to ensure that they are complete and conform to the standards defined herein. The Contractor shall provide the Architect/Engineer with a written certification that this inspection has been made.
4. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove that the optical fiber connections are correct.
6. The Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Architect/Engineer, the Contractor shall provide copies of the original test results.
7. All optical fiber cabling shall be 100% fault-free unless noted otherwise. If any optical fiber cable is found to be outside the specification defined herein, that optical fiber cable and the associated connector(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
9. The optical fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, the Contractor shall provide cable manufacturer's test report for each reel of cable provided. These test reports shall include manufacturer's on-reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.
  - a. On-the-reel bandwidth performance as tested at the factory. Factory data shall be provided upon request.
  - b. The testing noted for optical fiber cabling utilizes an Optical Time Domain Reflectometer (OTDR). However, the Contractor may submit to the Architect/Engineer for pre-approval of alternate fiber optic testing equipment.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## c. Tests Prior to Installation:

- 1) The Contractor, at their discretion and at no cost to the Owner, may perform an attenuation test with an OTDR at 850-nm or 1300-nm on each optical fiber of each cable reel prior to installation. The Contractor shall supply this test data to the Architect/Engineer prior to installation.

## d. Tests After Installation:

- 1) Upon completion of cable installation and termination, the optical fiber cabling shall be tested to include:

## a) Optical Attenuation (“Insertion Loss” Method):

- (1) Optical Attenuation shall be measured on all terminated optical fibers in one direction of transmission using the “Insertion Loss” method measurement in accordance with the TIA/EIA 526-14, Method B, and be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made. Multimode optical fibers shall be tested at  $850 \pm 30$  nm. Singlemode optical fibers (if applicable) shall be tested at  $1300 \pm 20$  nm.<sup>7</sup>

- (2) Attenuation of optical fibers shall not exceed the values calculated as follows:

$$\text{Attenuation (max.)} = 2 * C + L * F + S \text{ dB}$$

Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers), and F is the maximum allowable optical fiber loss (in dB/km). S is the total splice loss (# of splices \* maximum attenuation per splice).

## b) Verification of Link Integrity (OTDR):

- (1) All optical fibers shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multimode optical fibers shall be tested at 850-nm and 1300-nm (nominal). Singlemode optical fibers (if applicable) shall be tested at 1310-nm and 1550-nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers

of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used. Access jumpers used for testing shall match the type and core diameter of the fiber optic strand under test.

- (2) Set OTDR's test variables to the manufacturer's published backscatter coefficient and velocity of propagation figure for the specific strand of fiber under test. OTDR's range should be set to approximately 1.5 times the length of the strand under test, pulse width should be optimized for the length of the fiber optic strand under test, and number of averages should be adjusted to approximately 120 seconds per wavelength.
- (3) OTDR traces revealing a point discontinuity greater than 0.2 dB in a multimode optical fiber or 0.1 dB in a singlemode optical fiber (if applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that optical fiber by the Owner. The installation of that optical fiber cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that optical fiber cable and the associated terminations shall be replaced at the expense of the Contractor.

### 2.3 DOCUMENTATION/AS-BUILTS/RECORDS

#### A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 27 05 00 and Division 1. Documentation shall include the items detailed in the subsections below.
2. All documentation, including hard copy and electronic forms, shall become the property of the Owner.
3. The Architect/Engineer may request that a 10% random field retest be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Architect/Engineer, including a 100% retest. This retest shall be at no additional cost to the Owner.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## B. Copper Media Test Data:

1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package. The Contractor shall furnish this information in electronic form (CD-ROM). The CD-ROM shall contain the electronic equivalent of the test results as defined by the bid specification and be of a format readable by Microsoft Word (Version 6.0 or newer). The Contractor shall provide a licensed copy of the software required to view and print the data that is provided in a proprietary format. The Contractor shall furnish one (1) copy of the Data and Display (if applicable) software.

## C. Optical Fiber Media Test Data:

1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. OTDR traces of individual optical fiber "signatures" obtained as specified above shall be provided to the Architect/Engineer in electronic form on CD-ROM for review. Trace files shall be so named as to identify each individual optical fiber by location in the cable system and optical fiber number or color. Where traces are provided in electronic form, the Contractor shall provide along with the above documentation, one (1) licensed copy of software that will allow for the display of OTDR traces provided. The software shall run on a DOS or Microsoft Windows-based personal computer.

## D. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION 27 17 10



## SECTION 27 17 20 - SUPPORT AND WARRANTY

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. This section describes support and warranty requirements relating to the structured cabling system and related subsystems.

## 1.2 RELATED WORK

- A. Section 27 05 00 – Basic Technology Systems Requirements.

## 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURER REQUIREMENTS

- A. The Basis of Design for all structured cabling components is listed in the individual Division 27 sections. Alternative acceptable manufacturers will be accepted for this project.

- 1. Exceptions:

- a. CAT 3 copper ( $\geq 25$ -pair).
- b. Optical fiber.

- B. Additional acceptable manufacturers for horizontal cabling:

- 1. Belden
- 2. Berk-Tek / Leviton
- 3. Hubbell / Mohawk
- 4. TE Connectivity

- C. Additional acceptable manufacturers for optical fiber:

- 1. AFL Telecom
- 2. Corning

## 2.2 WARRANTY

- A. A two (2) year Product Installation Warranty shall be provided for the structured cabling system as described in the contract documents.
- B. The Product Installation Warranty shall cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

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HENRY VILAS ZOO  
CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

27 17 20

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION 27 17 20

## SECTION 28 05 00 - BASIC ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Basic Safety and Security System Requirements (herein referred to Security) specifically applicable to Division 28 sections, in addition to Division 1 - General Requirements.

## 1.2 SCOPE OF WORK

- A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing, and placing into satisfactory operation the security systems as shown on the drawings and specified herein.
- B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make their portion of the security systems a finished and working system.
- C. Description of systems include but are not limited to the following:
  - 1. Video Surveillance
  - 2. Fire Detection and Alarm
  - 3. Low Voltage Security Wiring (less than +120VAC) as specified and required for proper system control and communications.
  - 4. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
  - 5. Firestopping of penetrations of fire-rated construction as described in Specification Section 28 05 03.

## 1.3 OWNER FURNISHED PRODUCTS

- A. Ethernet Switches.
- B. Fiber Optic Patch Cables.

## 1.4 WORK SEQUENCE

- A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.
- B. Successful Bidders shall itemize all work and list associated hours and pay scale for each item.

## 1.5 ALTERNATES

- A. Alternate Bid 3 - Lump Sum: Exhibit Area Video Surveillance System
  - 1. Add price for providing video surveillance system equipment for Seal Building and Bear Building and yards.
- B. Alternate Bid 4 - Lump Sum: Concession Video Surveillance System
  - 1. Add price for video surveillance system for concession building.
- C. Alternate Bid 7 - Lump Sum: Seal Exhibit
  - 1. Deduct price for deleting the following: seal exhibit pool, seal LSS pumps and filters and associated piping work, seal underwater viewing shelter, and finishes in seal holding; all as indicated on drawings.

## 1.6 DIVISION OF WORK BETWEEN ELECTRICAL AND SECURITY CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
  - 1. "Electrical Contractor" as referred to herein refer to the Contractors listed in Division 26 of this Specification.
  - 2. "Electrical Contractor" shall also refer to the Contractor listed in Division 28 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
  - 3. "Security Contractor" as referred to herein refer to the Contractors listed in Division 28 of this Specification.
  - 4. Low Voltage Security Wiring: The wiring (less than 120VAC) associated with the Security Systems, used for analog and/or digital signals between equipment.
- C. General:
  - 1. The purpose of these Specifications is to outline typical Electrical and Security Contractor's work responsibilities as related to Security Systems including conduit, power wiring, and Low Voltage Security Wiring. The prime contractor is responsible for all divisions of work.
  - 2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Security Drawings. Other wiring, conduits, raceways,



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junction boxes, and electrical power not shown on the Security Drawings but required for the successful operation of the systems shall be the responsibility of the Security Contractor and included in the Contractor's bid.

3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Security systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Security Contractor has convened to determine the exact location and requirements of the installation.
4. This Contractor shall establish Electrical and Security utility elevations prior to fabrication and installation. The Security Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
  - a. Lighting Fixtures
  - b. Gravity Flow Piping, including Steam and Condensate
  - c. Sheet Metal
  - d. Electrical Busduct
  - e. Sprinkler Piping and other Piping
  - f. Conduit and Wireway
  - g. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Responsible for Security Systems grounding and bonding.
3. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Security Contractor's Responsibility:

1. Assumes all responsibility for the Low Voltage Security Wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of Security equipment which is required to be bonded to the telecommunications ground system.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

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## 1.7 COORDINATION DRAWINGS

## A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

## B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
  - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. KJWW will provide electronic file copies of

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ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by KJWW. KJWW will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

## C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
  - a. Scale of drawings:
    - 1) General plans: 1/4 Inch = 1'-0" (minimum).
    - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
    - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
    - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
    - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

## D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

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6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.8 QUALITY ASSURANCE

## A. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
2. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the installation, termination, testing, and placing into operation electronic security devices shall be individually trained by the manufacturer.

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3. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
4. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of electronic security devices and have personnel adequately trained in the use of such tools and equipment.
5. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
  - a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

## B. Compliance with Codes, Laws, Ordinances:

1. This Contractor shall conform to all requirements of the City of Madison, Wisconsin Codes, Laws, Ordinances and other regulations having jurisdiction over this installation.
2. This Contractor shall also conform to all published standards of the County of Dane, Wisconsin.
3. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
4. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, the codes and regulations shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.
6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

## C. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal, and/or other regulatory bodies.

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5. Pay all charges arising out of required inspections due to codes, permits, licenses, or as otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. All equipment and materials shall be as approved or listed by the following: (Unless approval or listing is not applicable to an item by all acceptable manufacturers.)
  - a. Factory Mutual
  - b. Underwriters' Laboratories, Inc.

## D. Examination of Drawings:

1. The drawings for the Security Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling so as to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications, or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install, terminate, and make completely ready for operation, the items mentioned.

## E. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit 2014.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.

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4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

## F. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

## 1.9 SUBMITTALS

## A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

## 1. Submittals list:

<u>Referenced Specification Section</u>	<u>Submittal Item</u>
28 05 00	Basic Electronic Safety and Security System Requirements
28 05 03	Through-Penetration Firestopping
28 23 00	Video Surveillance

## B. In addition to the provisions of Division 1, the following is required:

1. Submittals shall include all layout drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring diagrams; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
2. The Contractor shall submit either one electronic copy or three (3) paper copies of each shop drawing for review by the Architect/Engineer BEFORE releasing any equipment for manufacture or shipment.
3. Shop drawings which are larger than 11" x 17" or are plan size layout drawings such as wiring diagrams and cable tray drawings, shall be submitted on reproducible media. Submit one reproducible and one print of each drawing or plan. All Contractor approval stamps shall be made on the reproducible. The

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Architect/Engineer will return the reproducible copy of the shop drawings, complete with comments. This Contractor shall copy and distribute these reviewed shop drawings as required. All costs for copying and distribution of reproducible shop drawings shall be included by This Contractor in their bid.

4. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. CONTRACTOR'S APPROVAL STAMP IS REQUIRED ON ALL SUBMITTALS. APPROVAL WILL INDICATE THE CONTRACTOR'S REVIEW of all material and a COMPLETE UNDERSTANDING OF EXACTLY WHAT IS TO BE FURNISHED. Contractor shall clearly mark all deviations from the contract documents on all submittals. IF DEVIATIONS ARE NOT MARKED BY THE CONTRACTOR, THEN THE ITEM SHALL BE REQUIRED TO MEET ALL DRAWING AND SPECIFICATION REQUIREMENTS.
  5. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  6. The Contractor shall clearly indicate the size, finish, material, etc.
  7. All submittals shall be assembled in sets by Specification Section and by system.
  8. Each set shall be bound in a manufacturer's folder or inside of a manila file folder.
  9. Each set shall contain an index of the items enclosed with a general topic description on the cover.
  10. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is relevant to the work.
  11. Failure to comply with the above shall be reason to resubmit all shop drawing submittals.
  12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
  13. Provide documentation of all warranties required by the contract documents.
  14. Submit copy of the Contractor certification form contained at the end of specification section.
- C. Provide Schedule of Values for Technology Work:
1. Application forms: Use AIA Document Continuation Sheets G703 (or similar) as the form for application.
  2. Provide line items on the Schedule of Values including:
    - a. Video Surveillance Systems
    - b. Fire Alarm Systems



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3. Change orders shall have schedule of values broken out as listed above submitted with each change order.
4. Coordinate with the Project Architect/Engineer the items included in the Schedule of Values. The intent is to not create schedules in addition to those the Technology Contractor normally submits to the General Contractor for payment.

## 1.10 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
  1. Firestopping, including mechanical firestop systems.

## 1.11 PRODUCT DELIVERY, STORAGE, HANDLING &amp; MAINTENANCE

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
- B. Store materials on the site so as to prevent damage.
- C. Keep fixtures, equipment and materials clean, dry, and free from harmful conditions.

## 1.12 WARRANTY

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 28 may require additional warranty requirements for specific equipment or systems.
- B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.
- C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

## 1.13 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

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## 1.14 MATERIAL

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used in this contract.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured **in writing** from the Architect/Engineer not later than ten (10) days prior to the bid opening date. The Contractor bears full responsibility for the unnamed manufacturer's equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.
- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

## PART 2 - PRODUCTS

## 2.1 REFER TO INDIVIDUAL SECTIONS

## PART 3 - EXECUTION

## 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 05 33. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.
- C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.
- D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

### 3.3 FIELD QUALITY CONTROL

- A. General:
  - 1. Refer to specific Division 28 sections for further requirements.
  - 2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
  - 3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
  - 4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
- B. Protection of cable from foreign materials:
  - 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

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2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

## 3.4 PROJECT CLOSEOUT

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
  2. Refer to the end of Section 27 05 00 for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
  3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.
- C. Before final payment will be authorized, this Contractor must have completed the following:
  1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
  2. Submitted bound copies of approved shop drawings.
  3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
  4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
  5. Submitted testing reports for all systems requiring final testing as described herein.

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6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site (Henry Vilas Zoo, 702 South Randall Avenue, Madison, Wisconsin 53715); submit receipt to Architect/Engineer prior to final payment being approved.

## 3.5 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Submit three (3) properly indexed and bound copies, in “D” ring style notebooks, of the Operations and Maintenance Instructions to the Architect/Engineer for approval. Make all corrections or additions required.
- B. Operation and Maintenance Instructions shall include:
  1. Notebooks shall be heavy duty locking three ring binders and incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. “Peel and stick” labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. Provide “Wilson-Jones” or equal, color black. Size notebooks a minimum of 1/2" thicker than material for future inserts. Label the spine and front cover of each notebook. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other forms of binding will be acceptable.
  2. Prepare binder covers (front and spine) with printed title “Operation and Maintenance Instructions”, title of project, and subject matter of binder when multiple binders are required.
  3. Title page with project title, Architect, Engineer, Contractor, and Subcontractor with addresses, telephone numbers, and contacts.
  4. Table of Contents describing all index tabs.
  5. Listing of all Subcontractors and major equipment suppliers with addresses, telephone numbers, and contacts.
  6. Index tabs dividing information by specification section, major equipment, or systems. All tab titles shall be clearly printed under reinforced plastic tags.
  7. Copies of warranties.
  8. Copies of all final approved shop drawings and submittals.
  9. Copies of all factory inspection and/or equipment start-up reports.
  10. Schematic wiring diagrams of the equipment which have been updated for field conditions. Field wiring shall have label numbers to match drawings.
  11. Dimensional drawings of equipment.
  12. Detailed parts list with list of suppliers.
  13. Operating procedures for each system.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

14. Maintenance schedule and procedures. Include maintenance chart that lists routine maintenance requirements and frequency over one year time period.
15. Repair procedures for major components.
16. Replacement parts and service material requirements for each system and the frequency of service required.
17. Instruction books, cards, and manuals furnished with the equipment.

## 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.
- E. Refer to the individual specification sections for minimum hours of instruction time for each system.
- F. Operating Instructions:
  1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the security systems.
  2. If the Contractor does not have Engineers and/or Technicians on staff that can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

## 3.7 SYSTEM COMMISSIONING

- A. The security systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.
- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to insure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

## 3.8 RECORD DOCUMENTS

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- C. This Contractor shall maintain at the job site, a separate and complete set of Security Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- E. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

## 3.9 ADJUST AND CLEAN

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

END OF SECTION 28 05 00





## SECTION 28 05 03 - THROUGH PENETRATION FIRESTOPPING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

## 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

## 1.3 REFERENCES

- A. UL 723 - Surface Burning Characteristics of Building Materials
- B. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- C. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- D. Warnock Hersey - Directory of Listed Products
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- F. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- G. The Building Officials and Code Administrators National Building Code
- H. Wisconsin Administrative Code
- I. NFPA 5000 – Building Construction Safety Code

## 1.4 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 28 05 00.
- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Warnock Hersey Assembly number.
- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
  - 1. Types of penetrating items.
  - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
  - 3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
  - 4. F and T ratings for each firestop system.
- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

## 1.6 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
  - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
  - 2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings:
    - a. Floor penetrations located outside wall cavities.
    - b. Floor penetrations located outside fire-resistance-rated shaft enclosures.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.7 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the Construction Manager, General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.

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1. Review foreseeable methods related to firestopping work.
2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

## 1.8 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
  1. 3M; Fire Protection Produces Division.
  2. Hilti, Inc.
  3. RectorSeal Corporation, Metacaulk.
  4. Tremco; Sealant/Weatherproofing Division.
  5. Johns-Manville.
  6. Specified Technologies Inc. (S.T.I.)
  7. Spec Seal Firestop Products
  8. AD Firebarrier Protection Systems
  9. Wiremold/Legrand: FlameStopper

## 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- E. Provide firestopping systems allowing continuous insulation for all insulated pipes.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- F. Provide firestopping systems classified by UL or listed by Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated  
 F Rating = Floor/Wall Rating  
 T Rating = Floor/Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated  
 F Rating = Wall Rating  
 T Rating = 0

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated  
 F Rating = Wall/Floor Rating  
 T Rating (Floors) = Floor Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

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- G. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- H. Any openings in floors or walls not described in the UL or listed by Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

## 3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

## 3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

## 3.4 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
  - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Firestop System Supplier; UL or listed by Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

## 3.5 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the engineer and manufacturer's factory representative. The engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the engineer's discretion and the contractor's expense.

END OF SECTION 28 05 03

## SECTION 28 23 00 - VIDEO SURVEILLANCE

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Network Video Management System (NVMS) - General Requirements
- B. NVMS Manufacturers
- C. NVMS System Detailed Requirements
- D. NVMS Recording Requirements
- E. NVMS Cabling

## 1.2 RELATED WORK

- A. Section 26 05 33 - Conduit
- B. Section 26 05 13 - Wire and Cable
- C. Section 28 05 00 - Basic Electronic Safety and Security System Requirements

## 1.3 QUALITY ASSURANCE

- A. Integrator/Installer (Contractor): The Contractor must be a manufacturer-certified installation, service, and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming.
  - 1. The integrator must have local service representatives within 100 miles of the project site.

## 1.4 REFERENCES

- A. NFPA 70 - National Electrical Code
- B. Electronic Industries Association (EIA) Video Surveillance Equipment Standards
- C. UL 2044 - Standard for Commercial Closed Circuit Television Equipment
- D. UL 3044 - Standard for Safety for Surveillance Closed Circuit Television Equipment

## 1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 28 05 00.
- B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
  - 1. Compliance with each requirement of these documents.
  - 2. All component options and accessories specific to this project.
  - 3. Electrical power consumption rating and voltage.
  - 4. Heat generation for all power consuming devices.
  - 5. All required wiring shall be identified.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

6. Number of IP addresses that will be required from the Owner's Information Systems Department.
7. Statement of Acceptability of Designed Network Video Recorder (NVR):
  - a. If the Contractor agrees that the Network Video Recorder(s) designed and described herein is acceptable for the chosen manufacturer's solution and meets the demand of the application, this shall be stated in writing and submitted as part of the shop drawing submittal.
  - b. If the Contractor does not agree that the NVR(s) designed and described herein is acceptable for the chosen manufacturer's solution, Contractor shall itemize the quantity, technical specifications, and capacities of the NVR(s) required to support the functionality and device quantities required by the project drawings. Indicate the capacity utilization factor for each NVR.
  - c. Contractor's bid shall include any required changes in the NVR's capacity.
8. Calculation for storage required using the criteria contained in the project drawings.
9. Calculation for required network bandwidth, including any latency restrictions.
- C. System Drawings: Project-specific system CAD drawings shall be provided as follows:
  1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical cameras), the diagram may show one device and refer to the others as "typical" of the device shown.
- D. Sample format of site specific programming guides to be used for system planning/programming conference with Owner.
- E. Meeting agenda for planning/programming conference required in Part 3 of this specification.
- F. Submit detailed description of Owner training to be conducted at project end, including specific training time.
- G. Quality Assurance:
  1. Provide materials documenting experience requirements of the manufacturer and installing contractor.
  2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## H. Coordination Drawings:

1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 28 05 00 for coordination drawing requirements.

## 1.6 SYSTEM DESCRIPTION

- A. This specification section describes the furnishing, installation, commissioning and programming of a complete, turnkey, closed circuit television system.
- B. Performance Statement: This specification section and the accompanying project drawings are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
- C. Refer to the project drawings for model numbers for the Basis of Design for all equipment.

## 1.7 OWNER-SUPPLIED MATERIALS

- A. Ethernet Switches.
- B. Fiber Optic Patch Cables.

## 1.8 LICENSING REQUIREMENTS

- A. All licenses required for system operation shall be included in the Contractor's bid. Licenses shall include, but not be limited to, NVR, server, and workstation software, cameras, encoders/decoders, and any other licensing that is required by the manufacturer for operation of any system component.
  1. Camera licenses shall be provided for all cameras listed on the Individual CCTV Camera Requirements Schedule whether cameras are new or existing.
  2. The system shall be provided with installed software capacity to accommodate a minimum quantity of twelve (12) cameras. The licensing for all twelve (12) cameras shall **NOT** be included in the Contractor's bid. Licensing shall only be included for the quantity of cameras shown on the Individual CCTV Camera Requirements Schedule. However, the system's ability to support up to a total capacity of twelve (12) cameras shall **ONLY** require future payment of additional per-unit camera licensing fees by the Owner. In no case shall the Owner be required to upgrade the software provided in the Contractor's bid in order to achieve support for a total of twelve (12) cameras, including the payment of any software upgrade fees, installing a different software version, etc.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

3. If the manufacturer requires the purchase of a block of licenses (instead of selling a single license for a single device) the Contractor's bid shall include the appropriate block of licenses that accommodates all device quantities described by the project drawings, plus 25% additional devices for future growth.
4. Camera licensing that is restricted to a particular device MAC address or in any way is only valid for a particular manufacturer or model number is not acceptable. Camera licenses shall be issued such that the Owner can replace a camera with another camera brand and/or model number and transfer the license from the old camera to the new camera at no additional cost at any future time. This license transfer procedure shall be capable of being performed by the Owner and shall not require the services of an integrator.
  - a. Exception: When a camera license is issued as a no-cost license in the limited condition that the NVR manufacturer and the camera manufacturer are the same company, it is permissible to charge a future license fee to the Owner if the Owner elects to replace the NVR manufacturer-branded camera with a third party manufacturer's camera.

## 1.9 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 28 05 00.
- B. Provide final system block diagram showing any deviations from shop drawing submittal.
- C. Provide statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.
- D. Provide final CCTV Camera Type Schedule and Individual CCTV Camera Requirements Schedule documenting all changes made during construction.
- E. Warranty: Submit written warranty and complete all Owner registration forms.
- F. Complete all operation and maintenance manuals as described below.

## 1.10 OPERATION AND MAINTENANCE DATA

- A. Submit documents under the provisions of Section 28 05 00.
- B. Manuals: Final copies of the manuals shall be delivered within 14 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the manufacturer for each piece of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:
  1. Hardware Manual: The manual shall describe all equipment furnished including:
    - a. General description and specifications.
    - b. Installation and check out procedures.
    - c. System layout drawings and schematics.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- d. Alignment and calibration procedures.
2. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper installation, testing, and operation. The manual shall include:
  - a. Definition of terms and functions.
  - b. System use and application software.
  - c. Graphical user interface use.
  - d. Reports generation.
3. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:
  - a. NVR(s) and peripherals.
  - b. System startup and shutdown procedures.
  - c. Use of system.
  - d. Recovery and restart procedures.
  - e. Use of report generator and generation of reports.
  - f. Data entry.
  - g. Operator commands.
  - h. Alarm messages.
  - i. System permissions functions and requirements.
4. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

## 1.11 WARRANTY

- A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.
- B. Operation: Upon the performance of any scheduled adjustments or repairs, Contractor shall verify operation of the NVR and other system components.
- C. Emergency Service: The Owner will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service within the distance defined above. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365.
- D. Records and Logs: The Contractor shall keep records and logs of each task completed under warranty. The log shall contain all initial settings upon Substantial Completion. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the system.
- E. Work Requests: The Contractor shall separately record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within five (5) days after work is accomplished.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- F. System Modifications: The Contractor shall make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. To the fullest extent possible, the Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.
- G. Software: The Contractor shall provide all software updates during the period of the warranty and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with system operators, shall include training for the new changes/features enabled, and shall be incorporated into the operations and maintenance manuals, and software documentation.
- H. Refer to the individual product sections for further warranty requirements of individual system components.

## 1.12 ALTERNATES

- A. Alternate Bid 3 - Lump Sum: Exhibit Area Video Surveillance System
  - 1. Add price for providing video surveillance system equipment for Seal Building and Bear Building and yards.
- B. Alternate Bid 4 - Lump Sum: Concession Video Surveillance System
  - 1. Add price for video surveillance system for concession building.
- C. Alternate Bid 7 - Lump Sum: Seal Exhibit
  - 1. Deduct price for deleting the following: seal exhibit pool, seal LSS pumps and filters and associated piping work, seal underwater viewing shelter, and finishes in seal holding; all as indicated on drawings.

## PART 2 - PRODUCTS

## 2.1 NETWORK VIDEO MANAGEMENT SYSTEM – GENERAL REQUIREMENTS

- A. The network video management system (NVMS) shall be an NVR-based video security solution that provides management of digital video, audio and data across a TCP/IP network.
- B. The VMS shall utilize network switch ports provided by the Owner for all required IP connections. The Contractor shall provide the Owner with a complete list of all IP ports required.
- C. ONVIF Compliance
  - 1. The NVMS system shall be ONVIF certified as an ONVIF Network Video Client.
  - 2. Cameras shall be ONVIF certified as an ONVIF Network Transmitter unless specifically noted as an exception to this requirement in the project drawings.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. The NVMS system shall be an “open system.”
1. To meet this requirement, the NVMS must directly support cameras from a minimum of three (3) readily available camera manufacturers.
  2. The three (3) camera manufacturers must have no corporate relationship to the NVMS manufacturer.
  3. “Directly support” shall be defined as plug-n-play using drivers that are commercially available at the time of bid that utilize the ONVIF specification as the means of integration.
  4. In addition to the requirement to support three (3) independent manufacturer’s cameras, the NVMS may support an unlimited additional quantity of in-house or other proprietary cameras.
  5. The open system shall not require proprietary storage solutions. It shall support third party storage solutions, including:
    - a. Commercially available Direct Attached Storage (DAS) devices.
    - b. Network Attached Storage (NAS) devices.
  6. The system must have a published API/SDK permitting third party integrations to the product without restrictions.
  7. The NVMS shall support active directory using LDAP protocol.
- E. The NVMS system shall consist of the following hardware/software components:
1. Software:
    - a. NVR and client Desktop PC control software
    - b. Recording services, archival services, and storage management
    - c. Configuration tools
  2. System storage as specified on the project drawings.
  3. Cameras and related hardware as specified on the project drawings.
  4. Hardware: NVR(s) and miscellaneous hardware (keyboard, mouse, KVM) as specified on the projects drawings.
- F. Video from any camera on the system (on the LAN, WAN or Internet) shall be capable of being viewed from single or multiple workstations simultaneously at any time, limited only by network bandwidth.
- G. The NVMS shall support simultaneous displaying of live (30 fps) video of a minimum of 16 cameras while the video monitoring screen is configured in a 16-camera split configuration. In no case shall the frame rate of the camera be required to be restricted to less than 30 fps to display a 16-camera split view.

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- H. Simultaneous display and recording of every camera shall be supported with independent user-adjustable frame rates that can be set differently for the display stream and the recording stream. These independent settings shall be unique per camera.
- I. The NVMS monitoring software shall support any combination of recorded and live video in any multiple camera split view, including viewing recorded video and live video from the same camera.
- J. The NVMS shall support continuous recording and event-based recording simultaneously. This shall be capable of being set on a per camera basis.
- K. Viewing of video (live and recorded) shall be possible from client software from any client hardware that is connected to the security LAN/WAN or Internet (through appropriate firewalls). In addition, system administration shall be permitted from remote client hardware.

## 2.2 NVMS MANUFACTURERS

- A. Basis of Design NVR Manufacturer
  - 1. American Dynamics
- B. Acceptable Alternate NVR Manufacturers:
  - 1. Bosch
  - 2. Panasonic

## 2.3 NVMS SYSTEM DETAILED REQUIREMENTS

- A. Network Requirements: The NVMS shall support Ethernet 10/100 BaseT and Gigabit Ethernet.
  - 1. Network protocols shall be supported including TCP/IP, IPX, and UDP.
  - 2. The network interface shall allow remote access of the NVMS from anywhere on the end-users LAN/WAN or Internet (behind firewall).
  - 3. The system shall permit limiting of frame rate transmission to individual clients.
  - 4. Both Multicast and Unicast shall be supported.
  - 5. All transmission of system data shall be secured using Secure Socket Layer (SSL) security on the TCP/IP network.
  - 6. Simple Network Management Protocol (SNMP) shall be supported.
- B. Video Formats:
  - 1. The NVMS shall support MJPEG, MPEG-4, and H.264 compression formats.
  - 2. The system shall support any single stream of bandwidth up to 90Mbit/sec at 30 fps at 4872 x 3248 resolution with no system performance degradation, assuming appropriate network bandwidth.

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3. Video shall be recorded using a 256-bit encryption algorithm with authentication (watermarking) software suitable for evidentiary proceedings. The watermarking feature shall provide evidence of altered video.
    - a. The video shall be watermarked with the authentication key/signature during recording of live video to the drive.
    - b. A video player shall be provided with the NVMS system.
      - 1) The player shall have the ability to validate the authentication upon playback.
      - 2) This authentication shall provide the storage media name, camera name, video time, and user information.
      - 3) The authentication shall have the ability to be password protected.
  4. Resolution:
    - a. The camera resolution shall be user selectable on a per-camera basis. Selecting or changing resolution shall not require a restart of the application, server, or workstation.
    - b. The system shall support the following resolutions:
      - 1) NTSC Resolutions: 0CIF (176 x 120), CIF (352 x 240), 2CIF (704 x 240), 4CIF (704 x 480).
      - 2) VGA Resolutions: QVGA (320 x 240), VGA (640 x 480), SVGA (800 x 600), XVGA (1024 x 768), 4xVGA (1280 x 960).
      - 3) Megapixel Resolutions: SXGA (1280 x 1024: 1.3MP), SXGA + EXGA (1400 x 1050: 1.4 MP), UXGA (1600 x 1200: 1.9MP), WUXGA (1920 x 1200: 2.3MP), QXGA (2048 x 1536: 3.1MP), WQXGA (2560 x 1600: 4.1MP), QSXGA (2560 x 2048: 5.2MP), 3296 x 2472: 8MP, 4000 x 2672: 11MP, 4864 x 3248: 16MP, 6576 x 4384: 29MP.
        - a) 16:9 and 4:3 formats shall be supported.
      - 4) HDTV Resolutions: 720p, 1080(i/p) in 16:9 format.
- C. Remote Clients:
1. The NVMS system shall include the ability to view live video or playback recorded video over the LAN/WAN or the Internet from any PC. This function shall NOT require any installed client software. An industry standard Web Browser (e.g., Internet Explorer, Firefox, Chrome) shall be the only software required to view non-authenticated video from a remote PC.

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- a. Any plug-ins (e.g., ActiveX, Java, Flash) required to view remote video shall be capable of being pushed to the user's PC at the time of initiating the remote video viewing session.
  - b. Remote viewing shall be supported whether the remote client is:
    - 1) Inside the firewall containing the NVMS.
    - 2) Outside the firewall containing the NVMS.
    - 3) Accessing the NVMS through a VPN.
2. Remote Client Features:
- a. Display live video.
  - b. Digital zooming and panning of fixed cameras.
  - c. PTZ camera control in real time, including adjusting PTZ lock and dwell times.
  - d. Ability to access video from all accessible recording devices.
  - e. Priority-based camera control takeover.
  - f. Customizable camera viewing screen split configurations that are retained under the user login between remote client sessions.
- D. Software Security Requirements:
1. All users shall be capable of being authenticated against Active Directory using LDAP, before being granted system access. Should the Owner not use Active Directory, the NVMS shall provide a built-in login and credential management tool to permit rules-based access rights on a per-user basis.
  2. The access rights shall be selectable on a per-user basis. In addition, user groups shall be capable of being assigned whereby each user group has a common set of access rights. Users shall be capable of being assigned to these user groups by the system administrator.
  3. Access rights available for customization shall include:
    - a. Live Video Viewing:
      - 1) Use of PTZ controls.
      - 2) Start and stop of manual recording.
      - 3) Access to and exclusive from individual cameras and monitors.
      - 4) Access to system settings.
      - 5) Ability to define video blocking positions of PTZ cameras for certain users.
    - b. Viewing Recorded Video:
      - 1) Ability to export recorded video. including email.
      - 2) Access to system archiving and backup.



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- 3) Ability to watch recorded video from individual cameras.
  - 4) Ability to delete recorded video.
- c. Camera Setup:
- 1) Add or remove cameras from the system.
  - 2) Change camera settings including resolution and frame rate.
  - 3) Change motion detection and other defined triggers.
- d. General Settings:
- 1) Change client software settings.
  - 2) Ability for user to configure or change custom viewing screen configurations.
  - 3) Modify server settings.
  - 4) Change recording or bandwidth settings.
  - 5) Configure users.
  - 6) Access and configure external messaging capabilities.
  - 7) View, print, save and clear the system log.
- E. Pan/Tilt/Zoom (PTZ) Control:
1. The NVMS shall support PTZ control from any client, including remote clients.
  2. The following PTZ features shall be supported:
    - a. Priority Levels
    - b. Device Group Control
    - c. PTZ Override (Lockout)
    - d. Proportional PTZ Control
    - e. Preset Lock via video screen
    - f. Preset Tour
- F. Video Archiving:
1. The archiving feature shall be hardware independent, providing the ability to utilize commercial off-the-shelf mass storage devices as archived video destinations, including optical DVD, DAS, NAS, SAN, and other external storage drives.
  2. The archiving software shall provide the ability to manage and store video information from multiple recorded video locations to a central location.
  3. Each NVR shall have the ability to set its own unique archiving settings. Video shall automatically be archived based on user-defined "percentage full" settings. When the NVR reaches the designated capacity threshold, video shall be automatically copied to the archive storage destination, and space on the source of the recorded video shall be released for overwrite by new video information using a first-in, first-out algorithm.
    - a. Exception: Video marked or tagged by the user or by automated alarm inputs shall be retained by the archiving process despite its location in the first-in, first-out timeline.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

4. Regardless of the video's storage location (local or in the archive), the NVMS software shall automatically retrieve video associated with an event on demand by the user in response to a search, browse, or other retrieval action. The actual storage location of the video shall be transparent to the user.
    - a. Exception: Video archived to removable media (e.g., removable hard drives or optical DVD) shall require prompting to the user to insert the appropriate media.
  5. Archiving shall be capable of being scheduled such that archiving will only run during certain hours defined by the Owner.
  6. The NVMS solution shall be permitted to utilize advanced algorithms for managing onboard storage such as reducing the frame rate of recorded video for the oldest video as an alternative to completely removing the video using a first-in, first-out algorithm. If this option exists in the NVMS software, it must have the following features:
    - a. Ability of the Owner to completely disable the feature.
    - b. Ability to set a minimum frame rate that the system will not exceed.
    - c. Ability to set the feature on a per-camera basis.
- G. Video Viewing Layouts:
1. The NVMS shall support the ability to save the list of camera views currently being displayed, along with the currently selected template, with a user-defined name to be loaded as needed by the system operator.
  2. System operators shall have the ability to define multiple viewing templates that can be recalled and configured on an as-needed basis.
  3. This feature shall be subject to the access rights provided by the system administrator through their login credential.
- H. Still Image Capture/Save:
1. During playback or monitoring of video, the system shall have the ability to create and save a still picture. This operation shall not affect any other operation and shall not alter the recorded video. The file format shall be an industry standard format (JPEG, TIFF) allowing for file transfer via e-mail, printing, or file transfer to other media.
  2. This feature shall be subject to the access rights provided by the system administrator through their login credential.
- I. Export Video Clip to File:
1. The NVMS shall have to ability to save and export recorded video to a file (MPEG, AVI) for the purpose of sharing and reviewing video clips. The start and end times for each video segment shall be user defined. The exported video clip shall be viewable via a standard Windows media player.

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2. This feature shall be subject to the access rights provided by the system administrator through their login credential.

## J. Automated Motion Video Searching:

1. The system shall support advanced automated motion video searching against pre-recorded video. The automated motion video search shall analyze frames in a video segment to detect motion activity from image to image. It shall display thumbnail images of the frames with activity, complete with a histogram depicting the relative amount of activity within each frame.
2. The search shall be defined by selecting a specific camera and a specific time period in which the suspected activity took place. All motion events associated with that camera and time period shall be displayed in either a trace or thumbnail format for review.
3. Motion shall be capable of being restricted to any user-defined area of the screen as drawn by the user using a windowing tool in the software.

## K. The NVMS shall provide up to 10 different and independent programmable recording schedules.

1. The schedules may be programmed to provide different record frame rates for day, night, and weekend periods, as well as holidays and exception days.
2. Advanced task schedules may also be programmed that could specify allowed log-on times for user groups, when events may trigger alarms, and when data backups and archiving should occur.

## 2.4 NVMS RECORDING REQUIREMENTS

- A. The NVMS shall provide management of the recording and playback of video, audio, and data (bookmarking, alarm data, etc.).
- B. Refer to the CCTV Camera Type Schedule and Individual CCTV Camera Requirements Schedule on the project drawings for specific variables to be used on a per-camera basis for the purpose of calculating storage capacity and retention.
  1. Total distributed storage requirements shall be determined based on a minimum of 45 days storage retention.
  2. Unless otherwise noted on the Individual CCTV Camera Requirements Schedule, cameras shall be assumed to be recording 24 hours per day, 7 days per week, 365 days per year. Specific per-camera assumptions stated on the Individual CCTV Camera Requirements Schedule for percent motion shall be used in the storage calculation.
  3. Compression shall be permitted to be used in the storage calculation. The compression algorithm (MPEG-4, H.264, etc.) shall be used on a per-camera basis. If the NVMS permits variable levels of compression intensity, the use of the "average" or "medium" level setting shall be used in the storage calculation unless otherwise noted.

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4. The Contractor shall provide the complete storage analysis and calculation as a shop drawing.

## C. Network Video Recorder (NVR) Hardware Platform:

1. The NVR shall be defined as a storage device for recording IP video streams from IP cameras or from analog cameras that have been encoded to IP. In both cases, the NVR shall record IP streams from cameras or encoders located anywhere on the IP network without being direct-cable connected to the NVR.
2. Refer to the project drawings for specific requirements, model numbers, and basis of design for the NVR.
3. NVR Configuration:
  - a. The NVR shall contain one hard drive for the operating system and software, and all hard drive storage required to achieve the required storage retention.
  - b. Provide with RAID 5 hard disk controller configuration for the video storage hard drives.
4. The NVMS shall provide a failover function where an NVR can be assigned as a backup to other NVRs. When an assigned NVR goes out of service, the failover NVR takes over the responsibilities of the failed NVR. When the primary NVR returns to service, the control shall be automatically transferred back to the primary NVR.
5. It shall be possible to assign a redundant NVR to every NVR for use in normal operation of all NVR(s) in the system. The redundant NVR shall record the same streams as the primary NVR. The redundant NVR shall have its own disk drives where it shall store the recorded data.
  - a. It shall be possible to view the data recorded by the redundant NVR in the client software. The redundant NVR shall have camera symbols that can be placed in the camera selection tree. These cameras shall have the same name as the cameras of the primary NVR. An indication shall be provided to indicate that the camera names are located on the redundant NVR.

## 2.5 NVMS CABLING

- A. Refer to telecommunications specification sections for all requirements.
- B. UTP copper patch cords shall meet Category rating (CAT 3, CAT 5e, CAT 6, etc.) channel requirements specified for horizontal UTP cabling in specification section 27 15 00.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Comply with the manufacturer's instructions and recommendations for installation of all products.
- B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.
- C. Mount all cameras in the approximate locations shown on the drawings. Coordinate installation with other trades and utilities in the vicinity. Cameras containing fixed lenses, moved by more than 1'-0" from their location shown on the drawings, shall have a new lens calculation performed by the Contractor. Provide Architect/Engineer with results of lens calculation before proceeding with installation.
- D. Contractor is responsible to coordinate with Owner's IT Department on acquiring network connections as well as any network configuration information, such as IP numbers, that will be required to connect NVMS to Owner network (if applicable).
- E. Provide all low voltage and +120 VAC power to all devices as required for proper system operation. Refer to Sections 26 05 33 and 26 05 13 for further requirements.
- F. All low voltage security shall be routed with other low voltage cabling.
- G. Cabling shall be plenum rated when installed outside of conduit in plenum ceilings.

## 3.2 FIELD QUALITY CONTROL

- A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.
- B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the project drawings.
- C. It shall be the Contractor's responsibility to correct all inadequate picture quality issues prior to acceptance of the system.

## 3.3 MANUFACTURER'S FIELD SERVICES

- A. Installation shall be performed by a factory-trained and certified Contractor.
  - 1. The Contractor shall provide a comprehensive, site-specific customer planning guide for the system. The Contractor shall conduct a conference with the Owner prior to any installation to discuss the programming options of the system and the planning guide. The result of this planning guide shall be the determination of the system options for each device and for the software.

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- B. The Contractor shall include labor for all planning and all programming activities required to implement the Owner's operational preferences for each device and software. Any software programmable option, within the bounds of the capabilities of the hardware specified, shall be included.
- C. It shall be the responsibility of the Contractor to provide a complete, functional system as described by the project drawings. These responsibilities include:
  - 1. Complete hardware setup, installation, wiring, and software configuration of the system, including all remote operator locations and all peripheral hardware.
  - 2. Complete programming of all hardware and software options in accordance with the Owner's preferences as determined by the planning guide conference.
  - 3. Programming of all custom graphic GUI screens including devices.
  - 4. Complete system diagnostic verification.
- D. Contractor shall provide an authorized manufacturer's representative to commission the system and ensure that facility-wide standards and project setup procedures are adhered to.

## 3.4 SYSTEM ACCEPTANCE

- A. The vendor shall submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components and software. The Contractor shall perform the tests and document all results under the supervision of the manufacturer's system engineer.
- B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.

## 3.5 SYSTEM DOCUMENTATION

- A. Complete documentation shall be provided for the system. The documentation shall describe:
  - 1. All operational parameters of the system.
  - 2. Complete documentation of all programming and options.
  - 3. Complete operating instructions for all hardware and software.
- B. The following sections shall be provided in the system documentation:
  - 1. System Administrator Manual: Provides an overview and a step-by-step guide and instructions detailing all system administrator responsibilities and functions.
  - 2. User Manual: A step-by-step guide and instructions detailing all system user functions.

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3. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams, and schematic diagrams.

## 3.6 SYSTEM TRAINING

- A. All labor and materials required for on-site system training by a certified representative of the system manufacturer shall be provided. Training shall be conducted at the project site using the project equipment.
- B. Provide two weeks advanced notice of training to the Owner.
- C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- D. At a minimum, the following training shall be conducted:
  1. System Administrators: A course detailing the system functions and operations. Provide configuration training on all aspects of the system.
  2. Users: Provide a detailed course outlining the operational features of all aspects of the user interface. Topics shall include alarm monitoring functions, reports, error handling, alarm handling, output relay control, and general overview of the report hardware.
- E. Minimum on-site training times shall be:
  1. System Administrators: One (1) day.
  2. Users: Four (4) hours.

END OF SECTION 28 23 00





## SECTION 28 31 00 - FIRE ALARM AND DETECTION SYSTEMS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Fire alarm and detection systems

## 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years' experience.
- B. Installer: A factory-authorized licensed electrical or security contractor with five years' experience in the design, installation and maintenance of fire alarm systems by that manufacturer.
- C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 2. This person's name and certification number shall appear on the start-up and testing reports.

## 1.3 SUBMITTALS

- A. The City of Madison fire alarm submittal shall have Professional Engineer's stamp and signature of the state in which the project is completed. NOTE: The Architect/Engineer cannot stamp and seal submittal drawings not prepared under their supervision. The Contractor is responsible for the city submittal, including fee.

## 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 26 05 00.
- B. Store and protect products under provisions of Section 26 05 00.

## 1.5 REGULATORY REQUIREMENTS

- A. System: UL or FM Global listed.
- B. Conform to requirements of NFPA 101.
- C. Conform to requirements of Americans with Disabilities Act (ADA).
- D. Conform to UL 864 Fire Alarm and UL 1076 Security.

## 1.6 SYSTEM DESCRIPTION

- A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

- B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.
- C. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.
- D. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.
- E. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.
- F. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.
- G. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.

## 1.7 OPERATION AND MAINTENANCE DATA

- A. Submit data under provisions of Section 26 05 00.
- B. Include operating instructions, and maintenance and repair procedures.
- C. Include results of testing of all devices and functions.
- D. Include manufacturer's representative's letter stating that system is operational.
- E. Include shop drawings as reviewed by the local Authority Having Jurisdiction.

## 1.8 WARRANTY

- A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.
- B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

## PART 2 - PRODUCTS

## 2.1 [FAP-#]: FIRE ALARM CONTROL PANEL (FAP)

## A. Acceptable Manufacturers:

1. Simplex
2. Notifier
3. Edwards System Technology (EST)
4. Siemens Fire Safety

B. Control Panel: Modular, power-limited electronic design, UL 864 listed. Provide surface wall-mounted enclosure as shown on plans. Enclosure shall be minimum 0.060 steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.

C. Each Signaling Line Circuit (SLC loop) shall not be loaded over 80% of the maximum device capacity. For example, in the minimum system capacity column listed below, if the fire alarm manufacturer's system capacity of analog sensors per loop is 99 devices, then no more than 79 devices shall be wired on that loop. The minimum system capacity shall be as follows:

Minimum Total Addressable Points:	99
Minimum Total SLC loops (including board, ready for field connections):	1

## D. Signal Line Circuit Board (SLC):

1. Each board shall communicate directly with each addressable analog sensor and binary input to determine normal, alarm, or trouble conditions. Analog signals would be used for automatic test and determination of maintenance requirements.
2. Each board shall contain its own microprocessor and shall be provided to monitor addressable inputs and to control addressable outputs (addressable relays). The board shall communicate and provide power to all devices on its loop over a single pair of wires, except where 4-wire devices require a separate power circuit.
3. Class B, Style 4: Circuits NOT capable of transmitting an alarm beyond the location of the fault condition. Wiring of outgoing and return conductors is permitted to be run in the same conduit or cable.

## E. Notification Appliance Circuit (NAC) Board:

1. Each board shall contain its own microprocessor and shall be provided to control each notification appliance circuit. The board shall communicate and provide power to all devices on its loop.
2. Class B, Style Y: Circuits NOT capable of transmitting an alarm beyond the location of the fault condition. Wiring of outgoing and return conductors is permitted to be run in the same conduit or cable.

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## F. Central Processing Unit:

1. The central processing unit (CPU) shall communicate with the monitor and control all other modules in the panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the CPU.
2. The CPU shall execute all control-by-event programs for specific action to be taken if a designated situation is detected in the system. A real-time system clock for time annotations on the display and printer shall be included.
3. All power for the unit shall be supervised and supplied by the FAP.

## G. Display:

1. The board shall provide all controls and indicators used by the system operator and may also be used to program all control panel parameters.
2. The board shall provide an alphanumeric array for display of custom alphanumeric labels for all addressable points. It shall also provide indicators for AC Power, System Alarm, System Trouble, Display Trouble and Signal Silence.
3. Displayed descriptions of addressable points shall include actual room names/numbers selected by the Owner. This information shall be obtained prior to programming. Room names/numbers shown on floor plans shall not be used.
4. The board shall provide a touch key-pad with control capability to command all system functions and entry of any alphanumeric information. Twenty different passwords with four levels of security shall be supported to prevent unauthorized manual control or programming.

H. Memory: The CPU and display interface board shall be augmented by non-volatile field programmable memory. EPROM memory will also be allowed provided the memory is burned in with minimum expansion capability equal to the total system capacity of the panel. Memory shall not be lost upon primary and secondary power failure.

## I. Power Supply:

1. Input power shall be 120 VAC, 60 Hertz. Output power shall be as noted on the device specifications and drawings. Each component of the fire alarm system requiring 120 VAC input power shall be served from a dedicated branch circuit. Provide two #12 conductors and one #12 ground in 3/4" conduit to a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Identify/label breaker and branch circuit in accordance with NFPA requirements and Specification Section 26 05 53.
2. Adequate to supply 125% of all control panel and peripheral power needs as well as 125% of power required for all external audio-visual devices. The power supply may be increased as needed by adding additional modular expansion power supplies. Over-current protections shall be provided on all power outputs.

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3. All power supplies shall be designed and installed to meet UL and NFPA requirements for power-limited operation on all external initiating and indicating circuits.
4. The power supply shall provide integral charger for use with internal batteries. Battery capacity shall be sufficient for operation of the entire system for 24 hours in a non-alarm state followed by alarm mode for 15 minutes, plus 25% spare capacity for future devices.

## J. Surge Protection:

1. The fire alarm control panel shall be furnished with an integral surge protection device (SPD). Refer to 26 43 00. It may be installed in an external cabinet as recommended by the manufacturer. In any case, the SPD must be connected upstream of any fire alarm equipment connections through a disconnect switch using #12 conductors maintained as short and as straight as possible.
2. Any communications or signaling circuits associated with the fire alarm system, which leave or enter a facility, shall be provided with a surge protection device. The devices shall be as recommended by the fire alarm system manufacturer.

## K. Digital Communicator:

1. Provide dual phone line interface capable of fire alarm notification to the local fire department, fire protection agency, or monitoring service. Communicator shall report in SIA and most major communication formats, with the capability of transmitting each device address point in a format compatible with the central station receiver.
2. Monitoring fees and initial connection charges are not part of this project.
3. Communicator shall be fully supervised and shall operate on loop start phase lines ahead of the building PBX system.
4. Communicator shall be FCC registered. Contractor shall provide two RJ31X jacks. Contractor to provide connection of communicators to Owner's telephone system as shown on the drawings.
5. Approvals: UL listed - UL 864/NFPA 72, FM approved.
6. The communicator shall be provided integral to the fire alarm panel as furnished by the fire alarm panel manufacturer. If the panel construction requires a separate unit, the unit shall be as manufactured by Silent Knight, Ademco, or fire alarm panel manufacturer approved equal.

## 2.2 SIGNALING LINE CIRCUIT DEVICES

A. **[FA-120]:** Smoke Detectors:

1. Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Each smoke detector shall connect directly to an SLC loop.
3. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.
4. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
5. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.
6. A test means shall be provided to simulate an alarm condition.

**B. [FA-122]: Duct Smoke Detectors:**

1. Duct-type smoke detectors shall use the same analog photoelectric ionization sensor technology, with the same features specified for standard smoke detectors, except with additional features as specified below.
2. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Where the detector housing is larger than the duct height, the Contractor shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer's recommendations.
3. Provide a remote alarm LED indicator device (FA-240/241) if detector is not visible from a floor-standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate labeled: Duct Smoke Detector.

**C. [FA-160]: Monitor Modules:**

1. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.
2. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.
3. The module shall supply the required power to operate the monitored device(s).
4. The module shall provide address setting means using rotary decimal or DIP switches.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

D. **[FA-161]:** Addressable Relays:

1. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional slave relay(s), as required, rated for the electrical load being controlled (contractor to match voltage, amps, etc.).
2. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.
3. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.
4. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

## 2.3 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS

## A. Flow Switch:

1. Connection to flow switch to monitor fire protection flow switch or discharge output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed and MC; wired by EC.

## B. Monitor Switch:

1. Connection to monitor switch to monitor fire protection system supervisory switches or output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.

## C. Electronic Bell:

1. Electronic bell for sprinkler alarm, electro-mechanical type, 24 VDC. Furnished and installed by MC. Fire alarm control and power connections by EC.

## 2.4 WIRING

A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with NFPA 70, Article 760 for power-limited fire alarm signal service.

## B. Approved manufacturers of fire alarm cable:

1. Comtran Corp.
2. Helix/HiTemp Cables, Inc.
3. Rockbestos-Suprenant Cable Corp.
4. West Penn Wire/CDT.

## PART 3 - EXECUTION

## 3.1 SEQUENCES OF FIRE ALARM OPERATION

## A. General:

1. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

## B. Panel Alarm, Trouble, Supervisory Indication:

1. Appropriate system Alarm, Trouble, or Supervisory LED shall flash at the control panel.
2. A local signal in the control panel shall sound.
3. The LCD display shall indicate all information associated with the condition, including the name of the item, type of device and its location within the protected premises.
4. History storage equipment shall log the information associated with the fire alarm control panel (FAP) condition, along with the time and date.
5. Transmit the appropriate signal (supervisory, trouble, alarm) to the central station via the digital communicator.

## C. Fire Protection Electric Sprinkler Bell Sequence:

1. The fire alarm shall utilize an addressable relay to energize the electric sprinkler bell upon activation of the flow switch.

## D. Kitchen Hood Fire Suppression System Sequence:

1. The fire alarm system shall utilize an addressable monitor module to monitor the fire suppression system. Utilize an addressable relay to de-energize the kitchen equipment contactor upon system activation.

## E. HVAC Unit Shutdown Sequence:

1. The fire alarm system shall utilize addressable relays to de-energize all unit motor controllers. Coordinate other requirements with HVAC installer.
2. The fire alarm system shall directly shut down the unit through the local HVAC control device (i.e., variable frequency drive or motor starter).

## 3.2 INSTALLATION

## A. Install system in accordance with manufacturer's instructions and referenced codes.

## B. Fire Alarm Control Panel:

1. Install the control panel where shown on the drawings.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. All expansion compartments, if required, shall be located at the control panel.

## C. Devices:

## 1. General:

- a. All devices shall be coordinated to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.
- b. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall adjust location of device so that new location meets all requirements in NFPA 72 and all applicable building codes.

2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.

## 3. Duct-type Analog Smoke Detectors:

- a. Duct-type analog smoke detectors shall be installed on the duct where shown on the drawings and details. The sampling tubes shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
- b. All detectors shall be accessible.
- c. Duct-type detectors shall be installed according to the manufacturer's instructions.

## 4. Addressable Relays and Monitor Modules:

- a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.
- b. All modules shall be mounted in or on a junction box in an accessible location.

## D. Wiring:

1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes.
2. Wiring shall be installed in conduit from device to above accessible ceilings. Exposed plenum-rated cable (FPLP) shall be used above accessible ceilings supported every 4 feet or run in cable trays (if applicable) maintaining a

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- minimum of 5-inches clearance from all lighting ballasts. Fire alarm cabling shall not be installed in the same bridge rings or cable trays designated for the cabling of other systems.
3. All junction boxes shall be painted red with SLC and NAC circuits identified on cover.
  4. Fire Alarm Power Branch Circuits: Building wiring as specified in Section 26 05 13.
  5. Notification Appliance Circuits shall provide the features listed below. These requirements may require separate circuits for visual and audible devices.
    - a. Fire alarm temporal audible notification for all audio appliances.
    - b. Synchronization of all visual devices where two or more devices are visible from the same location.
    - c. Ability to silence audible alarm while maintaining visual device operation.
  6. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device with "E-Z Markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.
- E. Fire Alarm Cabling Color Code: Provide circuit conductors with insulation color coding as follows, or using colored tape at each conductor termination and in each junction box.
1. Power branch circuit conductors: In accordance with Section 26 05 53.
  2. Signaling line circuit: Overall red jacket with black and red conductors.
  3. DC power supply circuit: Overall red jacket with violet and brown conductors.
  4. Notification appliance circuit: Overall red jacket with blue and white conductors.
- F. Devices surface mounted in finished areas shall be mounted on surface backboxes furnished by fire alarm equipment supplier. Backboxes shall be painted to match device, shall be the same shape and size as the device shall not have visible knockouts.
- G. Make conduit and wiring connections to sprinkler flow switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer's product data and shop drawings.

## 3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 26 05 00.
- B. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.

## 3.4 MANUFACTURER'S FIELD SERVICES

- A. Provide manufacturer's field services under provisions of Section 26 05 00.
- B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.
- C. Note that room numbers depicted on the architectural/engineering drawings will not necessarily reflect the actual room (signage) numbers that the Owner selects. The Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Owner directs to identify each device. This list shall be a part of the floor plan record drawing to be turned in at the project closeout.

## 3.5 SYSTEM TRAINING

- A. System training shall be performed under provisions of Section 26 05 00.
- B. Minimum on-site training times shall be:
  - 1. System Operators: One (1) day.

END OF SECTION 28 31 00



## SECTION 310519.13 - GEOSYNTHETICS FOR EARTHWORK

## PART 1 GENERAL

## 1.1 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
  - 1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.
  - 2. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Current Edition at time of bid opening.

## 1.3 DESCRIPTION OF WORK

- A. The work under this section shall cover furnishing and installing geotextile fabrics for subgrade separation and stabilization, and under riprap in accordance with the contract drawings and specified herein, and in accordance with Section 645 of the State of Wisconsin, Department of Transportation, Standard Specifications.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Submittals - Division 01
- C. Subgrade Preparation - Division 31
- D. Riprap - Division 31

## 1.5 SUBMITTALS

- A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specifications. Information shall be in conformance with requirements of Submittals - Division 01 of these specifications.
- B. The Contractor shall furnish to the Engineer at least ten days prior to use in the work a manufacturer's Certified Report of Test or Analysis that the geotextile fabric delivered for use conforms to this specification. The delivered geotextile fabric shall bear markings to clearly identify it with the applicable test report furnished to the Engineer.

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## PART 2 PRODUCTS AND MATERIALS

## 2.1 GENERAL

- A. The geotextile fabric shall consist of either woven or nonwoven polyester, polypropylene, stabilized nylon, polyethylene or polyvinylidene chloride. All fabric shall have the minimum strength values in the weakest principal direction. Nonwoven fabric may be needle punched, heat bonded, resin bonded, or combinations thereof.
- B. The geotextile fabric shall be insect, rodent, mildew, and rot resistant.
- C. The geotextile fabric shall be furnished in a wrapping which will protect the fabric from ultraviolet radiation and from abrasion due to shipping and hauling. The geotextile is to be kept dry until installed.
- D. The geotextile fabric rolls shall be clearly marked showing the type of fabric.
- E. Samples of fabric for testing may be obtained from the job site as specified herein or as determined by the Engineer.
- F. If sewn seams are used, the Contractor shall furnish a field sewn seam sample produced from the geotextile fabric and thread and with the equipment to be used on the project, prior to its incorporation into the work.
- G. All numerical values specified below represent minimum/maximum average roll values (i.e., the average of minimum test results on any roll in a lot should meet or exceed the minimum specified values).

## 2.2 GEOTEXTILE FABRIC, TYPE SAS (SUBGRADE AGGREGATE SEPARATION)

- A. The fabric shall comply with the following physical properties:

<u>Test</u>	<u>Method</u>	<u>Value</u>
Grab Tensile Strength, lbs	ASTM D 4632	170 min.
Apparent Opening Size, U.S. Standard Sieve	ASTM D 4751	70 max.
Permittivity, SEC <sup>-1</sup>	ASTM D 4491	0.35 min.

- B. Acceptable materials are Geotex 701, LINQ 150EX, Mirafi 180N, Polytex 600, and Trevira Spunbond 1125, or equal.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 2.3 GEOTEXTILE FABRIC, TYPE R (RIPRAP)

- A. The fabric shall comply with the following physical properties:

Test	Method	Value
Grab Tensile Strength, lbs	ASTM D 4632	200 min.
CBR Puncture Strength	ASTM D 6241	500 min.
Apparent Breaking Elongation, Percent	ASTM D 4632	20 min.
Apparent Opening Size, U.S. Standard Sieve	ASTM D 4751	30 max.
Permittivity, SEC <sup>-1</sup>	ASTM D 4491	0.40 min.

- B. Acceptable materials are Geotex 801, LINQ 180EX, Mirafi 180N, and Trevira Spunbond 1125, or equal.

## 2.4 GEOTEXTILE FABRIC, TYPE HR (HEAVY RIPRAP)

- A. The fabric shall comply with the following physical properties:

Test	Method	Value
Grab Tensile Strength, lbs	ASTM D 4632	300 min.
CBR Puncture Strength	ASTM D 6241	800 min.
Apparent Breaking Elongation, Percent	ASTM D 4632	20 min.
Apparent Opening Size, U.S. Standard Sieve	ASTM D 4751	30 max.
Permittivity, SEC <sup>-1</sup>	ASTM D 4491	0.40 min.

- B. Acceptable materials are Geotex 1201, LINQ 275EX, Mirafi 1120N, Mirafi HP370, and Trevira Spunbond 1145, or equal.

## 2.5 GEOTEXTILE FABRIC, TYPE RSF (RECIRCULATING SAND FILTER)

- A. The filter fabric shall be of preferentially orientated isostatic polypropylene. Fabric shall be nonwoven and may be needle punched, heat bonded, resin bonded or combination thereof. Fabric shall have the following characteristics:

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

<u>Test Property</u>	<u>Test Method</u>	<u>Value Minimum Requirements</u> <sup>1</sup>
Nominal Weight (oz/yd <sup>2</sup> )	ASTM D5261	8.0
Grab Tensile (lbs)	ASTM D4632	205
Grab Elongation At Break (%)	ASTM D4632	50
Puncture Resistance (lbs)	ASTM D4833	95
Trapezoidal Tear (lbs)	ASTM D4533	85
Mullen Burst (psi)	ASTM D3786	300
Water Flow Rate (gpm/ft <sup>2</sup> )	ASTM D4491	130
Permittivity (sec <sup>-1</sup> )	ASTM D4491	1.6
Permeability kv (cm/sec)	ASTM D4491	0.4
A.O.S.2 (sieve size)	ASTM D4751	120-80
UV Resistance (500 hrs) <sup>3</sup>	ASTM D4355	>85
pH Resistance		2-13

- B. Acceptable manufacturer of filter fabric materials are Phillips 66, Polyfelt, Mirafi, Du Pont, Webtec, or equal.

## PART 3 CONSTRUCTION METHODS

## 2.6 GENERAL

- A. Installation procedures shall be in accordance with manufacturer's recommendations and as specified herein.
- B. Sewing. All factory and field seams shall be sewn with a thread having the same or greater durability as the material in the fabric. A 401 stitch conforming to Federal Standard No. 751a shall be used for all seams. All seams shall develop a tensile strength equal to or greater than 60 percent of the specified grab tensile strength of the fabric, unless otherwise specified.

## 2.7 GEOTEXTILE FABRIC, TYPE SAS

- C. Prior to the placement of the geotextile fabric, the subgrade shall be smoothed, shaped and compacted to the required grade, section, and density. After the fabric has been placed on the subgrade area, no traffic or construction equipment will be permitted to travel directly on the fabric.
- D. The fabric shall be rolled out on the roadway and pulled taut manually to remove wrinkles. Separate pieces of fabric shall be joined by overlapping or sewing. The fabric in the overlapped joints shall be placed with a minimum overlap of 18 inches.

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<sup>1</sup> Values in weaker principal direction. All minimum values represent minimum average roll values (i.e., test results from any sampled roll in a lot, tested in accordance with ASTM D 4759 shall meet or exceed the minimum values listed).

<sup>2</sup> Small sieve size number represents the maximum average roll value.

<sup>3</sup> UV resistance testing is based on results from independent conformance testing.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Weight or pins may be required to prevent lifting of the fabric by wind.
- F. After placement, the fabric shall be exposed no longer than 48 hours prior to covering.
- G. The base course material shall be placed over the fabric by back dumping with trucks and leveling with a crawler dozer. Construction equipment shall be such that ruts do not exceed 3 inches in depth. All ruts shall be filled with additional material. The smoothing of ruts without adding additional material will not be permitted. Damaged areas shall be covered with a patch of fabric using a 36 inch overlap in all directions.

## 2.8 GEOTEXTILE FABRIC, TYPE R

- H. The area shall be graded smooth and all stones, roots, sticks, or other foreign material which would interfere with the fabric being completely in contact with the soil shall be removed prior to placing the fabric.
- I. The fabric shall be placed loosely and laid parallel to the direction of the water movement. Pinning or stapling may be required to hold the geotextile in place. Separate pieces of fabric shall be joined by overlapping or sewing. The fabric in the overlapped joints shall be placed with a minimum overlap of 24 inches in the direction of the flow.
- J. After placement, the fabric shall be exposed no longer than 48 hours prior to covering.
- K. Damaged areas shall be covered with a patch of fabric using a 36 inch overlap in all directions.
- L. Placement of riprap shall be from the base of the slope upward. Height of free fall of riprap shall be determined by the Engineer but in no case shall this height exceed 12 inches.

## 2.9 GEOTEXTILE FABRIC, TYPE HR

- M. The construction methods for Type HR fabric shall conform to the requirements of Subsection 3.03, except that the height of freefall of riprap shall not exceed 6 inches.

## 2.10 GEOTEXTILE FABRIC, TYPE RSF (RECIRCULATING SAND FILTER)

- N. The fabric shall be placed directly upon the sand filter liner.
- O. After placement, the liner shall be exposed no longer than 48 hours prior to covering.
- P. Damaged areas shall be covered with a patch of fabric using a 36 inch overlap in all directions.

END OF SECTION

## SECTION 311000 - SITE CLEARING

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping, or sealing site utilities.
7. Temporary erosion and sedimentation control.

## 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

## 1.3 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

## 1.4 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction. See Site Access Plan.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises; coordinate location with Owner.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- E. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
  - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

## PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- C. Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

## 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

## 3.3 TREE AND PLANT PROTECTION

- A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

## 3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
  - 1. Arrange with utility companies to shut off indicated utilities.
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Architect's written permission.
- C. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

## 3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
  - 1. Grind down stumps and remove roots larger than **3 inches (75 mm)** in diameter, obstructions, and debris to a depth of **18 inches (450 mm)** below exposed subgrade.
  - 2. Use only hand methods or air spade for grubbing within protection zones.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of **8 inches (200 mm)**, and compact each layer to a density equal to adjacent original ground.

## 3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches (150 mm) in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

## 3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

## 3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

## SECTION 312000 - EARTH MOVING

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses and plants.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks and pavements.
6. Subbase course and base course for asphalt paving.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

## 1.2 DEFINITIONS

## A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

## B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

## C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

## D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

## E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

## F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

## G. Fill: Soil materials used to raise existing grades.

- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct preexcavation conference at Project site.

### 1.4 INFORMATIONAL SUBMITTALS

- A. Material test reports.

### 1.5 FIELD CONDITIONS

- A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.
- B. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
  - 1. Liquid Limit: 2%.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 12 percent passing a **No. 200 (0.075-mm)** sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M 0; with at least 95 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 8 percent passing a **No. 200 (0.075-mm)** sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 12 percent passing a **No. 200 (0.075-mm)** sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a **1-inch (25-mm)** sieve and not more than 8 percent passing a **No. 200 (0.075-mm)** sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a **1-1/2-inch (37.5-mm)** sieve and zero to 5 percent passing a **No. 8 (2.36-mm)** sieve.

## 2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches (750 mm)** deep; colored to comply with local practice or requirements of authorities having jurisdiction.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.



- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

### 3.2 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

### 3.3 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus **1 inch (25 mm)**. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
  - 2. Pile Foundations: Stop excavations **6 to 12 inches (150 to 300 mm)** above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
  - 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus **1 inch (25 mm)**. Do not disturb bottom of excavations intended as bearing surfaces.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
  - 1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
  - 2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

### 3.4 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### 3.5 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.

- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to **12 inches (300 mm)** higher than top of pipe or conduit unless otherwise indicated.
  - 1. Clearance: 12 inches (300 mm) each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
  - 1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trenches in Tree- and Plant-Protection Zones:
  - 1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
  - 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
  - 3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

### 3.6 SUBGRADE INSPECTION

- A. Proof-roll subgrade below the building slabs, pools, themework and pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

### 3.7 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.
  - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

### 3.8 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.9 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- D. Trenches under Roadways: Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- E. Initial Backfill: Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.
  1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Final Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
- G. Warning Tape: Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

### 3.10 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
  1. Under grass and planted areas, use satisfactory soil material.
  2. Under walks and pavements, use satisfactory soil material.
  3. Under steps and ramps, use engineered fill.
  4. Under pools (including shallow shot-crete construction), use engineered fill.
  5. Under building slabs, use engineered fill.
  6. Under footings and foundations, use engineered fill.

## 3.11 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

## 3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698; ASTM D 1557 and per Soils Report:
  - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
  - 2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
  - 3. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.
  - 4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

## 3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
  - 1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
  - 2. Walks: Plus or minus 1 inch (25 mm).
  - 3. Pavements: Plus or minus 1/2 inch (13 mm).
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

## 3.14 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
  - 1. Shape subbase course and base course to required crown elevations and cross-slope grades.
  - 2. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
  - 3. Compact subbase course[ and base course] at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698; ASTM D 1557.

## 3.15 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
  - 1. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
  - 2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

## 3.16 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform inspections:
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

## 3.17 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

## 3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

## SECTION 312319 - DEWATERING

## PART 1 GENERAL

## 1.1 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern the work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
  - 1. Wisconsin Administrative Code (WAC), Department of Natural Resources Environmental Protection Regulations, Current Edition.

## 1.3 DESCRIPTION OF WORK

- A. The work under this section shall cover furnishing all materials and labor to keep all excavations free of water during the preparation of the subgrade, to keep all concrete and masonry work free of water through the time period specified herein, and to keep the excavation free of water during backfilling.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Temporary Utilities - Division 01
- C. Structural Excavation for Structures - Division 31
- D. Trenching and Backfilling - Division 31
- E. Erosion and Sedimentation Controls - Division 31

## 1.5 SUBMITTALS (NONE)

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

## 1.7 PERMITS AND APPROVALS

- A. The Contractor shall obtain a High Capacity Well Permit from the Wisconsin Department of Natural Resources for all wells installed or operated for pumping groundwater to lower the water table, for which the single or aggregate well capacity may be 70 gallons per minute (gpm) or greater. The Contractor shall submit the High Capacity Dewatering Well Application (Form 3300-258) to the Wisconsin Department of Natural Resources, Private Water Supply Section, P.O. Box 7921,

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Madison, WI 53707, along with any necessary permit fees, and obtain said permit prior to the construction or operation of said high capacity well(s).

- B. The Contractor shall be responsible for all equipment, labor, materials and supplies required to comply with the requirements of the High Capacity Well Permit, if necessary, at no additional cost to the Owner.
- C. The Contractor shall apply for and obtain a General Discharge Permit for Pit and Trench Dewatering Wastewater, Wisconsin Pollution Discharge Elimination System (WPDES) Permit No WI-0049344-2.
- D. The Contractor shall be responsible for all requirements of the General Discharge Permit for Pit and Trench Dewatering, including monitoring, metering, sampling, testing, and reporting, and shall also be responsible for compliance with all discharge limits contained in the General Discharge Permit.
- E. The Contractor shall be responsible for all equipment, labor, materials and supplies required to comply with the requirements of the General Discharge Permit for Pit and Trench Dewatering, at no additional cost to the Owner.

## PART 2 PRODUCTS AND MATERIALS

## 2.1 GENERAL

- A. The Contractor shall furnish dewatering sumps, wells, discharge pipe, and pumping equipment as may be required to adequately dewater the work.

## 2.2 PUMPING EQUIPMENT

- A. Pumping equipment shall be capable of running continuously except for conditions which may be approved by the Engineer.

## 2.3 WELLS

- A. For the purposes of compliance, the provisions of chapter NR 812 apply to all new and existing drill holes to be utilized for the purpose of dewatering and the following:
  - 1. Wells governed under chapter NR 141 do not apply, unless they are high capacity wells, and shall not be used for the purpose of dewatering.

## PART 3 CONSTRUCTION METHODS

## 3.1 WATER LEVELS

- A. At all times during the excavation period and until its completion and acceptance at final inspection, ample means and equipment shall be provided with which to remove promptly, and dispose of properly, all water entering any excavation or other parts of the work. The excavation shall be kept



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dry and groundwater levels shall be kept low enough to prevent a quicksand condition from ruining the excavation bottom.

- B. Water levels shall be maintained at a level below all open excavations for structures and below the level of concrete until the concrete has been in place for 14 days or until test cylinders show the concrete strength to be at least 3,000 pounds per square inch or until high-early-strength concrete has been in place for 6 days or until test cylinders show the strength of the concrete to be at least 3,000 pounds per square inch. Water levels will be allowed to rise on structures prior to the concrete attaining its strength provided that water levels are raised uniformly on each side of walls. At no time shall water be allowed to rise on a structure within 12 hours of the final concrete placement.
- C. Concrete immersed in water for the required period of time shall be an acceptable alternative for the concrete curing specified in Cast-in-Place Concrete - Division 03 of these specifications.
- D. Water levels shall be maintained at a minimum level of 6 inches below the invert elevation of a pipe during placement.

## 3.2 WELLS

- A. For the purposes of construction and installation, and abandonment, the provisions of chapter NR 812 apply to all drillholes and wells.
- B. For the purpose of operation for wells used for dewatering, these operations shall be in accordance with the requirements of these specifications, the Engineer and all local, municipal, and state codes, rules and regulations.

## 3.3 DISCHARGE LINE

- A. Discharge line shall be at a location approved by the Engineer.

## 3.4 DISPOSAL OF WATER

- A. All water discharged from work sites shall be disposed of in such a manner to minimize erosion and sedimentation. Water must be discharged to a hard surface such as metal sheeting, wood sheeting, concrete, etc., so that erosion at the discharge point is eliminated.
- B. Temporary and permanent erosion and sedimentation control measures shall be performed by the Contractor during construction to control water pollution, erosion and siltation, through the use of intercepting embankments, berms, dikes, dams, settling basins, sodding, planting and other erosion control devices or methods.
- C. No water shall be discharged to sanitary sewers.
- D. No water containing settleable solids shall be discharged into storm sewers.

## 3.5 SAMPLING AND MONITORING

- A. Sampling and monitoring shall be performed by the Contractor in accordance with WPDES permit requirements. The cover letter accompanying the permit shall specify which parameters shall be monitored to assure compliance with water quality standards or treatment technology based standards.
- B. Samples representative of the discharge shall be collected after treatment and prior to discharge to the environment. When treatment efficiency reporting is required, the influent sample shall be collected before the water passes through the treatment unit.

END OF SECTION

## SECTION 312323.14 - GRANULAR FILL

## PART 1 GENERAL

1.1        APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
  - 1. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Current Edition at time of bid opening.
  - 2. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.

## 1.3 DESCRIPTION OF WORK

- A. The work covered under this section shall consist of furnishing all material, equipment, and labor required to execute the filling, compaction, and testing of all subgrade excavations for this project.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Subgrade Preparation - Division 31

## 1.5 SUBMITTALS (NONE)

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

## PART 2 PRODUCTS AND MATERIALS

## 2.1 GRANULAR FILL

- A. All granular subbase and granular fill materials shall conform to Section 209 of the State of Wisconsin, Department of Transportation, Standard Specifications.

## PART 3 CONSTRUCTION METHODS

## 3.1 COMPACTION

- A. Granular fill materials shall be mechanically compacted in 6 inch to 8 inch lifts to 93 percent maximum dry density per modified proctor (ASTM-D1557).

END OF SECTION 312323.14

## SECTION 31 23 33

## TRENCHING AND BACKFILLING

## PART 1 GENERAL

## 1.1 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
  1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.
  2. Code of Federal Regulations (CFR), Title 29, Chapter XVII - Occupational Safety and Health Administration (OSHA), Department of Labor, Part 1926 Regulations, Current Edition.
  3. Wisconsin Administrative Code (WAC), Department of Natural Resources, Environmental Protection, Regulations, Current Edition.
  4. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Current Edition at time of bid opening.

## 1.3 DESCRIPTION OF WORK

- A. The work under this section shall include all excavating, trenching, and backfilling for utilities as indicated from the contract drawings and as specified herein.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Dewatering - Division 31
- C. Rock Excavation – Division 31
- D. Structural Excavation for Structures - Division 31
- E. Erosion and Sedimentation Controls - Division 31
- F. Utility Horizontal Directional Drilling – Division 33

## 1.5 SUBMITTALS (NONE)

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

## PART 2 PRODUCTS AND MATERIALS

## 2.1 INSITU BACKFILL MATERIAL

- A. Previously excavated soil free of organic debris, clay balls, and aggregate larger than 1-1/2 inches as approved by the Engineer.

## 2.2 IMPORTED GRANULAR BACKFILL (TRUCKED BACKFILL) MATERIAL

- A. Imported granular fill (trucked backfill) shall be sand conforming to State of Wisconsin, Department of Transportation, Standard Specifications Subsection 209.2.2, Grade No. 1 Granular Backfill or well-graded sand and gravel conforming to Subsection 305.2.2.1 of said State Standard Specification 1-1/4 inch dense graded base with not more than eight percent (8 percent) by weight passing a No. 200 sieve.

## 2.3 FLOWABLE BACKFILL

- A. A cubic yard of flowable backfill shall consist of 1,350 pounds of sand, 775 pounds of #1 stone, 1,150 pounds of #2 stone, and 25 gallons of water. All weights are damp weights and no additional water will be allowed.

## PART 3 CONSTRUCTION METHODS

## 3.1 SURFACE OBSTRUCTIONS

- A. Structures, sidewalk, driveways, curb and gutter, trees, shrubs, lawns, signs, fences, utilities, survey monuments, pavements, culverts and other appurtenances which are adjacent to the right-of-way or work easements, shall be carefully protected against damage. In the event of damage or inadvertent injury or removal of these surface features by failure of the Contractor to exercise reasonable precautions or proper construction techniques, he shall bear the full cost and responsibility for resulting damages and shall replace or repair such damage as early as possible. No allowance for extra payment or time lost will be allowed for such interferences that the Contractor could have suspected or anticipated during pre-bid site inspection and interpretation of the bidding documents.
- B. Clearing, grubbing, and removal of all pavements, sidewalks, curbs, signs, poles, fences, etc., shall be done only as necessary for the completion of the work. Brush, trees, shrubs, concrete, rubble, and other removals, which are not intended to be replaced, shall be disposed of by the Contractor off the work site.
- C. Obstructions, which are intended to be reset, shall be stored and protected by the Contractor. Fences, signs, mailboxes, trees, shrubs, structures, and similar features requiring removal, shall be restored to their original position except where permanent removal is indicated.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Monuments for land surveys encountered in the path of work shall be carefully protected from movement. Should removal be necessary, the Contractor shall notify the Engineer in advance. The Contractor will be held responsible for re-establishing monuments lost due to his negligence or failure to notify the Engineer at least 24 hours in advance of disturbing.

## 3.2 SUBSURFACE OBSTRUCTIONS

- A. The approximate location and size of sewers, drains, culverts, gas mains, water mains, survey monuments, electric and telephone conduits and other underground structures shown on the drawings are based on records available to the Owner or surface markings indicating their existence.
- B. The Contractor shall use caution in excavating and trenching so that the exact location of underground structures, both known and unknown, may be determined; he shall be held responsible for the repair of such structures when broken or otherwise damaged during construction.
- C. The Contractor shall make arrangements with the utility companies for any relocation of interfering utilities. No extra cost due to unexpected delays or coordination work shall be incurred on the Owner except for authorized utility alterations performed by the Contractor as provided below.
- D. When the Engineer permits the Contractor to make a change to avoid a utility relocation, the Engineer shall determine whether the change constitutes extra work as defined in the General Conditions.
- E. Any underground utilities or other structures, which the Contractor wishes to have moved to facilitate construction, shall be arranged with the owner of such structures. The Contractor shall pay all costs of the accommodation.
- F. In the event that there is any question as to whether any of the above enumerated obstructions, underground utilities or other structures cross or pass through the space occupied by the completed structures of this contract, the Engineer's decision shall be binding upon the Owner and the Contractor.
- G. During the construction of the pipe lines, it may be necessary to cross under certain sewers, drains, culverts, water lines, gas lines, electric conduits and other underground structures. Where necessary, the flow in drains or culverts shall be diverted so that the excavation is kept dry during the progress of the construction work. Every effort shall be made to prevent damage to such underground structures. Wherever such structures are disturbed or broken, they shall be restored to good condition at no additional cost to the Owner.
- H. The Contractor shall use sand or gravel backfill beneath said structures. This backfill shall be deposited and thoroughly compacted by mechanical means in layers not to exceed 6 inches in depth.

## 3.3 EXCAVATION

- A. General. All excavation of every description and of whatever substances encountered shall be performed to the depths indicated or as otherwise specified.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

1. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed and wasted as specified. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations and any water accumulated therein shall be removed by pumping or by other approved methods.
  2. Sheeting and shoring shall be placed as may be necessary for the protection of the work and for the safety of personnel. Unless otherwise indicated, excavation shall be by open cut.
- B. Trench Excavation. Trenches shall be of the necessary width for proper laying of pipe and shall conform to WAC requirements. The banks of pipe trenches shall conform to OSHA requirements and the Contractor is responsible for all safety requirements of said codes.
1. Care shall be taken not to overexcavate. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe. Bell holes and depressions for joints shall be dug after the trench bottom has been graded, and in order that the pipe rest on the prepared bottom for as nearly its full length as practicable, bell holes and depressions shall be only of such length, depth, and width as required for properly making the particular type of joint. Stones shall be removed as necessary to avoid point bearing.
  2. Except as hereinafter specified for wet or other unstable material, overdepths shall be backfilled as and with materials specified for, backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such material shall be overexcavated to a depth to allow for construction of a stable pipe bedding. The trench shall be backfilled to the proper grade with suitable approved materials.
  3. Trench Width. The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall not be less than 6 inches nor exceed 8 inches on either side of the pipe, unless otherwise approved by the Engineer in writing. The width of the trench above that level shall be as wide as necessary for sheeting and bracing and the proper performance of the work.
  4. Excavation for Appurtenances. Excavation for manholes and similar structures shall be sufficient to leave at least 12 inches clear space between the outer surface of structure and the bank or timber that may be used to hold and protect the banks. Any overdepth excavation below such appurtenances that has not been directed will be considered unauthorized and shall be refilled with sand, gravel, or concrete, as directed, at no additional cost to the Owner.
  5. Embedment. Embedment for utilities shall be as specified in the respective utility specification section.
- C. Protection and Removal of Utility Lines. The Contractor shall notify all affected utility companies at least three consecutive working days preceding his construction operations to coordinate his work regarding poles, wires, valve boxes and other surface obstructions and to determine the location of gas, water main, power, light, telephone or telegraph conduit or service connection thereto or any other subsurface structure that crosses or passes through the space occupied by any of the proposed improvements. The Contractor shall make advance arrangements with the utility companies for any relocation of interfering utilities so as not to delay construction.

- D. Interruptions of Services. Interruptions of utility services to existing buildings or facilities which become necessary either directly or indirectly due to work required under this contract shall be coordinated with the Owner through the Engineer. If the down time for connections is limited by them as to duration and time (weekend, nights or holidays), the Contractor shall perform the work during the designated period at no additional cost to the Owner.

### 3.4 BACKFILLING

- A. Types of Backfill. Backfill for sanitary sewers, water mains, storm sewers, culverts, and drainpipes is the material placed between the bedding and the ground surface. Debris, frozen material, organic matter, unstable material, or stones greater than 8 inches in diameter shall not be suitable for backfill. Large clods and stones not exceeding 8 inches in diameter, when allowed for use as backfill, shall not be placed within two feet of the top of the pipe. Backfill shall be of the following types:
1. Type I Backfill:
    - a. Type I backfill shall be used where shown on the contract drawings or stated in Special Procedures - Division 01, and unless directed otherwise shall extend from the top of the embedment to the underside of surface restoration.
    - b. Type I backfill shall be used under and around all existing underground structures, tunnels, conduits, and pipes crossing the excavation. Such backfill shall extend underneath and on all sides to a structure, tunnel, conduit or pipe.
    - c. Type I backfill shall be selected fill material consisting of granular subbase course, base course or approved existing sand. The backfill material shall be mechanically compacted in 6-inch layers, from a distance of one foot above the pipe to the surface. The degree of compaction shall be to 95 percent maximum dry density per modified proctor (ASTM D1557).
  2. Type II Backfill:
    - a. Type II backfill shall be used where shown on the contract drawings or stated in Special Procedures - Division 01.
    - b. Type II backfill shall be suitable excavated material, or other approved material, placed in uniform layers and mechanically compacted. The following compaction percentages based on the maximum dry density per modified proctor (ASTM D1557) for the materials are required:
      - 1) For fine grained soils (more than 50 percent passing the No. 200 sieve).  
Zone III: From bottom of surface restoration to 3 feet below - 91 percent  
Zone II: From bottom of Zone III to top of the embedment - 88 percent  
Zone I: Specified as embedment
      - 2) For coarse grained soils (less than 50 percent passing the No. 200 sieve).  
Zone III: From bottom of surface restoration to 3 feet below - 93 percent  
Zone II: From bottom of Zone III to top of the embedment - 90 percent  
Zone I: Specified as embedment
  3. Type III Backfill:
    - a. Type III backfill shall be used in all areas where shown on the Plans or stated in Special Procedures - Division 01. Backfill material shall be suitable excavated material placed, from top of embedment to the bottom of surface restoration, in 12 to 18 inch layers and consolidated by jetting, spading, tamping, or puddling, to the approval of the Engineer, to insure complete filling of the trench.



4. Type IV Backfill:
    - a. Utilize Type III Backfill with the following jetting: at least a 1-1/2 inch jetting hose, equipped with a regulating valve which permits the hydrant valve to be fully open during use, with a minimum 1-1/2 inch diameter pipe nozzle at least 6 feet long shall be used. During the flooding operation, the nozzle shall be inserted as deeply into the backfill as is possible without damaging the sewers, water mains, or foundations. The insertions shall be made at intervals of 5 feet or less and maintained until the backfill is saturated. Depressions caused by flooding shall be backfilled until there is no further settlement.
  5. Flowable Backfill:
    - a. The materials shall be placed in a clean cement mixer truck and thoroughly mixed. Just prior to placement, the mixer shall be run at mixing speed for one full minute to insure an even mixture. The mixture shall be deposited in the trench directly from the mixer truck. Copies of the load tickets shall be provided to the Engineer.
- B. After Settlement. Should after settlement occur, succeeding any of the above backfilling methods, the Contractor shall scarify the surface of the fill material and place additional fill material in the same manner as herein described so that the surface elevation conforms to that shown on the Plans. No additional compensation shall be allowed for repairing filled areas where after-settlement occurs.
- C. Backfill Placement. The excavated space around and above underground structures, tunnels, conduits and pipes not filled with embedment material and where select fill backfill is not shown or specified may be backfilled by machine.
- D. Backfilling work shall be done in such a way as to prevent dropping of material directly on top of any conduit or pipe through any great vertical distance. In no case shall backfilling material from a bucket be allowed to fall directly on a structure or pipe and in all cases, the bucket shall be lowered so that the shock of falling earth will not cause damage.
- E. Lumps shall be broken up and if there are any stones, pieces of crushed rock or lumps, which cannot be readily broken up, they shall be distributed throughout the mass so that all interstices are solidly filled with fine material. Stones, lumps and clods shall also be placed to maintain a 2 foot minimum separation distance from the top of the pipe or structure. No frozen material shall be used for backfilling.

END OF SECTION 312333

## SECTION 312500 - EROSION AND SEDIMENTATION CONTROLS

## PART 1 GENERAL

## 1.1 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
1. State of Wisconsin, Department of Natural Resources (WDNR), Conservation Practice Standards, Current Edition.
  2. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Current Edition at time of bid opening.

## 1.3 DESCRIPTION OF WORK

- A. The work under this section shall cover providing the necessary materials, equipment and labor to control erosion and sedimentation controls by the methods specified herein. If no specific quantities are shown on the contract drawings, the Contractor shall use whatever quantities are necessary to prevent sediment transport off the job site, into permanent manmade storm water conveyances or management facilities or to Waters of the State.
- B. The Contractor will be required to provide erosion control as per the current edition of the applicable State of Wisconsin, Department of Natural Resources (WDNR), Conservation Practice Standards. Copies of these standards can be obtained by contacting the following:

State of Wisconsin Department of Natural Resources  
Non-Point Source and Land Management Section  
101 South Webster Street, P.O. Box 7921  
Madison, WI 53707-7921

or by visiting the following website:

[http://dnr.wi.gov/topic/stormwater/standards/const\\_standards.html](http://dnr.wi.gov/topic/stormwater/standards/const_standards.html)

- C. The Engineer has prepared an erosion control plan for this project. The intent of this plan is to identify erosion control provisions for the construction site that comply with local, state, and federal regulations. The Contractor shall submit for approval by the appropriate regulatory agency any changes to the Erosion Control Plan, prior to beginning any construction on the project which may cause erosion in the portion of the site where the change to the Erosion Control Plan is proposed.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)

- B. Clearing and Grubbing - Division 31
- C. Grading - Division 31
- D. Subgrade Preparation - Division 31
- E. Structural Excavation for Structures - Division 31
- F. Trenching and Backfilling - Division 31
- G. Riprap - Division 31
- 1.5 SUBMITTALS (NONE)
- 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

## PART 2 PRODUCTS AND MATERIALS

### 2.1 TOPSOIL

- A. Topsoil shall be fertile, friable, natural loam surface soil, reasonably free of subsoil, clay lumps, brush, weeds and free of roots, stumps, stones larger than 2 inches in any dimension, and other matter harmful to plant growth. Topsoil to supplement insufficient topsoil on the site shall originate from local sources, but not from bogs or marshes.

### 2.2 LIME

- A. Lime used for soil amendment shall be agricultural grade limestone ground sufficiently fine so that 80 percent passes a No. 8 sieve. Lime shall contain 80 percent calcium carbonate equivalent. Moisture shall not exceed 10 percent.

### 2.3 FERTILIZER

- A. Fertilizer used in conjunction with seeding shall be dry, free-flowing granular fertilizer suitable for application by agricultural fertilizer spreaders or blower equipment, or non-volatile liquid commercial fertilizer, having an analysis of 20-10-10 (Nitrogen-Phosphoric Acid-Potash), or equal, unless use of phosphorus based fertilizers are banned by the community where the work is to be completed. In such communities, an analysis of 20-0-10, or equal, shall be used. Fertilizer having other analysis shall be applied at a rate to achieve at least the individual following amounts of nutrient per unit area:

<u>Nutrient</u>	<u>Application Rate</u> (Per Acre)	<u>Application Rate</u> (Per 1000 Sq. Ft.)
Nitrogen (N)	100 pounds	2.3 pounds
Phosphoric Acid (P <sub>2</sub> O <sub>5</sub> )	50 pounds	1.2 pounds
Potash (K <sub>2</sub> O)	50 pounds	1.2 pounds

## 2.4 SEEDING FOR CONSTRUCTION SITE EROSION CONTROL

- A. Seeding for Construction Sites shall conform with Wisconsin DNR Conservation Practice Standard 1059.
- B. Seed mixtures shall conform to one of the following:
  - 1. WisDOT, 2003. State of Wisconsin Standard Specifications For Highway and Structure Construction. Section 630, Seeding.
  - 2. United States Department of Agriculture – Natural Resource Conservation Service Field Office Technical Guide Section IV, Standard 342, Critical Area Planting.
  - 3. UWEX Publication A3434 Lawn and Establishment & Renovation.
- C. All seed shall conform to the requirements of the Wisconsin Statutes and of the Administrative Code Chapter ATCP 20.01 regarding noxious weed seed content and labeling.
- D. Seed mixtures that contain potentially invasive species or species that may be harmful to native plant communities shall be avoided.
- E. Seed shall not be used later than one year after the test date that appears on the label.
- F. Seed shall be tested for purity, germination and noxious weed seed content and shall meet the minimum purity and germination requirements as prescribed in the current edition of Rules for Testing Seed, published by the Association of Official Seed Analysts.

## 2.5 MULCH FOR CONSTRUCTION SITES

- A. Mulching for construction sites shall conform with Wisconsin DNR Conservation Practice Standard 1058.
- B. Mulch shall consist of natural biodegradable material such as plant residue (including but not limited to straw, hay, wood chips, bark and wood cellulose fiber), or other equivalent materials of sufficient dimension (depth or thickness) and durability to achieve the intended effect for the required time period.
- C. Mulch shall be environmentally harmless to wildlife and plants. Materials such as gravel, plastic, fabric, sawdust, municipal solid waste, solid waste byproducts<sup>1</sup>, shredded paper, and non-biodegradable products shall not be used.
- D. Mulch shall be free of diseased plant residue (i.e., oak wilt), noxious weed seeds, harmful chemical residues, heavy metals, hydrocarbons and other known environmental toxicants.
- E. Marsh hay shall not be used as mulch in lowland areas but may be used on upland sites to prevent the spread of invasive, nonnative species (i.e., reed canary grass) commonly found in marsh hay.
- F. Straw and hay mulch that will be crimped shall have a minimum fiber length of 6 inches.
- G. Wood chips or wood bark shall only be used for sites that are not seeded.

## 2.6 EROSION MAT

- A. Non-Channel Erosion Mat products shall conform with Wisconsin DNR Conservation Practice Standard 1052.
- B. Channel Erosion Mat products shall conform with Wisconsin DNR Conservation Practice Standard 1053.
- C. Erosion mat shall conform to the requirements of the State of Wisconsin, Department of Transportation, Product Acceptability List (PAL) for Erosion Control Revegetative Mat (ECRM) and Turf-Reinforcement Mat (TRM).
- D. For mats that utilize netting, the netting shall be bonded to the parent material to prevent separation of the net for the life of the product.
- E. For urban class mats the following material requirements shall be adhered to:
  - 1. Only 100% organic biodegradable netted products are allowed, including parent material, stitching, and netting.
  - 2. The netting shall be stitched with biodegradable thread/yarn to prevent separation of the net from parent material.
  - 3. All materials and additive components used to manufacture the anchoring devices shall be completely biodegradable as determined by ASTM D 5338.
  - 4. Mats with photodegradable netting shall not be installed after September 1st.
  - 5. Steel wire pins or staples shall not be used in lawns.

## 2.7 SEEDING AND SODDING

- A. Seeding and sodding shall conform to Seeding - Division 32 and Sodding - Division 32.

## 2.8 STRAW BALE EROSION BARRIERS

- A. Straw Bale (Sediment Bale Barriers) shall conform with Wisconsin DNR Conservation Practice Standard 1055.
- B. Bales used for erosion control shall be either hay or straw, shall have rectangular surfaces, and shall be tightly bound with twine, not wire. The material in the bales shall be reasonably free of grain, weed seed and mold, and shall be dry and suitable for the purpose intended.
- C. The minimum cross sectional area for wood stakes shall be 2.0 by 2.0 inches nominal.
- D. The minimum diameter of steel (rebar) stakes shall be one-half inch.

## 2.9 SEDIMENT CONTROL FENCE (SILT FENCE)

- A. Silt Fence shall conform with Wisconsin DNR Conservation Practice Standard 1056.
- B. Silt fence shall be in accordance with Section 628.2.6 of the State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction.

- C. Wood Posts:
  - 1. Wood Posts used to support the fabric shall be at least 2 inch x 2 inch in cross-section and shall be a minimum of 12 inches longer than the height of the silt fence. Posts shall be made from kiln-dried hickory or Oak.
  - 2. Staples used to attach silt fence to wood posts shall be at least 0.5-inches in length.
- D. Steel Supports:
  - 1. Steel posts shall be at least 5 feet long with a strength of 1.33 pounds per foot and shall have projections for the attachment of fasteners.
  - 2. The silt fence fabric shall be attached in at least three places on the upslope side with 50 pound plastic tie straps or wire fasteners.
- E. Silt fence shall have a support cord.
- F. The Contractor shall furnish upon request a manufacturer's Certificate of Compliance that the geotextile fabric as furnished meets the above requirements.
- G. Silt Fence shall be installed in accordance with Wisconsin DNR Conservation Practice Standard 1056.

#### 2.10 STONE DITCH CHECKS

- A. Stone Ditch Checks shall be installed in accordance with Wisconsin DNR Conservation Practice Standard 1062.

#### 2.11 RIPRAP

- A. Riprap shall be established in accordance with Riprap - Division 31 of this specification.

#### 2.12 LAND APPLICATION OF POLYACRYLAMIDE

- A. Land Application of Polyacrylamide shall be performed in accordance with Wisconsin DNR Conservation Practice Standard 1050.

#### 2.13 STONE TRACKING PAD

- A. Stone Tracking Pads shall be established in accordance with Wisconsin DNR Conservation Practice Standard 1057.
- B. The aggregate for tracking pads shall be 3 to 6 inch clear or washed stone. All material to be retained on a 3-inch sieve.

#### 2.14 VEGETATIVE BUFFERS

- A. Vegetative Buffers for Construction shall be established in accordance with Wisconsin DNR Conservation Practice Standard 1054.
- B. Prior to land disturbance the perimeter of vegetative buffers shall be flagged or fenced to prevent equipment from creating ruts, compacting the soil and to prevent damage to existing vegetation.

- C. Trees should not be cut down to establish a vegetative buffer. Other erosion control measures are preferred.

#### 2.15 TEMPORARY SEDIMENT TRAPS

- A. Temporary Sediment Traps shall conform with Wisconsin DNR Conservation Practice Standard 1063.
- B. The stone outlet of a Sediment Trap shall consist of a stone section of embankment located at the discharge point. Stone shall consist of angular well graded 3 to 6 inch clear washed stone.
- C. If filter fabric is indicated for the up-slope side of the stone outlet, a monofilament type fabric shall be used (such as WisDOT Type FF or equivalent).

#### 2.16 TEMPORARY CONSTRUCTION SITE DIVERSION

- A. Temporary Construction Site Diversions shall conform to Wisconsin DNR Conservation Practice Standard 1066.

#### 2.17 DUST CONTROL

- A. Dust Control measures shall be implemented in accordance with Wisconsin DNR Conservation Practice Standard 1068.
- B. Asphalt and petroleum based products shall not be used for dust control.
- C. Mulch or seed and mulch may be applied to protect exposed soil from wind erosion according to the provisions of WDNR Conservation Practice Standard 1058 Mulching for Construction Sites and 1059 Seeding for Construction Site Erosion Control.
- D. Polymers may be used for dust control according to the provisions of WDNR Conservation Practice Standard 1050 Erosion Control Land Application of Polymers.
- E. Tackifiers and Soil Stabilizers Type A – Products must be selected from the WisDOT Erosion Control PAL.
- F. Solid board fences, snow fences, burlap fences, crate walls, bales of hay and similar material may be used to control air currents and blown soil.

#### 2.18 CONSTRUCTION SITE DE-WATERING

- A. Construction Site Dewatering activities shall be conducted in accordance with Wisconsin DNR Conservation Practice Standard 1061.

#### 2.19 STORM DRAIN INLET PROTECTION

- A. Storm Drain Inlet Protection shall conform Wisconsin DNR Conservation Practice Standard 1060.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. All fabrics used as part of an inlet protection device must be selected from the list of approved fabrics certified for inlet protection, Geotextile Fabric, Type FF in the current edition of the WisDOT Product Acceptability List (PAL).
  - C. Inlet Protection Barriers include, but are not limited to, straw bales, sandbags, other material filled bags and socks, and stone weepers.
  - D. Manufactured bags, when used, shall conform to the standards below:
    - 1. Minimum Size 14 x 26 inches
    - 2. Grab Tensile strength of fabric, ASTM D-4632 = 95 lb. min.
    - 3. UV stability, ASTM D-4355 = 70 % min.
    - 4. Fabric shall be sewn together with double stitching.
  - E. Straw Bale installation shall conform to the criteria outlined in the WDNR Conservation Practice Standard (1055) Sediment Bale Barrier (Non-Channel).
  - F. Stone weeper installation shall conform to the criteria in WDNR Conservation Practice Standard (1063) Sediment Trap.
- 2.20 DITCH CHECK (CHANNEL)
- A. Ditch Checks for erosion and sediment control in drainage ditches and channels shall conform Wisconsin DNR Conservation Practice Standard 1062.
  - B. Stone ditch checks shall be constructed of a well-graded angular stone, a D50 of 3 inch or greater, sometimes referred to as breaker run or shot rock.
  - C. Manufactured products listed in WisDOT's PAL are also acceptable for temporary ditch checks.
  - D. Silt fence and single rows of straw bales are not permitted.
- 2.21 LAND APPLICATION OF ANIONIC POLYACRYLAMIDE (POLYMERS, PAM).
- A. Land Application of Anionic Polyacrylamide (PAM) shall conform Wisconsin DNR Conservation Practice Standard 1050.
  - B. Anionic PAM mixtures shall be environmentally benign, harmless to fish, aquatic organisms, wildlife, and plants. Anionic PAM mixtures shall be non-combustible.
  - C. Cationic PAM shall not be used at any level. Anionic PAM mixtures shall have  $\leq 0.05\%$  free acrylamide monomer by weight as established by the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA).
  - D. The manufacturer or supplier shall provide a product expiration date for anionic PAM mixtures based on product expiration date of PAM in pure form. PAM shall not be used if the expiration date will be reached prior to establishment of vegetation in areas where PAM is to be used.
  - E. Contractor shall store and mix polymer in accordance with manufacturer or supplier written instructions.



## PART 3 CONSTRUCTION METHODS

## 3.1 EROSION CONTROL REQUIREMENTS

- A. The erosion control requirements specified in the project Storm Water Management Plan shall be adhered to at all times.
- B. Temporary and permanent erosion control measures shall be performed by the Contractor. The Contractor shall control water pollution, erosion, and siltation through the use of intercepting embankments, berms, dikes, dams, settling basins, slope paving, ditch checks, riprap, mulches, erosion mats, seeding, sodding, plantings and other erosion control devices or methods.
- C. The Contractor shall submit for approval his plan of operations for accomplishing temporary and permanent erosion control work relating to grubbing, grading, paving and other work which might create erosion.
- D. The area of erosive land exposed to the elements by grubbing, excavation, borrow and fill operations at any one time shall be minimized to the maximum extent practicable and the duration of such exposure prior to final trimming, finishing and seeding or application of temporary erosion control measures shall be as short as practicable. Construction in and adjacent to rivers, streams, lakes, or other waterways shall be performed in such a manner as to avoid washing, sloughing or deposition of materials into such waterways which would obstruct or impair the flow thereof thus endangering the roadway or stream banks, or which would result in undue or avoidable contamination, pollution or siltation of such waterways.
- E. The Owner or Designated Representative shall have full authority to suspend or limit grading and other operations pending adequate performance of such permanent erosion control measures as finish grading, topsoiling, mulching, matting and seeding and any temporary erosion control measures ordered by the Engineer.
- F. Grubbing and grading operations shall be performed in proper sequence with other work to minimize erosion. Intercepting ditches or dikes shall be constructed as soon as practical after clearing and grubbing operations are completed and prior to or during the operations of excavating the cuts. Where erosion is likely to be a problem, the permanent erosion control measures shall follow immediately after the grading operations if conditions permit, unless the Engineer shall authorize temporary erosion control measures.
- G. Water pumped from the site shall be treated by temporary sedimentations basins, grit chambers, sand filters, upslope chambers, hydro-cyclones, swirl concentrators, or other appropriate controls designed and used to remove total suspended solids (TSS) to 40 mg/l or less for the highest dewatering pumping rate. If the water is demonstrated to contain less than 40 mg/l TSS during dewatering operations, then no control is needed before discharge. Water may not be discharged in a manner that causes erosion of the site or receiving channels. Construction Site Dewatering activities shall be conducted in accordance with Wisconsin DNR Conservation Practice Standard 1061.

- H. The Contractor shall take all possible precautions to prevent sediment from being tracked onto public or private roadways. Any sediment reaching a public or private road shall be removed by street cleaning (not flushing) before the end of each workday.
- I. All storm drain or culvert inlets shall be protected with appropriate erosion control practices as identified in the appropriate Conservation Practice Standard. Channelized runoff from adjacent areas passing through the site shall be diverted around disturbed areas, if practical. Otherwise, the channel shall be protected. Sheet flow runoff from adjacent areas greater than 10,000 square feet in area shall also be diverted around disturbed areas unless shown to have resultant runoff velocities of less than 0.5 ft/sec across the disturbed area for one-year design storms having a duration of from 0.5 to 24 hours. Diverted runoff shall be conveyed in a manner that will not erode the conveyance and receiving channels.
- J. All disturbed ground left inactive for seven (7) or more days shall be stabilized by seeding or sodding (only prior to October 15) or by mulching or covering, or other equivalent control measure.
- K. For sites with more than 10 acres disturbed at one time, or if a channel originates in the disturbed area, one or more Temporary Sediment Traps shall be constructed in accordance with Wisconsin DNR Conservation Practice Standard 1063. The basin discharge rate shall also be sufficiently low as to not cause erosion along the discharge channel or the receiving water.
- L. For sites with less than 10 acres disturbed at one time, sediment control fences, hay bales, or equivalent control measures shall be placed along all sideslope and downslope sides of the site. If a channel or area of concentrated runoff passes through the site, sediment control fences shall be placed along the channel edges to reduce sediment reaching the channel.
- M. Any soil or dirt storage piles containing more than ten cubic yards of material should not be located with a downslope drainage length of less than 25 feet to a roadway or drainage channel. If remaining for more than seven (7) days, they shall be stabilized by mulching, vegetative cover, tarps, or other means. Erosion from piles which will be in existence for less than seven (7) days shall be controlled by placing hay bales or sediment control fence barriers around the pile. In-street utility repair or construction soil; or dirt storage piles located closer than 25 feet to a roadway or drainage channel must be covered with tarps or a suitable alternative control must be used if exposed for more than seven (7) days, and storm drain or culvert inlets must be protected with straw bales or other appropriate filtering barriers (CPS 1060).

### 3.2 TEMPORARY SEEDING

- A. Seeding for Construction Sites shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1059.
- B. Temporary Seeding (Cover Crop) - Areas needing protection during periods when permanent seeding is not applied shall be seeded with annual species for temporary protection. See table below for seeding rates of commonly used species. The residue from this crop may either be incorporated into the soil during seedbed preparation at the next permanent seeding period or left on the soil surface and the planting made as a no-till seeding.

<u>Species</u>	<u>Lbs/Acre</u>	<u>Percent Purity</u>
Oats	131 <sup>1</sup>	98
Cereal Rye	131 <sup>2</sup>	97
Winter wheat	131 <sup>2</sup>	95
Annual Ryegrass	80 <sup>2</sup>	97

<sup>1</sup> Spring and summer seeding

<sup>2</sup> Fall seeding

- C. Permanent Seeding - Rates shall be based on pounds or ounces of Pure Live Seed (PLS) per acre. If a nurse crop is used in conjunction with permanent seeding, the nurse crop shall not hinder establishment of the permanent vegetation. A nurse crop shall be applied at 50% its temporary seeding rate when applied with permanent seed.
- D. Inoculation - Legume seed shall be inoculated in accordance with the manufacturer's recommendations. Inoculants shall not be mixed with liquid fertilizer.
- E. Sowing
1. Seed grasses and legumes no more than 1/4 inch deep. Distribute seed uniformly. Mixtures with low seeding rates require special care in sowing to achieve proper seed distribution.
  2. Seed may be broadcast, drilled, or hydroseeded as appropriate for the site.
  3. Seed when soil temperatures remain consistently above 53°F. Dormant seed when the soil temperature is consistently below 53°F (typically November 1st until snow cover). Seed shall not be applied on top of snow.
- F. Turf seedlings must not be mowed until the stand is at least 6 inches tall. Do not mow closer than 3 inches during the first year of establishment.
- G. Alternate plans must be submitted for approval.
- 3.3 APPLICATION OF STRAW OR HAY MULCH
- A. Mulching for Construction Sites shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1058.
- B. Application Rate:
1. Mulch shall cover a minimum of 80% of the soil surface for unseeded areas. For seeded areas, mulch shall be placed loose and open enough to allow some sunlight to penetrate and air to circulate but still cover a minimum of 70% of the soil surface.
  2. Mulch shall be applied at a uniform rate of 1½ to 2 tons per acre for sites that are seeded, and 2 to 3 tons per acre for sites that are not seeded. This application results in a layer of ½ to 1½ inches thick for seeded sites, and 1½ to 3 inches thick for sites not seeded.
  3. Wood chips or wood bark shall be applied at a rate of 6 to 9 tons per acre to achieve a minimum of 80% ground cover. This application should result in a layer of wood chips or wood bark ½ to 1½ inches thick.
- C. In areas where mulch is to be placed over seed, mulch shall be placed within 24 hours of seeding.

- D. Mulch Anchoring Methods - Anchoring of mulch shall be based on the type of mulch applied, site conditions, and accomplished by one of the following techniques:
1. Crimping: Immediately after spreading, the mulch shall be anchored by a mulch crimper or equivalent device consisting of a series of dull flat discs with notched edges spaced approximately 8 inches apart. The mulch shall be impressed in the soil to a depth of 1 to 3 inches.
  2. Polypropylene Plastic, or Biodegradable Netting: Apply plastic netting over mulch application and staple according to manufacturer's recommendations.
  3. Tackifier: Tackifier shall be sprayed in conjunction with mulch or immediately after the mulch has been placed. Tackifiers must be selected from those that meet the WisDOT Erosion Control Product Acceptability List (PAL). Asphalt based products shall not be applied.
    - a. The tackifiers shall be applied at the following minimum application rates per acre:
      - 1) Latex-Base: mix 15 gallons of adhesive (or the manufacturer's recommended rate which ever is greater) and a minimum of 250 pounds of recycled newsprint (pulp) as a tracer with 375 gallons of water.
      - 2) Guar Gum: mix 50 pounds of dry adhesive (or the manufacturer's recommended rate which ever is greater) and a minimum of 250 pounds of recycled newsprint (pulp) as tracer with 1,300 gallons of water.
      - 3) Other Tackifiers: (Hydrophilic Polymers) mix 100 pounds of dry adhesive (or the manufacturer's recommended rate which ever is greater) and a minimum of 250 pounds of recycled newsprint (pulp) as a tracer with 1,300 gallons of water.

#### 3.4 PLACING EROSION MAT

- A. Installation instructions shall be supplied by the manufacturer. The Contractor shall install the mat in accordance with the manufacturer's recommendations and in accordance with Section 628.2 of the State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, and the State of Wisconsin, Department of Transportation general requirements for erosion mat except as may be modified herein.
- B. Erosion control revegetative mats shall be installed after all topsoiling, fertilizing, liming and seeding is complete.
- C. The mat shall be in firm and intimate contact with the soil. It shall be installed and anchored per the manufacturer's recommendation.
- D. The mat shall be unrolled and draped loosely, without stretching, so that continuous ground contact is maintained. In ditches, mat shall be unrolled and applied parallel to the direction of drainage. On slopes, mat shall be applied parallel to the slope direction.
- E. Turf-reinforcement mat shall be installed in conjunction with the topsoiling operation and shall be followed by Erosion Control Revegetative Mat installation.
- F. At time of installation, document the manufacturer and mat type by retention of material labels and manufacturer's installation instructions. Retain this documentation until the site has been stabilized.
- G. In channels and on slopes, each upslope and each downslope end of each piece of mat shall be placed in a 4-inch trench, stapled on 12-inch centers, backfilled and tamped. Where one roll ends

and second roll starts, the upslope piece shall be brought over the end of the downslope roll so that there is a 12 inch overlap, placed in a 4 inch trench, stapled on 12 inch centers, backfilled and tamped. In channels, erosion mats shall extend for whichever is greater: upslope one-foot minimum vertically from the ditch bottom or 6 inches higher than the design flow depth.

- H. On slopes, where two or more widths of mat are applied, the two edges shall be overlapped according to the manufacturer's installation instructions and stapled at 18 to 24 inch intervals along the exposed edge of the lap joint. The body of the mat shall be stapled in a grid pattern with staples 3 feet on center each way.
- I. Where heavy concentrations of water or extremely erodible soil conditions exist, as noted on the contract drawings, erosion checks shall be installed at intervals of 50 feet, or less. Such a check shall consist of a 4-inch deep trench perpendicular to the flow direction across the entire width of the fabric. The mat shall be stapled at 9-inch intervals along the bottom of the trench across the entire width of the mat. The trench shall then be backfilled and tamped.
- J. If anchoring devices become loosened, or if any fabric loosens, is torn or undermined, repairs shall be made immediately without additional compensation.
- K. Erosion mat when used in conjunction with fertilizing and seeding done for surface restoration, shall be installed immediately after fertilizing and seeding operations have been completed. Straw or hay mulch shall not be used under the fabric.
- L. Erosion mat shall at a minimum be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period.
  - 1. If there are signs of rilling under the mat, install more staples or more frequent anchoring trenches. If rilling becomes severe enough to prevent establishment of vegetation, remove the section of mat where the damage has occurred. Fill the eroded area with topsoil, compact, reseed and replace the section of mat, trenching and overlapping ends per manufacturer's recommendations. Additional staking shall be provided where rilling was filled.
  - 2. If the reinforcing plastic netting has separated from the mat, remove the plastic and if necessary replace the mat.
  - 3. Maintenance shall be completed as soon as possible with consideration to site conditions.

### 3.5 VEGETATIVE BUFFERS

- A. Vegetative Buffers for Construction shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1054.
- B. Trees should not be cut down to establish a vegetative buffer.
- C. A stand of dense vegetation shall be maintained to a height of 3 – 12 inches.
- D. Vegetative buffers shall at a minimum be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period. Vegetative buffers shall be inspected for proper distribution of flows, sediment accumulation and signs of rill formation.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. If the vegetative buffer becomes silt covered, contains rills, or is otherwise rendered ineffective, other perimeter sediment control measures shall be installed. Eroded areas shall be repaired and stabilized. Repair shall be completed as soon as possible with consideration to site conditions.

## 3.6 TEMPORARY SOD PLACEMENT

- A. The Contractor shall place sod with edges in close contact and with joints staggered. Sod placement on slopes shall commence at the bottom of the slope, and the rows shall be laid perpendicular to the slope. The edge of the sod at the tops of slopes shall be turned slightly under, and a layer of soil shall be compacted over the edge to direct surface drainage over the edge onto the top of the sod. Sod placement in areas other than on slopes shall be made so that the top sod surface is flush with adjoining surfaces.
- B. On slopes steeper than 4:1 horizontal to vertical, the Contractor shall stake the sod with split cedar shingles, or other equally effective stakes, spaced from 18 to 36 inches apart along the longitudinal axis of the sod strip. These stakes shall be placed near the top edge of the sod strip and shall be driven flush with the sod.
- C. After the sod is placed, it shall be rolled or firmly tamped to press the sod onto the underlying soil. The Contractor shall, at the end of the day in which the sod is laid, thoroughly soak all sodded areas by sprinkling them with water.
- D. Sod shall be maintained in a moist, growing condition. The Contractor shall repair all areas damaged by erosion or traffic of any kind.

## 3.7 PLACING HAY BALE BARRIERS

- A. Straw Bale (Sediment Bale Barriers) shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1055.
- B. Sufficient bales shall be on the site to create the necessary barriers prior to the start of groundbreaking operations. The bales shall be stacked and covered with plastic sheeting until required for use.
- C. At a minimum, sediment bale barriers shall be placed in a single row, lengthwise on the contour, with the ends of adjacent sediment bale barriers tightly abutting one another. The holes between bales shall be chinked (filled by wedging) with straw, hay or equivalent material to prevent water from escaping between the bales.
- D. The maximum allowable slope lengths contributing runoff to a sediment bale barrier are specified below:

Slope Barrier Row Spacing
< 2% 100 feet
2 to 5% 75 feet
5 to 10% 50 feet
10 to 33% 25 feet
33 to 50% 20 feet
> 50% Not Permitted

- E. Sediment bale barriers shall not be placed perpendicular to the contour.
- F. The end of the sediment bale barrier shall be extended upslope to prevent water from flowing around the barrier ends.
- G. Installed sediment bale barrier shall be a minimum of 10 inches high and shall not exceed a maximum height of 20 inches from ground level.
- H. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a sediment bale barrier and the length of the proposed barrier to a minimum depth of 4 inches. After bales are staked and chinked, the excavated soil shall be backfilled and compacted against the barrier. Backfill to ground level on the down slope side. On the upslope side of the sediment bale barrier backfill to 4 inches above ground level.
- I. At least two wood stakes, "T" or "U" steel posts, or 1/2 inch rebar driven through at equidistance along the centerline of the barrier shall securely anchor each bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes shall be driven a minimum 12-inches into the ground to securely anchor the sediment bale barriers.
- J. Bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings.
- K. Sediment bale barriers shall, at a minimum, be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period.
- L. Damaged or decomposed sediment bale barriers, any undercutting, or flow channels around the end of the sediment bale barriers shall be repaired.
- M. Sediment shall be properly disposed of once the deposits reach 1/2 the height of the sediment bale barrier.
- N. Sediment bale barriers and anchoring devices shall be removed and properly disposed of when they have served their usefulness, but not before the upslope areas have been permanently stabilized.
- O. Any sediment deposits remaining in place after the sediment bale barrier is no longer required shall be dressed to conform to the existing grade, prepared, and seeded.

### 3.8 CONSTRUCTION OF SEDIMENT CONTROL FENCE (SILT FENCE)

- A. Silt Fence shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1056.
- B. When installed as a stand-alone practice on a slope, silt fence shall be placed on the contour. The parallel spacing shall not exceed the maximum slope lengths for the appropriate slope as specified:

Slope Fence Spacing  
< 2% 100 feet  
2 to 5% 75 feet  
5 to 10% 50 feet  
10 to 33% 25 feet  
> 33% 20 feet  
> 50% Not Permitted

- C. Silt fences shall not be placed perpendicular to the contour.
- D. The ends of the fence shall be extended upslope to prevent water from flowing around the ends of the fence.
- E. When attached to wooden posts the silt fence fabric shall be stapled, using at least 0.5-inch staples, to the upslope side of the posts in at least 3 places.
- F. When attached to steel supports the silt fence fabric shall be attached in at least three places on the upslope side with 50 pound plastic tie straps or wire fasteners. To prevent damage to the fabric from fastener, the protruding ends shall be pointed away from the fabric.
- G. The maximum spacing of posts for nonwoven silt fence shall be 3 feet and for woven fabric 8 feet.
- H. Where joints are necessary, each end of the fabric shall be securely fastened to a post. The posts shall then be wrapped around each other to produce a stable, secure joint or shall be overlapped the distance between two posts.
- I. On the terminal ends of silt fence the fabric shall be wrapped around the post such that the staples are not visible.
- J. A minimum of 20 inches of the post shall extend into the ground after installation.
- K. Anchoring – Silt fence shall be anchored by spreading at least 8 inches of the fabric in a 4 inch wide by 6 inch deep trench, or 6 inch deep V-trench on the upslope side of the fence. The trench shall be backfilled and compacted. Trenches shall not be excavated wider and deeper than necessary for proper installation.
- L. Removal – Silt fences shall be removed once the disturbed area is permanently stabilized and no longer susceptible to erosion.
- M. Silt fences shall at a minimum be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24 hour period.
- N. Damaged or decomposed fences, undercutting, or flow channels around the end of barriers shall be repaired or corrected.
- O. Sediment shall be properly disposed of once the deposits reach 1/2 the height of the fence.



## 3.9 STONE TRACKING PAD

- A. Stone Tracking Pads shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1057.
- B. The tracking pad shall be installed prior to any traffic leaving the site.
- C. The aggregate shall be placed in a layer at least 12 inches thick. On sites with a high water table, or where saturated conditions are expected during the life of the practice, stone tracking pads shall be underlain with a WisDOT Type R geotextile fabric to prevent migration of underlying soil into the stone.
- D. Tracking pads and tire washing stations shall, at a minimum, be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period.
- E. The tracking pad performance shall be maintained by scraping or top-dressing with additional aggregate.
- F. A minimum 12-inch thick pad shall be maintained.

## 3.10 STORM DRAIN INLET PROTECTION

- A. Storm Drain Inlet Protection shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1060.
- B. The contributing drainage area to the inlet protection device shall be one acre or less. In instances where a larger contributing drainage area exists, runoff shall be routed through a properly designed sediment trapping or settling device upstream of inlet.
- C. Other than Type D inlet protection devices, no gaps shall be left in the material used that would allow the flow of water to bypass the inlet protection device.
- D. Filter Fabric Barrier Criteria - See Inlet Protection Detail
  1. Inlet protection Type A devices shall be utilized around inlets and unpaved areas until permanent stabilization methods have been established. Type A devices shall be utilized on inlets prior to installation of curb and gutter or pavement, and where safety considerations are not compromised on the site.
  2. Type B shall be utilized after the casting and grate are in place.
  3. Type D shall be utilized in areas where other types of inlet protection are identified as incompatible with roadway and traffic conditions, causing possible safety hazards when ponding occurs at the inlet. Type D shall only be used after castings are in place on top of the inlet boxes.
  4. Type D inlet protection shall conform to the standard drawing as shown in the contract drawings. There shall be a three-inch space between the bag and the sides of the inlet to prevent the inlet sides from blocking the overflow; and shall only be used in inlets deeper than 30 inches from the top of grate to bottom of the inlet. If such clearance is not available, cinch or tie the sides of the bag (with rope or ties) to provide clearance.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- E. Criteria Applicable to the Post-Paving/Curbing Phase of Construction
1. Inlet protection Types B, C, and D are applicable to post paving construction. See Inlet Protection Detail.
    - a. Type B shall be utilized on inlets without curb box.
    - b. Type C shall be utilized on street inlets with curb heads. A 1½ inch x 3½ inch (37 mm by 87 mm) minimum, piece of wood shall be wrapped and secured in the fabric and placed in front of the curb head as shown in the contract drawings. The wood shall not block the entire opening of the curb box and be secured to the grate with wire or plastic ties.
    - c. Type D.
- F. Remove inlet protection devices once the contributing drainage area is stabilized with appropriate vegetation or impervious area.
- G. Inlet protection shall be at a minimum inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period.
- H. Sediment deposits shall be removed and the inlet protection device restored to its original dimensions when the sediment has accumulated between 1/3 to 1/2 the design depth of the device, or when the device is no longer functioning as designed. Removed sediment shall be deposited in a suitable area and stabilized.
- I. Any material falling into the inlet shall be removed.
- 3.11 DITCH CHECK (CHANNEL)
- A. Ditch Checks for erosion and sediment control in drainage ditches and channels shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1062.
  - B. Ditch checks shall be utilized during rough grading and shall be removed once the final grading and channel stabilization is applied, unless intended to be part of a permanent storm water management plan.
  - C. Channel erosion mat or other nonerodible materials shall be placed at the base of a ditch check, and extended a minimum of 6 feet, to prevent scour and washing out the toe of the ditch check. DNR Conservation Practice Channel Erosion Mat (1053) contains criteria for the placement of erosion mat in this location.
  - D. Stone ditch checks may be underlain by a nonwoven geotextile fabric to ease installation and removal. If the geotextile fabric is extended, it can serve purpose specified in item 3.11 C above.
  - E. Chink or seal stone and rock ditch checks to minimize the flow through the ditch check.
  - F. For added stability, the base of a stone or rock ditch check shall be keyed into the soil to a depth of 6-inches.
  - G. Ditch checks shall, at a minimum, be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24 hour period.

- H. Unless incorporated into a permanent storm water management system, ditch checks shall be removed once the final grading and channel stabilization is applied.
- I. Maintenance shall be completed as soon as possible with consideration to site conditions.

### 3.12 TEMPORARY SEDIMENT TRAPS

- A. Temporary Sediment Traps shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1063.
- B. Sediment traps shall be constructed prior to disturbance of up-slope areas and placed so they function during all phases of construction.
- C. The depth of the sediment trap measured from the sediment trap bottom to the invert of the stone outlet, shall be at least three feet to minimize re-suspension and provide storage for sediment.
- D. The sediment trap shall have a length to width ratio of at least 2:1. The position of the outlet to the inlet shall be as such to minimize short-circuiting of the water flow path.
- E. Side slopes shall be no steeper than 2:1.
- F. Embankments of temporary sediment traps shall not exceed five feet in height measured from the downstream toe of the embankment to the top of the embankment. Construct embankments with a minimum top width of four feet, and side slopes of 2:1 or flatter. Earthen embankments shall be compacted.
- G. Sediment traps shall be constructed with both a principal and emergency spillway. The stone outlet of a sediment trap shall consist of a stone section of embankment (stone outlet) located at the discharge point. The stone outlet section provides a means of dewatering the basin back to the top of the permanent storage between storm events, and also serves as a non-erosive emergency spillway for larger flow events.
- H. The stone outlet shall have a minimum top width of 2 feet and a maximum side-slope of 2:1.
- I. The stone outlet shall be protected from undercutting by excavating a keyway trench across the stone foundation and up the sides to the height of the outlet.
- J. Sediment Traps shall, at a minimum, be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period. Sediment may need to be removed more frequently.
- K. Deposits of sediment shall be removed when they reach a depth of one foot.
- L. If the outlet becomes clogged it shall be cleaned to restore flow capacity.
- M. Maintenance shall be completed as soon as possible with consideration given to site conditions.
- N. Sediment traps shall be removed and the location stabilized after the disturbed area draining to the sediment trap is stabilized and no longer susceptible to erosion.

## 3.13 TEMPORARY CONSTRUCTION SITE DIVERSION

- A. Temporary Construction Site Diversions shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1066.
- B. The minimum berm cross section shall have side slopes of 2:1 (horizontal:vertical) or flatter, a minimum top width of two feet and a minimum height of 1.5 feet.
- C. Diversions that are to serve longer than 30 days shall be stabilized as soon as they are constructed.
- D. Diversions shall, at a minimum, be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period.
- E. Maintenance shall be completed as soon as possible with consideration to site conditions.
- F. Accumulated sediment shall be removed when it reaches one half the height of the diversion berm.
- G. Diversions shall be removed and the area stabilized according to construction contract drawings.

## 3.14 DUST CONTROL

- A. Dust Control measures shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1068.
- B. Polymers may be used in areas that do not receive vehicle traffic. Dry applied polymers must be initially watered for activation to be effective for dust control. Polymers shall be utilized in accordance with the provisions of WDNR Conservation Practice Standard 1050 Erosion Control Land Application of Polymers.
- C. Tackifiers and Soil Stabilizers Type A – Products must be installed at rates conforming to the WisDOT Erosion Control PAL.
- D. Chlorides shall be applied according to the most recent version of the WisDOT Standard Specifications for Highway and Bridge Construction.
- E. Barriers - Barriers shall be placed at right angles to prevailing wind currents at intervals of about 15 times the barrier height.
- F. Areas that have dust control practices shall at a minimum be inspected daily.

## 3.15 LAND APPLICATION OF ANIONIC POLYACRYLAMIDE (POLYMERS).

- A. Land Application of Anionic Polyacrylamide (polymers) shall be installed and maintained in accordance with Wisconsin DNR Conservation Practice Standard 1050.
- B. Application rates shall not exceed manufacturer's written application rate recommendations that shall not exceed the WDNR use restrictions.

- C. Maximum application rates, in parts per million (ppm or mg/L or mg/kg), shall be determined by multiplying 1.4 by the number of pounds applied per acre. This number shall be less than or equal to the WDNR use restriction. Repeated applications of anionic PAM mixtures may be applied, if necessary, to ensure adequate effectiveness.
- D. The application method shall provide uniform coverage to the target area and avoid drift to non-target areas.
- E. When used on bare soil, without seed or mulch, anionic PAM mixtures shall be used on slopes 2.5:1 or flatter.
- F. Anionic PAM mixtures shall not be applied to channel bottoms.
- G. The applicator of anionic PAM mixture shall document, at the time of application, the following: name of applicator, application rate per acre, date applied, product type, weather conditions during application, and method of application. Copies of this documentation shall be entered into the contractor's monitoring log or project diary and made available upon request.
- H. Unused liquid anionic PAM mixtures shall be minimized. Excess material shall not be applied at a rate greater than the maximum application rate. Disposal shall not occur in storm water conveyance systems (i.e., storm sewer manholes, storm sewer inlets, ditches, and culverts).
- I. PAM shall not be used within 30 feet of surface waters of the state.
- J. Maintenance will consist of reapplying anionic PAM mixtures to disturbed areas, including high use traffic areas, which interfere in the performance of this practice.
- K. Anionic PAM mixtures should be reapplied in areas where wind or rill erosion is apparent and whenever an area has been graded, driven upon, or otherwise disturbed since the anionic PAM mixture was last applied.

END OF SECTION 312500

## SECTION 313700 - RIPRAP

## PART 1 GENERAL

## 1.1 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
  - 1. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Current Edition at time of bid opening.

## 1.3 DESCRIPTION OF WORK

- A. The work covered under this section shall consist of furnishing all material, equipment, and labor required to execute the riprapping for this project and in accordance with the provisions of Section 606 of the State of Wisconsin, Department of Transportation, Standard Specifications.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Geosynthetics for Earthwork - Division 31

## 1.5 SUBMITTALS (NONE)

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

## PART 2 PRODUCTS AND MATERIALS

## 2.1 MATERIALS

- A. Materials used in this work shall meet the requirements for the class of material named in Special Procedures - Division 01 or shown on the contract drawings. Stone shall be durable field or quarry stone approved by the Engineer prior to placing. It shall be sound, hard, dense, resistant to the action of air and water, and free from seams, cracks or other structural defects.
- B. Riprap. Stone pieces for riprap shall range in weight from approximately 25 to 150 pounds, with not less than approximately 50 percent of the pieces weighing more than 60 pounds.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Medium Random Riprap. Stone pieces for medium random riprap shall be well graded ranging in weight up to 200 pounds or more. Not less than approximately 50 percent of the total volume shall consist of pieces weighing 80 pounds or more with not less than 80 percent weighing 15 pounds or more.
- D. Heavy Riprap. Stone pieces for heavy riprap shall be well graded, ranging in weight up to 400 pounds or more. Not less than approximately 50 percent of the total volume shall consist of pieces weighing 150 pounds or more, and not less than approximately 80 percent of the total volume shall consist of pieces weighing 40 pounds or more.
- E. Mortar. Mortar shall be composed of three parts of clean sand for mortar and one part of any one of the following materials, by volume: masonry cement, a mixture of 50 percent portland cement and 50 percent masonry cement or a mixture of 50 percent portland cement and 50 percent hydrated lime.

## PART 3 CONSTRUCTION METHODS

## 3.1 EXCAVATION

- A. The bed for the riprap shall be properly trimmed and shaped.

## 3.2 PLACING RIPRAP

- A. Stone placed above the waterline shall be placed by hand. It shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjoining stones. The stones shall be laid perpendicular to the slope with ends in contact. The riprap shall be thoroughly compacted as construction progresses and the finished surface shall present an even, tight surface. The larger stone shall be placed in the lower courses. Interstices between stones shall be chinked with spalls firmly rammed into place. Unless otherwise provided, riprap shall be at least 12 inches in thickness, measured perpendicular to the slope.

## 3.3 PLACING MEDIUM RANDOM AND HEAVY RIPRAP

- A. Medium and heavy riprap may be placed by any mechanical means that will produce a completed job within reasonable tolerances of the typical section shown on the contract drawings. Unless otherwise provided on the contract drawings, heavy riprap shall be not less than 24 inches in thickness and medium random riprap shall not be less than 18 inches thick. Hand work will be limited to the amount necessary to fill large voids or to correct segregated areas.

END OF SECTION

## SECTION 321216 - ASPHALT PAVING

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Hot-mix asphalt paving.

## B. Related Requirements:

1. Section 312000 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

## 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

## 1.3 ACTION SUBMITTALS

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

## 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Wisconsin DOT for asphalt paving work.
  1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

## PART 2 - PRODUCTS

## 2.1 AGGREGATES

- A. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- B. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.



- C. Mineral Filler: ASTM D 242/D 242M, rock or slag dust, hydraulic cement, or other inert material.

## 2.2 ASPHALT MATERIALS

- A. Asphalt Binder: Per Wisconsin DOT Standards.
- B. Tack Coat: [ASTM D 977] [or] [AASHTO M 140] emulsified asphalt, or [ASTM D 2397] [or] [AASHTO M 208] cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

## 2.3 AUXILIARY MATERIALS

- A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles, or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.
- B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

## 2.4 MIXES

- A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by and complying with the following requirements:
  - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
  - 2. Base Course: See drawings.
  - 3. Surface Course: See drawings.

## PART 3 - EXECUTION

### 3.1 PATCHING

- A. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- B. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

### 3.2 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of **0.05 to 0.15 gal./sq. yd.** (**0.2 to 0.7 L/sq. m**).
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

### 3.3 PLACING HOT-MIX ASPHALT

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  - 1. Spread mix at a minimum temperature of **250 deg F (121 deg C)**.
  - 2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than **10 feet (3 m)** wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### 3.4 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
  - 1. Clean contact surfaces and apply tack coat to joints.
  - 2. Offset longitudinal joints, in successive courses, a minimum of **6 inches (150 mm)**.
  - 3. Offset transverse joints, in successive courses, a minimum of **24 inches (600 mm)**.
  - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

## 3.5 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
  - 1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
  - 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

## 3.6 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  - 1. Base Course: Plus or minus 1/2 inch (13 mm).
  - 2. Surface Course: Plus 1/4 inch (6 mm), no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
  - 1. Base Course: 1/4 inch (6 mm).
  - 2. Surface Course: 1/8 inch (3 mm).
  - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

## 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Replace and compact hot-mix asphalt where core tests were taken.
- C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

## 3.8 WASTE HANDLING

- A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216

## SECTION 321313 - CONCRETE PAVING

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Service Drives.
2. Walks.

## 1.2 ACTION SUBMITTALS

## A. Product Data: For each type of product indicated.

## B. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

## 1.3 QUALITY ASSURANCE

## A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless otherwise indicated.

## PART 2 - PRODUCTS

## 2.1 STEEL REINFORCEMENT

## A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

## B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

## C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

D. Reinforcing Bars: ASTM A 615/A 615M, **Grade 60 (Grade 420)**; deformed.

## E. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

- F. Deformed-Steel Wire: ASTM A 496/A 496M.
- G. Dowel Bars: ASTM A 615/A 615M, **Grade 60 (Grade 420)** plain-steel bars stainless steel. Cut bars true to length with ends square and free of burrs.
- H. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

## 2.2 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
  - 1. Portland Cement: ASTM C 150, gray portland cement Type I/II; Supplement with the following:
    - a. Fly Ash: ASTM C 618, [**Class C**] [**or**] [**Class F**].
    - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33, uniformly graded. Provide aggregates from a single source.
- C. Water: Potable and complying with ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

## 2.3 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd. (305 g/sq. m)** dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

## 2.4 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

## 2.5 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to **ACI 301 (ACI 301M)**, with the following properties:
  - 1. Compressive Strength (28 Days): 3500 psi (24.1 MPa).
  - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
  - 3. Slump Limit: 4 inches (100 mm), plus or minus **1 inch (25 mm)**.
  - 4. Air Content: 6 percent plus or minus 1.5 percent.
- B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

## 2.6 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

# PART 3 - EXECUTION

## 3.1 EXAMINATION AND PREPARATION

- A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
- B. Remove loose material from compacted subbase surface immediately before placing concrete.

## 3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

## 3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

### 3.4 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

### 3.5 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.
- B. Comply with **ACI 301 (ACI 301M)** requirements for measuring, mixing, transporting, placing, and consolidating concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed paving surface with a straightedge and strike off.
- E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

### 3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.



1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

### 3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching **0.2 lb/sq. ft. x h (1 kg/sq. m x h)** before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by **[moisture curing] [moisture-retaining-cover curing] [curing compound] [or] [a combination of these]**.

### 3.8 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
  1. Elevation: 1/2 inch.
  2. Thickness: Plus **3/8 inch (10 mm)**, minus **1/4 inch (6 mm)**.
  3. Surface: Gap below **10-foot- (3-m-)** long, unlevelled straightedge not to exceed **1/2 inch (13 mm)**.
  4. Joint Spacing: **3 inches (75 mm)**.
  5. Contraction Joint Depth: Plus **1/4 inch (6 mm)**, no minus.
  6. Joint Width: Plus **1/8 inch (3 mm)**, no minus.

### 3.9 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

## SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Cold-applied joint sealants.
  - 2. Joint-sealant backer materials.
  - 3. Primers.

## 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Paving-Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.

## PART 2 - PRODUCTS

## 2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

## 2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type NS.

## 2.3 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer.

## 2.4 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

## PART 3 - EXECUTION

## 3.1 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Cleaning of Joints: Clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
- C. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer.
- D. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.
- E. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of joint-sealant backings.
  - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
  - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- F. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
  - 1. Place joint sealants so they fully contact joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- G. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
  2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- H. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.
- I. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

END OF SECTION 321373

## SECTION 321400 - UNIT PAVING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
1. Stone pavers set in mortar setting beds.
  2. Steel edge restraints.

## 1.2 ACTION SUBMITTALS

- A. Product Data: For materials other than water and aggregates.
- B. Samples for unit pavers joint materials and edge restraints.

## 1.3 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or build on frozen subgrade or setting beds.
- B. Weather Limitations for Bituminous Setting Bed: Install bituminous setting bed only when ambient temperature is above 40 deg F (4 deg C) and when base is dry.
- C. Weather Limitations for Mortar and Grout:
1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
  2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.

## PART 2 - PRODUCTS

## 2.1 STONE PAVERS

- A. Quartz-Based Stone Pavers: made from quartz-based stone complying with ASTM C 616, Classification I Sandstone II Quartzitic Sandstone.
1. Products: Subject to compliance with requirements, stone varieties that may be incorporated into the Work include, but are not limited to, the following:
    - a. Natural Flagstone.

2. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
3. Finish: As selected by Architect from manufacturer's full range.
4. Thickness: Not less than 1-1/2 inches (38 mm) unless otherwise indicated.
5. Face Size: Varies.

## 2.2 EDGE RESTRAINTS

- A. Steel Edge Restraints: Manufacturer's standard painted steel edging 1/4 inch (6.4 mm) thick by 5 inches (125 mm) high with loops pressed from or welded to face to receive stakes at 36 inches (900 mm) o.c., and steel stakes 15 inches (380 mm) long for each loop.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Border Concepts, Inc.
    - b. Collier Metal Specialties, Inc.
    - c. J. D. Russell Company (The).
    - d. Sure-loc Edging Corporation.
  2. Color: As selected by Architect from manufacturer's full range.

## 2.3 ACCESSORIES

- A. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.
- B. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

## 2.4 MORTAR SETTING-BED MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type II.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Sand: ASTM C 144.
- D. Latex Additive: Manufacturer's standard acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
- E. Water: Potable.

## 2.5 GROUT MATERIALS

- A. Polymer-Modified Tile Grout: ANSI A118.7, sanded.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. [Boiardi Products; a QEP company.](#)
  - b. [Bostik, Inc.](#)
  - c. [C-Cure.](#)
  - d. [Custom Building Products.](#)
  - e. [Jamo Inc.](#)
  - f. [Laticrete International, Inc.](#)
  - g. [MAPEI Corporation.](#)
  - h. [ProSpec.](#)
  - i. [Southern Grouts & Mortars, Inc.](#)
  - j. [Summitville Tiles, Inc.](#)
  - k. [TEC, Specialty Construction Brands, Inc.](#)
- B. Grout Colors: As selected by Architect from manufacturer's full range.
- C. Water: Potable.

## 2.6 MORTAR AND GROUT MIXES

- A. General: Comply with referenced standards and with manufacturers' written instructions. Discard mortars and grout if they have reached their initial set before being used.
- B. Mortar-Bed Bond Coat: Mix neat cement and latex additive water to a creamy consistency.
- C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C 270, Proportion Specification.
- D. Latex-Modified, Portland Cement Setting-Bed Mortar: Comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.
- E. Latex-Modified, Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.
- F. Packaged Grout Mix: Proportion and mix grout ingredients according to grout manufacturer's written instructions.



## PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

- A. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- B. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
- C. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged.
  - 1. Provide joint filler at waterproofing that is turned up on vertical surfaces unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.
- D. Tolerances: Do not exceed **1/16-inch (1.6-mm)** unit-to-unit offset from flush (lippage) nor **1/8 inch in 24 inches (3 mm in 600 mm)** and **1/4 inch in 10 feet (6 mm in 3 m)** from level, or indicated slope, for finished surface of paving.
- E. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."
- F. Expansion and Control Joints: Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
- G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

## 3.2 MORTAR SETTING-BED APPLICATIONS

- A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed **1/16-inch (1.6-mm)** thickness for bond coat.
- C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
- E. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform ~~1/16-inch-~~ (1.5-mm-) thick bond coat to mortar bed or to back of each paver with a flat trowel.
- F. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
- G. Spaced Joint Widths: Provide ~~3/4-inch~~ (19-mm) nominal joint width with variations not exceeding plus or minus ~~3/16 inch~~ (4.5 mm).
- H. Grouted Joints: Grout paver joints complying with ANSI A108.10.
- I. Grout joints as soon as possible after initial set of setting bed.
  - 1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
  - 2. Tool exposed joints slightly concave when thumbprint hard.
- J. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.
- K. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
  - 1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.

END OF SECTION 321400

## SECTION 321816.13 - PLAYGROUND PROTECTIVE SURFACING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Organic loose-fill surface.

## 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each playground surface system, include materials, plans, cross sections, drainage, installation, penetration details, and edge termination.
- C. Samples: For each exposed product and for each color and texture specified.

## 1.3 INFORMATIONAL SUBMITTALS

- A. Material certificates.
- B. Material test reports.
- C. Product certificates.
- D. Product test reports.
- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.

## 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Standards and Guidelines: Comply with CPSC No. 325, "Handbook for Public Playground Safety"; ASTM F 1292; and ASTM F 1487.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of playground surface system that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

## 2.1 ORGANIC LOOSE-FILL SURFACE - mulch

- A. Double-Shredded Hardwood Mulch or Double Shredded Bark Mulch: Random-sized, shredded twice. No pieces shall be larger than 2" long, rounded edges, containing no bark, leaves, twigs, or foreign or toxic materials according to ASTM F 2075; graded according to manufacturer's standard specification for material consistency for playground surfaces and for accessibility according to ASTM F 1951.
  - 1. Uncompressed Material Depth: Not less than **12 inches (300 mm)**.
- B. Engineered Wood Fibers: Random-sized wood fibers, in manufacturer's standard fiber size, containing no bark, leaves, twigs, or foreign or toxic materials according to

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

ASTM F 2075; graded according to manufacturer's standard specification for material consistency for playground surfaces and for accessibility according to ASTM F 1951.

1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. [Fibar Group LLC \(The\); Fibar System](#)
  - b. [GameTime, a PlayCore, Inc. company; GT Impax Fiber.](#)
  - c. [New England Bark Mulch & Playground Surfacing, Division of Supreme Forest Products, Inc.; Playground Safety Fiber.](#)
  - d. [SofSolutions Inc.; SofFall.](#)
  - e. [Zeager Bros., Inc.; Wood Carpet.](#)
2. Uncompressed Material Depth: Not less than **12 inches (300 mm)**.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Hard-Surface Substrates: Verify that substrates are satisfactory for unitary playground surface system installation and that substrate surfaces are dry, cured, and uniformly sloped to drain within recommended tolerances according to playground surface system manufacturer's written requirements for cross-section profile.
  1. Repair unsatisfactory surfaces and fill holes and depressions.
  2. Mechanically scarify or otherwise prepare concrete substrates to achieve recommended degree of roughness.
  3. Saw cut concrete for terminal edges of playground surface systems as indicated.
  4. Treat control joints and other nonmoving substrate cracks to prevent telegraphing through playground surface system.
- B. Comply with playground surface system manufacturer's written installation instructions. Install playground surface system over area and in thickness indicated.
- C. Loose-Fill Edgings: Place as indicated, and permanently secure in place and attach to each other according to edging manufacturer's written instructions.
- D. Loose Fill: Place playground surface system materials including manufacturer's standard amount of excess material for compacting naturally with time to required depths after Installation of playground equipment support posts and foundations.
- E. Compacting and Grading: Uniformly compact and grade loose fill according to manufacturer's written instructions to an even surface free from irregular surface changes as indicated. Hand rake to a smooth finished surface and to required elevations.

## 3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of completed applications of playground surface system shall take place according to ASTM F 1292.
- C. Remove and replace applications of playground surface system where test results indicate that it does not comply with requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with requirements.

END OF SECTION 321816.13

## SECTION 323113 - CHAIN LINK FENCES AND GATES

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes chain-link fences and swing gates.

## 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to [ASCE/SEI 7] <Insert requirement>:
  - 1. Minimum Post Size: Determine according to ASTM F 1043 for framework up to 17 feet high, and post spacing not to exceed 6 feet.
  - 2. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified and on the following:
    - a. Wind Loads: <Insert loads>.
    - b. Exposure Category: [B] [C] [D].
    - c. Fence Height: 17 feet.
    - d. Material Group: [IA, ASTM F 1043, Schedule 40 steel pipe] [IC, electric-resistance-welded round steel pipe] <Insert group>.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each polymer-coated product and for each color and texture specified, in 6-inch (150-mm) lengths for components and on full-sized units for accessories.
- D. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of chain-link fence and gate, from manufacturer.

- B. Product Test Reports: For framing strength according to ASTM F 1043.
- C. Sample of special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 2. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle. Comply with CLFMI Product Manual and with requirements indicated below:
  - 1. Fabric Height: As indicated on Drawings.
  - 2. Steel Wire Fabric: 6 gauge.
    - a. Mesh Size: 2 inches (50 mm).
    - b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. (366 g/sq. m) after weaving.
      - 1) Color: Painted black.
  - 3. Selvage: Knuckled at both selvages.

#### 2.2 FENCE FRAMING

- A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:
  - 1. Fence Height: As indicated on Drawings.
  - 2. Heavy Industrial Strength: Material Group IA, round steel pipe, Schedule 40.
    - a. Line Post: See Plans.

- b. End, Corner and Pull Post: See Plans.
- 3. Horizontal Framework Members: Intermediate, top and bottom rails complying with ASTM F 1043.
- 4. Brace Rails: Comply with ASTM F 1043.
- 5. Metallic Coating for Steel Framing:
  - a. Type A zinc coating.
- 6. Polymer coating over metallic coating.
  - a. Color: Painted black.

### 2.3 TENSION WIRE

- A. Metallic-Coated Steel Wire: **0.177-inch- (4.5-mm-)** diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:
  - 1. Type II, zinc coated with minimum coating weight matching chain-link fabric coating weight.

### 2.4 SWING GATES

- A. General: Comply with ASTM F 900 for gate posts and single swing gate types.
  - 1. Gate Leaf Width: 36 inches (914 mm).
  - 2. Gate Fabric Height: As indicated.
- B. Pipe and Tubing:
  - 1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
  - 2. Gate Posts: Round tubular steel.
  - 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded.
- D. Hardware:
  - 1. Hinges: 360-degree inward and outward swing.
  - 2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
  - 3. Lock: Provide for padlock.
  - 4. Closer: None.

### 2.5 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g /sq. m) zinc.
  - a. Polymer coating over metallic coating.
2. Aluminum: Mill finish.

## 2.6 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
  1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
- D. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.
- E. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- F. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
  1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- a. Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.
  - b. Concealed Concrete: Top 2 inches (50 mm) below grade as indicated on Drawings to allow covering with surface material.
  - c. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
- G. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
- H. Line Posts: See drawings.
- I. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Provide horizontal tension wire at the following locations:
1. As indicated.
- J. Chain-Link Fabric: Apply fabric to beam of enclosing framework. Take below grade as indicated.
- K. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.
- L. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

END OF SECTION 323113

## SECTION 323223 - SEGMENTAL RETAINING WALLS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes single- and multiple- depth segmental retaining walls with soil reinforcement.
- B. Related Sections:
  - 1. Section 312000 "Earth Moving" for excavation for segmental retaining walls.

## 1.2 PERFORMANCE REQUIREMENTS

- A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Performance: Engineering design shall be based on loads due to soil pressures resulting from grades indicated and be according to NCMA's "Design Manual for Segmental Retaining Walls."
- D. Seismic Performance: Engineering design shall be based on loads and factors due to soil pressures resulting from grades indicated and be according to [NCMA's "**Segmental Retaining Walls - Seismic Design Manual.**"] <Insert applicable requirement.>
  - 1. Horizontal Peak Ground Acceleration (A) for Project: <Insert value>.

## 1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:
  - 1. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.
  - 2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each color and texture of concrete unit required.
- C. Delegated-Design Submittal: For segmental retaining walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and field quality-control reports for compliance of materials and construction with design.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Materials Submittals: The Contractor shall submit manufacturers' certifications two weeks prior to start of work stating that the SRW units and geosynthetic reinforcement meet the requirements of Section 2 of this specification.
- B. Design Submittal: The Contractor shall submit two sets of detailed design calculations and final retaining wall plans for approval at least two weeks prior to the beginning of wall construction. All calculations and drawings shall be prepared and sealed by a professional Civil Engineer (P.E.) – (Wall Design Engineer) experienced in SRW design and licensed in the state where the wall is to be built.
- C. Preconstruction test reports.
- D. Field quality-control reports.

## PART 2 - PRODUCTS

## 2.1 SEGMENTAL RETAINING WALL UNITS

- A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus **1/16 inch (1.6 mm)** from specified dimension.
  - 1. Provide units that comply with requirements for freeze-thaw durability.
  - 2. Provide units that interlock with courses above and below by means of integral lugs or lips, pins or clips.
- B. Color: As selected by Architect from manufacturer's full range.
- C. Shape and Texture: Provide units of basic shape and dimensions indicated with smooth exposed faces.
- D. Shape and Texture: Provide units matching basic shape, dimensions, and face texture indicated by referencing manufacturer's pattern designation.

## 2.2 INSTALLATION MATERIALS

- A. Pins and Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.
- B. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.
- C. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for base material.
- D. Drainage Fill: Comply with requirements in Section 334600 "Subdrainage."
- E. Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.
- F. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.
  - 1. Apparent Opening Size: **No. 70 to 100 (0.212- to 0.150-mm)** sieve, maximum; ASTM D 4751.
  - 2. Minimum Grab Tensile Strength: **110 lb (49.9 kg)**; ASTM D 4632.
- G. Subdrainage Pipe and Filter Fabric: Comply with requirements in Section 334600 "Subdrainage."
- H. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement and as follows:
  - 1. Geosynthetic reinforcement shall consist of high-tenacity PET geogrids, HDPE geogrids, or geotextiles manufactured for soil reinforcement applications. The type, strength and placement of the geosynthetic reinforcement shall be determined by procedures outlined in this specification and the NCMA Design Manual for Segmental Retaining Walls (3<sup>rd</sup> Edition 2009) and materials shall be specified by Wall Design Engineer in their final wall plans and specifications. The manufacturers / suppliers of the geosynthetic reinforcement shall have demonstrated construction of similar size and types of segmental retaining walls on previous projects. The geosynthetic type must be approved one week prior to bid opening.

## PART 3 - EXECUTION

### 3.1 RETAINING WALL INSTALLATION

- A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.
  - 1. Lay units in running bond.
  - 2. Form corners and ends by **[using special units] [cutting units with motor-driven saw] [or] [splitting units with mason's hammer and chisel]**.

- B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.
- C. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.
  - 1. Tamp units into leveling base as necessary to bring tops of units into a level plane.
- D. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.
- E. Cap Units: Place cap units and secure with cap adhesive.

### 3.2 FILL PLACEMENT

- A. General: Comply with requirements in Section 312000 "Earth Moving," NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.
- B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.
- C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment.
  - 1. Use only hand-operated compaction equipment within **48 inches (1200 mm)** of wall, or one-half of height above bottom of wall, whichever is greater.
  - 2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.
    - a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.
  - 3. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."
  - 4. Place drainage geotextile against back of wall and place layer of drainage fill at least 12 inches (300 mm) wide behind drainage geotextile to within **12 inches (300 mm)** of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.
- D. Place a layer of drainage fill at least 12 inches (300 mm) wide behind wall to within **12 inches (300 mm)** of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.
- E. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.
- F. Place impervious fill over top edge of drainage fill layer.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- G. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of **8 inches (200 mm)** into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.
1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
  2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
  3. Do not dump fill material directly from trucks onto geosynthetics.
  4. Place at least **6 inches (150 mm)** of fill over reinforcement before compacting with tracked vehicles or **4 inches (100 mm)** before compacting with rubber-tired vehicles.
  5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

## 3.3 DESIGN

- A. The design analysis for the final, P.E. – stamped retained wall plans prepared by the Wall Design Engineer shall consider the external stability against sliding and overturning, internal stability and facial stability of the reinforced soil mass, and shall be in accordance with acceptable engineering practice and these specifications. The internal and external stability analysis shall be performed in accordance with the “NCMA Design Manual for Segmental Retaining Walls, 3<sup>rd</sup> Edition” using the recommended minimum factors of safety in this manual.
- B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.

END OF SECTION 323223

## SECTION 329113 - SOIL PREPARATION

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes planting soils specified by composition of the mixes.
- B. Related Requirements:
  - 1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.

## 1.2 DEFINITIONS

- A. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- B. Imported Soil: Soil that is transported to Project site for use.
- C. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- F. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- G. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- H. USCC: U.S. Composting Council.

## 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

## 1.4 ACTION SUBMITTALS

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

- B. Samples: For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

### PART 2 - PRODUCTS

#### 2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

- A. Planting-Soil Type “Native Soil”: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
  - 1. Ratio of Loose Compost to Soil: 1:3 by volume.
  - 2. Ratio of Loose Sphagnum Peat to Soil: 1:3 by volume.
- B. Planting-Soil Type: Imported, naturally formed soil from off-site sources and consisting of loamy sand according to USDA textures; and modified to produce viable planting soil.
  - 1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least **4 inches (100 mm)** deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
  - 2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 4 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
  - 3. Unacceptable Properties: Clean soil of the following:
    - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.



- c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches (50 mm) in any dimension.
4. Amended Soil Composition: Blend imported, unamended soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
  - a. Ratio of Loose Compost to Soil: 1:3 by volume.
  - b. Ratio of Loose Sphagnum Peat to Soil: 1:3 by volume.

## 2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
  1. Class: T, with a minimum of 99 percent passing through a No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through a No. 60 (0.25-mm) sieve.
  2. Class: O, with a minimum of 95 percent passing through a No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through a No. 60 (0.25-mm) sieve.
  3. Form: Provide lime in form of ground dolomitic limestone.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Perlite: Horticultural perlite, soil amendment grade.
- E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 (0.30-mm) sieve.
- F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

## 2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
  1. Feedstock: Limited to leaves.
  2. Reaction: pH of 5.5 to 8.
  3. Soluble-Salt Concentration: Less than 4 dS/m.
  4. Moisture Content: 35 to 55 percent by weight.
  5. Organic-Matter Content: 30 to 40 percent of dry weight.
  6. Particle Size: Minimum of 98 percent passing through a 4-inch (100-mm) sieve.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch (13-mm) sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.
- C. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
- D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

## 2.4 FERTILIZERS

- A. Commercial Fertilizer: Milorganite complete fertilizer of neutral character, consisting of fast-nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, potassium in the following composition:

## PART 3 - EXECUTION

## 3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

## 3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches (150 mm) and stockpile until amended.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
- D. Screening: Pass unamended soil through a 2-inch (50-mm) sieve to remove large materials.

## 3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Spread unamended soil to total depth of 6 inches (150 mm), but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
    - a. Mix fertilizer with planting soil no more than seven days before planting.
  - 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 12 inches (300 mm) in loose depth for material compacted by compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 85 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is indicated on Drawings.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

## 3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of **6 inches (150 mm)**. Remove stones larger than **1-1/2 inches (38 mm)** in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Application: Spread planting soil to total depth of **6 inches (150 mm)**, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Lifts: Apply planting soil in lifts not exceeding **8 inches (200 mm)** in loose depth for material compacted by compaction equipment, and not more than **4 inches (100 mm)** in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

## 3.5 BLENDING PLANTING SOIL IN PLACE

- A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of **6 inches (150 mm)**. Remove stones larger than **1-1/2 inches (38 mm)** in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Apply soil amendments, and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
  - 1. Mix fertilizer with planting soil no more than seven days before planting.
- D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

## 3.6 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

- A. Application: Apply compost component of planting-soil mix; **4 inches (100 mm)** of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

## 3.7 PROTECTION AND CLEANING

- A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle traffic.
  - 4. Foot traffic.
  - 5. Erection of sheds or structures.
  - 6. Impoundment of water.
  - 7. Excavation or other digging unless otherwise indicated.
- C. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

## SECTION 329200 - TURF AND GRASSES

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Seeding.
2. Sodding.

## 1.2 DEFINITIONS

- A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.

## 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Certification of grass seed.
  1. Certification of each seed mixture for turfgrass sod.
- B. Product certificates.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
  1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  2. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
    - a. Landscape Industry Certified Technician - Exterior.

- b. Landscape Industry Certified Lawncare Manager.
  - c. Landscape Industry Certified Lawncare Technician.
3. Pesticide Applicator: State licensed, commercial.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

### PART 2 - PRODUCTS

#### 2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
  - 1. Quality: State-certified seed of grass species as listed below for solar exposure.
  - 2. Quality: Seed of grass species as listed below for solar exposure, with not less than **[85]** **<Insert number>** percent germination, not less than **[95]** **<Insert number>** percent pure seed, and not more than **[0.5]** **<Insert number>** percent weed seed: See Plans.

#### 2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows: See Plans.

#### 2.3 FERTILIZERS

- A. Commercial Fertilizer: Milorganite.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 2.4 MULCHES

- A. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.
- B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

## 2.5 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

## PART 3 - EXECUTION

## 3.1 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

## 3.2 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).
  - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 2 lb/1000 sq. ft. (0.9 kg/92.9 sq. m).
- C. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- D. Protect seeded areas with slopes not exceeding 1:6 by spreading mulch. Spread uniformly at a minimum rate of 2 tons/acre (42 kg/92.9 sq. m) to form a continuous blanket 1-1/2 inches (38 mm) in loose thickness over seeded areas.
  - 1. Anchor mulch by crimping into soil with suitable mechanical equipment.
- E. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch, peat mulch or planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch (4.8 mm), and roll surface smooth.

## 3.3 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  - 1. Lay sod across slopes exceeding 1:3.
  - 2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week and until rooted, after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

## 3.4 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
- B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings.

## 3.5 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
  - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

END OF SECTION 329200

## SECTION 329300 - PLANTS

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Plants.
2. Tree-watering devices.
3. Landscape edgings.

## B. Related Requirements:

1. Section 329600 "Transplanting" for transplanting non-nursery-grown trees.

## 1.2 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- C. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation for drawing designations for planting soils.
- D. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

## 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples of each type of mulch.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Sample warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

## 1.7 QUALITY ASSURANCE

- A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 1. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- B. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- C. Handle planting stock by root ball.
- D. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.
- E. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

## 1.9 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:
  - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
  - b. Structural failures including plantings falling or blowing over.
2. Warranty Periods: From date of Substantial Completion.
  - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
  - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
  - c. Annuals: Three months.

## PART 2 - PRODUCTS

### 2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- C. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

### 2.2 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
  1. Size: 5-gram tablets.
  2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

### 2.3 MULCHES

- A. Organic Mulch: Shredded hardwood, Ground or shredded bark, Wood and bark chips or Pine straw.
- B. Mineral Mulch: Rounded riverbed gravel or smooth-faced stone.

1. Size Range: 3/4 inch (19 mm) maximum, 1/4 inch (6.4 mm) minimum.
2. Color: Readily available natural gravel color range.

#### 2.4 WEED-CONTROL BARRIERS

- A. Do not install in mulch beds.

#### 2.5 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

#### 2.6 LANDSCAPE EDGINGS

- A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
  1. Edging Size: See Plans.
  2. Finish: Manufacturer's standard paint.

#### 2.7 TREE-WATERING DEVICES

- A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

### PART 3 - EXECUTION

#### 3.1 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Blend planting soil in place.
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

#### 3.2 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
  2. Excavate approximately three times as wide as ball diameter.
  3. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
  4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

### 3.3 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Set each plant plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.
1. Backfill: Planting soil For trees, use excavated soil for backfill.
  2. Balled and Burlapped Stock: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from root balls completely. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  3. Balled and Potted and Container-Grown Stock: Carefully remove root ball from container without damaging root ball or plant.
  4. Fabric Bag-Grown Stock: Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  5. Bare-Root Stock: Support stem of each plant and spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working. Carefully work backfill around roots by hand. Bring roots into close contact with the soil.
  6. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  7. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

## 3.4 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. Do not apply pruning paint to wounds.

## 3.5 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

## 3.6 PLANTING AREA MULCHING

- A. Do not install weed-control barriers.
- B. Mulch backfilled surfaces of planting areas and other areas indicated.
  - 1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch (75-mm) average thickness, with 24-inch (600-mm) radius around trunks or stems. Do not place mulch within 3 inches (75 mm) of trunks or stems.
  - 2. Organic Mulch in Planting Areas: Apply 3-inch (75-mm) average thickness of organic mulch extending 12 inches (300 mm) beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) of trunks or stems.

## 3.7 EDGING INSTALLATION

- A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches (760 mm) apart, driven below top elevation of edging.



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- B. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4- to 6-inch- (100- to 150-mm-) deep, shovel-cut edge as indicated on Drawings. Shown in Detail A, Sheet LS2.1.

## 3.8 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- D. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- E. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

## 3.9 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
  - 1. Maintenance Period for Trees and Shrubs: Six months from date of Substantial Completion.
  - 2. Maintenance Period for Ground Cover and Other Plants: Six months from date of Substantial Completion.

END OF SECTION 329300

## SECTION 331000 - WATER UTILITIES

## PART 1 GENERAL

## 1.1 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern the work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- B. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American National Standards Institute (ANSI) and American Water Works Association (AWWA), Specifications and Standards:
  - a. ANSI/AWWA C104/A21.4 - American Water Works Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings, Current Edition.
  - b. ANSI/AWWA C105/A21.5 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems, Current Edition.
  - c. ANSI/AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings for Water, Current Edition.
  - d. ANSI/AWWA C111/A21.11 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings, Current Edition.
  - e. ANSI/AWWA C151/A21.51 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, Current Edition.
  - f. ANSI/AWWA C153/A21.53 - American National Standard for Ductile-Iron Compact Fittings for Water Service, Current Edition.
  - g. ANSI/AWWA C500 - American Water Works Association/American National Standard for Metal-Seated Gate Valves for Water Supply Service, Current Edition.
  - h. ANSI/AWWA C502- American Water Works Association Standard for Dry-Barrel Fire Hydrants, Current Edition.
  - i. ANSI/AWWA C504 - American Water Works Association Standards for Rubber-Seated Butterfly Valves, Current Edition
  - j. ANSI/AWWA C509- American Water Works Association Standard for Resilient-Seated Gate Valves for Water Supply Service, Current Edition.
  - k. ANSI/AWWA C515 - American Water Works Association Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service, Current Edition.
  - l. ANSI/AWWA C600 - American Water Works Association Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances, Current Edition.
  - m. ANSI/AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water, Current Edition.
  - n. ANSI/AWWA C651 - American Water Works Association Standard for Disinfecting Water Mains, Current Edition.
  - o. ANSI/AWWA C800 - American Water Works Association Standard for Underground Service Line Valves and Fittings, Current Edition.
  - p. ANSI/AWWA C900 - American Water Works Association Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-inch through 12-inch, for Water Transmission and Distribution, Current Edition.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- q. ANSI/AWWA C901 – American Water Works Association Standard for Polyethylene (PE) Pressure Pipe and Tubing, ½-inch through 3 inches for Water Service, Current Edition.
- r. ANSI/AWWA C906 – American Water Works Association Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution and Transmission, Current Edition.
- 2. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards:
  - a. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, Current Edition.
  - b. ASTM A865/A865M - Specification for Threaded Couplings, Steel, Black and Zinc-Coated (Galvanized) Welded and Seamless, for Use in Steel Pipe Joints, Current Edition.
  - c. ASTM C12 – Standard Practice for Installing Vitrified Clay Pipe Lines, Current Edition.
  - d. ASTM C578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation, Current Edition.
  - e. ASTM D1598 – Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure, Current Edition.
  - f. ASTM D1599 – Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings, Current Edition.
  - g. ASTM D1785 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120, Current Edition.
  - h. ASTM D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter, Current Edition.
  - i. ASTM D2241 – Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series), Current Edition.
  - j. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications, Current Edition.
  - k. ASTM D2464 – Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80, Current Edition.
  - l. ASTM D2466 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40, Current Edition.
  - m. ASTM D2467 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80, Current Edition.
  - n. ASTM D2513 – Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings, Current Edition.
  - o. ASTM D2737 – Standard Specification for Polyethylene (PE) Plastic Tubing
  - p. ASTM D2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
  - q. ASTM D2855 – Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings, Current Edition.
  - r. ASTM D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter, Current Edition.
  - s. ASTM D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals, Current Edition.
  - t. ASTM D3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing, Current Edition.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- u. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Material, Current Edition.
  - v. ASTM F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, Current Edition.
  - w. ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing, Current Edition.
3. Factory Mutual Research (FM), Specification and Standards, Current Edition.
  4. National Fire Protection Agency (NFPA 24).
  5. Underwriters Laboratories, Inc. (UL) Specifications and Standards, Current Edition.

## 1.3 DESCRIPTION OF WORK

- A. The work under this section shall cover furnishing all materials, equipment, labor and supervision required for water main as shown on the contract drawings and as specified herein.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Submittals - Division 01
- C. Geosynthetics for Earthwork - Division 31
- D. Trenching and Backfilling - Division 31
- E. Erosion and Sedimentation Controls - Division 31
- F. Tracer Wire – Division 33

## 1.5 SUBMITTALS

- A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specifications. Information shall be in conformance with requirements of Submittals - Division 01 of these specifications.
- B. Contractor shall submit such submittals and details required for the construction and installation of the materials. Submittals and details shall indicate the intended materials arrangement, dimensions, major support requirements, plot area and intricate or detailed construction requirements.

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

## PART 2 PRODUCTS AND MATERIALS

## 2.1 PIPE

- A. All water main 4 inches in diameter or larger shall meet the following minimum requirements:
1. Ductile Iron Pipe. Shall meet the requirements of ANSI/AWWA C151/A21.51, Class 52. Standard cement-mortar lining shall meet the requirements of ANSI/AWWA C104/A21.4.
  2. Polyvinyl Chloride Pipe. Shall meet the requirements of ANSI/AWWA C900-07, Pressure Class (PC) 235, minimum; or ASTM D2241, Pressure Rating (PR) 250, minimum; and a DR 18 or less.
  3. High Density Polyethylene Pipe (HDPE). Polyethylene pipe shall meet or exceed the requirements of ANSI/AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4 inch through 63 inch for Water Distribution and Transmission. Pipe furnished shall be approved for potable water and marked to indicate so with a continuous blue stripe. Pipe shall be either PE3408, HDPE Class 160, DR11 or PE4710, HDPE Class 160, DR13.5. Pipe shall have outside diameters similar to ANSI/AWWA C151/A21.51 ductile iron pipe. Ends shall be plain for butt fuse joining.
- B. All water main less than 4 inches in diameter shall meet the following minimum requirements:
1. Galvanized steel pipe and joints shall meet the requirements of ASTM A53.
  2. Copper pipe shall be Type K copper tubing and shall conform to ANSI/AWWA C800.
  3. High Density Polyethylene Pipe (HDPE) shall meet the requirements of ASTM D2239 or D3035 and shall have a minimum working pressure of 160 psi.

## 2.2 FITTINGS

- C. All fittings for water main 4 inches in diameter or larger shall meet the following minimum requirements:
1. Ductile Iron Pipe. Full body fittings shall conform to ANSI/AWWA C110/ A21.10 and ANSI/AWWA C111/A21.11 with bituminous coating. Compact fittings shall conform to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11 with bituminous coating. All fittings shall be provided with cement mortar lining conforming to ANSI/AWWA C104/A21.4. Only ductile iron fittings manufactured in North America shall be allowed.
  2. Polyvinyl Chloride Pipe. Full body fittings shall conform to ANSI/AWWA C110/ A21.10 and ANSI/AWWA C111/A21.11 with bituminous coating. Compact fittings shall conform to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11 with bituminous coating. All fittings shall be provided with cement mortar lining conforming to ANSI/AWWA C104/A21.4. Only ductile iron fittings manufactured in North America shall be allowed.

3. High Density Polyethylene (HDPE). All fittings shall be molded polyethylene fused-type, PE3408, HDPE Class 160, DR11 or PE4710, HDPE Class 160, DR 13.5, and have outside diameters similar to ANSI/AWWA C151/A21.51 ductile iron pipe. Ends shall be plain for butt fuse joining.
- D. All fittings for water main less than 4 inches in diameter shall meet the following minimum requirements:
1. Steel Pipe. Fittings shall meet the requirements of ANSI B16.5 or ANSI B16.9 or ANSI B16.11 or ANSI B16.28.
  2. High Density Polyethylene Pipe (HDPE). All fittings shall be molded polyethylene fused-type, PE3408, HDPE Class 160, DR11 or PE4710, HDPE Class 160, DR 13.5, and have outside diameters similar to ANSI/AWWA C151/A21.51 ductile iron pipe. Ends shall be plain for butt fuse joining.

## 2.3 JOINTS

- A. All joints for water main 4 inches in diameter or larger shall meet the following minimum requirements:
1. Ductile Iron Pipe. Joints shall be either push-on or mechanical joint conforming to ANSI/AWWA C111/A21.11 unless specified otherwise. All joints, fittings, etc., shall be equipped to provide electric continuity. The continuity must be provided through the use of a trademarked, well-established method acceptable to the Engineer.
  2. Polyvinyl Chloride Pipe. Joints shall be push-on type employing rubber gaskets and conform with ASTM D3139.
  3. High Density Polyethylene (HDPE). Joints shall be butt fusion meeting the requirements of ASTM D3261. Electrofusion meeting the requirements of ASTM F1055 shall be used where necessary for pipe coupling or where approved by the engineer.
- B. All joints for water main less than 4 inches in diameter shall meet the following minimum requirements:
1. Steel Pipe. Joints shall meet the requirements of ASTM A865.
  2. High Density Polyethylene (HDPE). Joints shall be butt fusion meeting the requirements of ASTM D3261. Electrofusion meeting the requirements of ASTM F1055 shall be used where necessary for pipe coupling or where approved by the engineer.
- C. All joints for water main requiring joint restraint shall meet the following minimum requirements:
1. Mechanical Joints. Mechanical joints shall be installed with wedge action restraining glands, Mega-Lug by EBAA Iron Sales, Inc. or equal.
  2. Push-on Joints. Restrained push-on joints for straight pipe shall be as manufactured by the Pipe Manufacturer. Gaskets shall meet the material requirements of ANSI/AWWA C111/A21.11. Restrained joint retainer rings shall be manufactured of ductile iron compatible with pipe.
  3. All restrained joints shall have a pressure rating equal to that of the pipe.

## 2.4 VALVES

- A. All valves for water main 4 inches thru 12 inches in diameter shall meet the following minimum requirements:

1. Valves shall be resilient-seated gate valves, mechanical joint conforming to ANSI/AWWA C509 or ANSI/AWWA C515 unless specified otherwise.
- B. All valves for water main less than 4 inches in diameter shall meet the following minimum requirements:
  1. Mueller Mark II Oriseal or approved equal.
- C. All valves for water main larger than 12 inches in diameter shall meet the following minimum requirements:
  1. Valves shall be rubber-seated butterfly valves, mechanical joint conforming to ANSI/AWWA C504 unless specified otherwise.
- D. Valves shall be installed with the following accessories:
  1. Valve Box. Valve box shall consist of a top section, bottom section, base, drop lid, and necessary extensions and all shall be cast iron. Lid shall have the word "WATER" cast on the lid.
  2. Valve Box Adaptor. All 4 inch or larger valves shall be installed with a Valve Box Adaptor as manufactured by Adaptor Inc., or equal.
  3. Valve boxes for valves 2 inch and smaller shall be Mueller, Minneapolis pattern, 6 foot 6 inch bury, 1-1/4 inch upper, pentagon nut opening with stationary rod.

## 2.5 HYDRANTS

- A. Hydrants shall be a Waterous Pacer, Model WB67 meeting the following requirements unless noted otherwise in Special Procedures - Division 01.
- B. All hydrants for water main shall meet the following minimum requirements:
  1. Hydrants shall be dry barrel fire hydrant, dry top design, conforming to ANSI/AWWA C502 with mechanical joint base connection.
  2. Hydrants shall be manufacturer's premium model, Underwriters Laboratories, Inc. (UL) and Factory Mutual Research (FM) listed fire hydrant.
  3. Hydrants shall be traffic design with protective groundline coupling (traffic flange) which assures reliable fracture at traffic impact. This coupling shall also allow hydrant rotation to any position after hydrant installation.
  4. Hydrant to be furnished as standard 3-way style with two 2-1/2 inch and one 4-1/2 inch standard hose nozzles (chains on nozzle caps are required). Hydrants shall have 5-1/4 inch main valve openings.
  5. Hydrant operating nut shall be a standard two-piece pentagon (5 sided). Operating assembly shall include, as a minimum, thrust washer, revolving nut with seal for dry top design, and lifetime lubrication.
  6. Hydrant base shall contain a barrel drain operated by hydrant activator.
  7. All hydrants shall be connected to the main with a 6-inch diameter (minimum) water main pipe conforming to the requirements of this section.
  8. Upper barrel section shall be a minimum 16 inches.
  9. National standard thread, operating nut will be a standard 1-1/2 inch pentagon, CCW open
  10. Mechanical joint connections.
  11. Painted red.
  12. Maintain electrical continuity.

13. Resilient wedge main seat.
14. Bronze to bronze fittings.
15. Tapped drainport opening with plug.

- C. Hydrants shall be furnished having 7 feet bury or as shown on the contract drawings or as defined in Special Procedures - Division 01.

## 2.6 WATER SERVICES

- A. All water service lines shall be 1 inch unless shown otherwise on the contract drawings or as specified in Special Procedures – Division 01. All service lines for water main shall meet the following minimum requirements:

1. Copper.
  - a. Service lines shall be Type K copper tubing and shall conform to ANSI/AWWA C800.
2. High Density Polyethylene (HDPE).
  - a. Service lines shall be polyethylene CTS (copper tube size) meeting the requirements of ASTM D2737 and AWWA C901. Line shall be rated for use with water at 73.4°F, have a pressure class of 250 psi, and be NSF/ANSI 61 and NSF/ANSI 14 approved. Service line tubing shall be DriscoPlex 5100 Ultraline (SDR 9) or approved equal.

- B. All corporations for water services shall meet the following minimum requirements:

1. Ductile iron water mains
  - a. Corporation stops shall conform to ANSI/AWWA C800 for copper service lines.
  - b. Corporations larger than 1 inch shall be furnished and installed with service saddles.
  - c. Service saddles shall be rated for 250 psi, have a coated ductile iron body, 304 stainless steel strap and nitrile O-ring gasket. Service saddles shall meet all applicable parts of ANSI/AWWA C800.
  - d. Corporation stops shall be Mueller Ground Key Conductive Compression or as specified in Special Procedures - Division 01.
2. PVC water mains
  - a. Service line connection to PVC pipe shall be made using a saddle type connection. A simple threaded connection shall not be acceptable.
  - b. Service saddles shall be rated for 250 psi, have a coated ductile iron body, 304 stainless steel strap and nitrile O-ring gasket. Tapping saddles shall meet all applicable parts of ANSI/AWWA C800.
  - c. Corporation stops shall be Mueller Ground Key Conductive Compression or as specified in the Special Procedures – Division 01. Stainless steel stiffeners are required for compression fitting connections.
3. High Density Polyethylene (HDPE) water mains
  - a. Tapping tees with electrofusion saddles shall be used for HDPE water mains.
    - 1) Tapping tees shall meet ASTM F1055.
    - 2) HDPE service pipe shall be butt fused to the tapping tee.
    - 3) Electrofusion saddles shall be manufactured by Central Plastics Company.
  - b. Service saddles
    - 1) Service saddles shall be rated for 250 psi, have a coated ductile iron body, 304 stainless steel strap, nitrile O-ring gasket, and spring washers



- specifically designed for use on HDPE pipe. Service saddles shall meet all applicable parts of ANSI/AWWA C800.
- 2) Service saddles shall be manufactured by Smith-Blair for use on HDPE pipe.
- c. Corporation stops shall be Mueller Ground Key Conductive Compression or as specified in the Special Procedures – Division 01. Stainless steel stiffeners are required for compression fitting connections.
- C. All curb stops for water services shall meet the following minimum requirements:
1. Copper water services
    - a. Curb stops shall be designed for use with copper service lines and shall conform to ANSI/AWWA C800.
    - b. Curb stops shall be Mueller Mark II Oriseal with conductive compression fittings or as specified in Special Procedures - Division 01.
  2. High Density Polyethylene (HDPE) water services
    - a. Curb stops shall be Mueller Mark II Oriseal with threaded connections or as specified in Special Procedures - Division 01.
    - b. Threaded stainless steel by HPDE transition fittings shall be supplied for each curb stop. Transition fittings shall be butt fused to the service pipe. Transition fittings shall be manufactured by Central Plastics.
- D. All curb boxes for water services shall be Mueller, Minneapolis pattern, 6 foot 6 inch bury, 1-1/4 inch upper, pentagon nut opening with stationary rod or as specified in Special Procedures - Division 01.

## 2.7 HDPE BY MECHANICAL JOINT ADAPTERS

- A. The HDPE by MJ Adapters shall be manufactured by Central Plastics Company or equal. The adapter shall comply with ANSI/AWWA C906 and be manufactured for use on pipe conforming ASTM D2513, D3035, F714. The adapter shall be molded from a PPI and NSF listed pre-blended virgin resin in accordance with the material specifications listed in ASTM D3350 with a cell classification of 345464C and be compatible for heat fusion with any pipe manufactured from a like or similar resin.
1. Adapters shall be tested according to ASTM D1599 and ASTM D1598.
  2. HDPE Adapters shall be sized for use with ductile iron pipe size HDPE pipe.
  3. Adapters shall be used for all transitions from HDPE to valves or ductile iron pipe.
  4. HDPE by MJ Adapters for pipe 12 inch or greater must be designed for use with butterfly valves. Submittals shall specifically indicate this feature.
  5. Adapters must provide thrust restraint.

## 2.8 POLYETHYLENE ENCASEMENT

- A. Polyethylene encasement shall be polyethylene film tube conforming to ANSI/AWWA C105/A21.5. Polyethylene film sheet conforming to ANSI/AWWA C105/A21.5 may be used at odd-shaped appurtenances where the use of tube is not practical.
- B. The polyethylene film shall be clearly marked with the information required in ANSI/AWWA C105/A21.5.

## 2.9 INSULATION

- A. Insulation shall be extruded polystyrene insulation (25 psi) conforming to ASTM C578, Type IV in 4 foot x 8 foot sheets with minimum thickness of 2 inches.

## PART 3 CONSTRUCTION METHODS

## 3.1 GENERAL

- A. All construction shall be done in conformance with ANSI/AWWA C600 unless otherwise specified.

## 3.2 EXCAVATION

- A. Excavation shall conform to Trenching and Backfilling - Division 31 of these specifications except as modified herein.

## 3.3 FIELD INSPECTION OF MATERIALS

- A. Before lowering and while suspended, the pipe or fittings shall be inspected for defects. All materials used in the work must pass field inspection.

## 3.4 DIRECTION OF LAYING

- A. Unless otherwise ordered, pipe shall be laid with the bell ends facing the direction of laying. When the grade exceeds 30 feet of rise per one hundred feet of trench, the bells shall be face upgrade.

## 3.5 INSTALLATION

- A. The Contractor shall have sufficient and adequate equipment on the site of the work for unloading and lowering pipe and fittings into the trench.
- B. Extreme care shall be exercised by the Contractor in handling all pipe, fittings, and special castings so as to prevent breakage. Under no circumstances shall they be dropped into the trench or so handled as to receive hard blows or jolts when being moved.
- C. The Contractor shall supply and install pipe fittings, couplings, bends, and appurtenances as required to complete the project.
- D. All tees, crosses, bends, and reducers shall be cast or ductile iron. No PVC appurtenances will be allowed.
- E. Contractor shall install temporary water service to all users where water service will be interrupted for more than 4 hours. Contractor shall coordinate interruption to business and commercial users so the interruption will not cause a disruption of business or commercial activities. All users shall be given 24 hour notice of service interruption, except during emergencies.
- F. Abandoned water mains or hydrant leads shall have their ends plugged with concrete.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- G. All existing water mains being replaced are to remain in service until the new water mains are tested and accepted. The Contractor shall make arrangements with the Owner and the Engineer to sequence connection and operation of new mains and abandonment of existing mains.

## 3.6 JOINING OF PIPE

- A. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. If the crew cannot put the pipe into the trench and in place without getting earth into it, the Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe.
- B. During laying operations, no debris, tools, clothing, or other materials shall be placed in the pipe.

## 3.7 CUTTING OF PIPE

- A. Pipe shall be cut at right angles to the centerline of the pipe. Cutting shall be done in a neat workmanlike manner without damage to the pipe and so as to leave a smooth end.
- B. All pipes shall be cut with an approved mechanical cutter. The cut end of a pipe to be used with rubber gasket joints shall be tapered by grinding or filing about 1/8 inch back at an angle of approximately 30 degrees with the centerline of the pipe, and any sharp or rough edges shall be removed.

## 3.8 OBSTRUCTIONS IN LINE OR GRADE

- A. Whenever it becomes necessary to lay a main over, under or around a known obstruction, the Contractor will furnish and install the required fittings.
- B. If an unknown underground structure interferes with the work to such an extent that an alteration of the plan is required, the Contractor shall notify the Engineer.

## 3.9 THRUST RESTRAINT

- A. Thrust restraint is required for all bends, caps, plugs, tees, and valves adjacent to tees. Thrust restraint shall be provided by use of concrete buttresses and wedge action restraining glands.
- B. Concrete buttresses shall be poured against firm, undisturbed ground. When concrete buttresses cannot be placed against undisturbed ground they shall be placed against fill material of composition conforming to the requirements of ASTM C12 or ASTM D2321 as applicable for rigid and flexible pipe respectively, compacted to 95 percent of the modified proctor density for the material. The buttresses shall be constructed to the minimum dimensions as shown on the contract drawings or as required by the Engineer. All buttresses shall be formed to keep the joints free of concrete.
- C. Solid precast concrete blocks may be used in lieu of the poured buttresses when approved by the Engineer. When concrete blocks are used, they shall be stepped-out to match the minimum dimensions required for poured concrete buttresses.
- D. Ductile iron or PVC pipe connecting to HDPE pipe must be restrained a sufficient distance upstream to prevent joint separation due to contraction of the HDPE pipe. The minimum length of restrained

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

pipe required shall be as shown on the contract drawings or as specified in Special Procedures - Division 01. If no minimum length for restrained joints is specified, the Contractor shall submit the restrained joint calculations to the Engineer for review prior to construction.

- E. Restrained joint fittings shall be used in conjunction with concrete buttresses. When restrained joint fittings are used, a sufficient length of pipe on each side of the fitting shall be restrained to resist the thrust forces. The minimum length of restrained pipe required shall be as shown on the contract drawings or as specified in Special Procedures - Division 01. If no minimum length for restrained joints is specified, the Contractor shall submit the restrained joint calculations to the Engineer for review prior to construction.
- F. Thrust restraint is not required for HDPE water mains with HDPE fittings except where transitioning to other pipe materials.

## 3.10 JOINT DEFLECTION

- A. The maximum allowable deflection for ductile iron pipe will be as given in ANSI/AWWA C600. If excess deflection is required, special bends shall be furnished to provide angular deflections.
- B. The maximum deflection shall be as specified by the manufacturer.

## 3.11 DEPTH

- A. The water main shall be placed at a depth as to prevent freezing. This depth shall provide six and one-half feet (6'-6") of cover over iron/copper pipe and one-half foot more for other materials unless otherwise shown on the contract drawings or required by Special Procedures - Division 01 of these specifications.
- B. Insulation shall be installed if bury is less than six and one-half feet (6'-6") or utility crossing effectively removes earthen freeze protection. Insulation shall be installed as shown on the contract drawings or as directed by the Engineer in the field.

## 3.12 UNSTABLE SOIL

- A. If in the opinion of the Engineer the trench bottom is of unstable material, the Engineer may direct the Contractor to excavate the unstable material and replace same with 3/4 inch washed stone. Washed stone used in such cases shall be considered incidental and included in the price bid for water main unless bid or specified otherwise. Where the condition of unstable material is unusually severe, the Engineer may order the placement of a concrete cradle. Materials used for concrete cradles, when not called for in the Contract Documents, shall be paid for by Change Order at a negotiated price.

## 3.13 EMBEDMENT

- A. Class B embedment shall be used for all ductile iron or HPDE pipe installed under this contract in accordance with the contract drawings and ASTM C12, or as indicated in Special Procedures - Division 01 of these specifications.

- B. Class II embedment shall be used for all PVC pipe installed under this contract in accordance with the contract drawings and ASTM D2321, or as indicated in Special Procedures - Division 01 of these specifications.

### 3.14 SETTING VALVES

- A. Valves in water mains shall be provided and installed in locations as shown on the contract drawings. A valve box and valve box adaptor shall be provided for every valve unless otherwise specified. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the wrench nut of the valve. The box cover shall be flush or up to a 1/2 inch lower than the surface of the finished pavement.
- B. HDPE by mechanical joint adapters must be used at all valves installed on HDPE pipe.

### 3.15 SETTING HYDRANTS

- A. Hydrants shall be located as shown on the contract drawings or as directed by the Engineer. All hydrants shall stand plumb and shall have the pumper nozzle facing the curb. Hydrants shall be set to the established grade, which shall be hereinafter considered as with nozzles at least 18 inches above the ground such that the following one or more conditions apply:
  1. Nozzle center is 18-24 inches above the top of proposed curb.
  2. Nozzle center is 18-24 inches above the existing ground line.
  3. Nozzle center is 18 inches above the proposed ground surface elevation for that hydrant location.The above hydrant vertical placement may be accomplished by adding hydrant extensions. The unit price bid for the hydrant shall include the cost of extensions.
- B. All hydrant drainport shall be plugged in the following conditions:
  1. Hydrant drainport would be installed below groundwater table.
  2. Hydrant is placed in area with known soil contamination.
  3. Soil materials and coloration indicate groundwater may be above hydrant drainport.
  4. Plugging is shown on the contract drawings or is directed by the Engineer the field.
- C. Wherever a hydrant is set in soil that is pervious, drainage shall be provided at the base of the hydrant by placing coarse gravel or crushed stone mixed with coarse sand, from the bottom of the trench to at least 6 inches above the waste opening in the hydrant and to a distance of 1 foot around the elbow. The drainage material shall be wrapped with non-woven geotextile fabric Type SAS conforming to the requirements of Geosynthetics for Earthwork - Division 31 of these specifications.
- D. Wherever a hydrant is set in clay or other impervious soil, drainage shall be provided at the base of the hydrant by placing compacted coarse gravel or compacted crushed stone mixed with coarse sand, under and around the elbow of the hydrant to a level of 6 inches above the waste opening in the hydrant and to a distance 3 feet along the trench back toward the main.
- E. All hydrants shall be constructed with a minimum of six and one-half feet (6'-6") of cover over the lead, or as shown on the contract drawings or specified in Special Procedures - Division 01, and be set on a solid concrete block.

- F. All hydrants shall be installed with thrust restraint utilizing concrete buttresses and joint restraint, see thrust restraint this section.

### 3.16 INSTALLING SERVICES

- A. All corporations shall have proper sized tapping saddle furnished with them if used with PVC water main. All costs related to tapping saddles shall be included in the corporation unit price. Taps shall be cut-in using a “shell cutter” tapping device to capture all loose materials.

### 3.17 POLYETHYLENE ENCASEMENT

- A. Polyethylene encasement shall be installed where shown in the contract drawings or as required in the Special Procedures - Division 01. Installation of polyethylene encasement shall conform to ANSI/AWWA C105/A21.51.
- B. The polyethylene film shall be fitted to the contour of the pipe creating a snug, but not tight, encasement. Sufficient slack shall be provided in contouring to prevent stretching the polyethylene where it bridges irregular surfaces, such as joints or fittings, and to prevent damage to the polyethylene caused by backfilling operations. Overlaps and ends shall be secured with adhesive tape or plastic tie straps. For installations below the water table, circumferential wraps of tape shall be placed at two foot intervals along the barrel of the pipe.
- C. All fittings and valves shall be fully wrapped with polyethylene.
- D. Exposure to sunlight of the polyethylene film shall be kept to a minimum.

### 3.18 TRACER WIRE

- A. Trace wire shall be installed in conjunction with all PVC, HDPE, or non-conductive water main and services in accordance with Tracer Wire – Division 33 and with the Contract Drawings and the Special Procedures – Division 01.

### 3.19 DISINFECTING WATER MAIN

- A. All water main and services shall be disinfected in conformance with ANSI/AWWA C651. The main will not be accepted or placed in service until two consecutive satisfactory tests are taken 24 hours apart from samples from the new main following the final flushing.
- B. At least one set of samples shall be collected from every 1,200 feet of the new water main, plus one set of samples from the end of the main and a minimum of one set from each water main branch.
- C. The testing lab shall furnish copies of lab results from the bacteriological tests run on the water mains to the Engineer.

### 3.20 WATER SUPPLY DECHLORINATION

- A. Chlorinated water discharged directly or indirectly to surface waters as a result of flushing newly installed water mains, discharging water tanks or reservoirs, hydrant flushing, test pumping wells, or any other circumstance shall be dechlorinated in accordance with the current “Hydrostatic Test Water or Water Supply System Water General Permit, WPDES Permit No. WI-0057681”. The free

chlorine residual of discharged water shall be reduced to 0.1 parts per million or less, or to the normal operating concentration of the chlorine residual maintained in the water supply system.

- B. The concentration of free chlorine residual shall be measured at the point of surface water entrance.

### 3.21 TESTING

- A. All equipment required for hydrostatic testing shall be furnished and operated by the Contractor subject to the approval of the Engineer. This equipment shall include all sampling taps and necessary flushing appurtenances.
1. Hydrostatic tests shall consist of pressure and leakage test in accordance with ANSI/AWWA C600, Hydrostatic Testing. The hydraulic tests shall be conducted at 150 percent of normal operating pressure or 150 psi, whichever is greater.
    - a. Water shall not be added during the pressure test. No pipe section will be accepted if the test pressure drops more than 5 psi within the two-hour test duration.
    - b. The leakage is the amount of water required to bring the pressure back up to the starting pressure once the pressure test passes.
  2. Hydrostatic tests shall be conducted on sections of water main recommended as ready by the Contractor and approved by the Engineer. No section shall be less than one block (approximately 400 feet) of water main unless conditions warrant such testing of smaller sections.
  3. Where water services are installed to facilities which may include fire sprinkler systems, a pressure test and leakage test shall be performed on the water service in accordance with NFPA 24.
- B. Where ductile iron water main is installed, a random section of completed main will be selected by the Engineer for a continuity test. This random section shall be subjected to 300 amps DC for 15 minutes. All equipment necessary to make the test and to establish a closed circuit with the test section of water main providing one leg of the circuit shall be provided by the Contractor at no additional cost to the Owner. The Contractor shall take whatever precautions he deems necessary such as filling the water main with water prior to testing to protect the gaskets and building the amperage up slowly while watching an ammeter.
1. If the random section passes the test, the electrical continuity for the entire water main installation will be considered acceptable.
  2. Should the random section fail the test, it shall be repaired by and at the expense of the Contractor until it can pass the test. Also, the remainder of the project will be divided into test sections by the Engineer and tested for compliance by and at the expense of the Contractor.
- C. All tracer wire must be tested for electrical continuity. All equipment necessary to make the test and to establish continuity of all tracer wire shall be provided by the Contractor.

END OF SECTION 331000

## SECTION 333113 - PUBLIC SANITARY UTILITY SEWERAGE PIPE

## PART 1 GENERAL

## 1.1 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern the work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
  - 1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.

## 1.3 DESCRIPTION OF WORK

- A. The work under this section shall cover furnishing and installing all pipe and fittings for the sanitary sewer as shown on the contract drawings and as specified herein.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Trenching and Backfilling - Division 31
- C. Erosion and Sedimentation Controls - Division 31
- D. Sanitary Sewer Televising - Division 33
- E. Sanitary Sewer Manholes - Division 33
- F. Tracer Wire – Division 33

## 1.5 SUBMITTALS

- A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specifications. Information shall be in conformance with requirements of Submittals - Division 01 of these specifications.
- B. Contractor shall submit such submittals and details required for the construction and installation of the materials. Submittals and details shall indicate the intended materials arrangement, dimensions, major support requirements, plot area and intricate or detailed construction requirements.

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)



## PART 2 PRODUCTS AND MATERIALS

## 2.1 PIPE

- A. Concrete Pipe. Pipe shall be of the bell and spigot type and meet the requirements of ASTM C14 for extra strength pipe.
- B. PVC and ABS Composite Pipe. Pipe shall be of the sleeve type and meet the requirements of ASTM D2680 for composite pipe and D1784 and D4673 for rigid PVC compounds and rigid ABS plastics, respectively.
- C. PVC Pipe. Four inch to 15 inch diameter pipe shall be Type PSM SDR-35 and meet the requirements of ASTM D3034. Pipe over 15 inch diameter shall meet the requirements of ASTM F679. Pipe shall be of the bell and spigot type and meet the requirements of ASTM D3034 Type PSM SDR-35.
- D. Ductile Iron Pipe. Pipe shall conform to the requirements of ANSI 21.51 (AWWA C151) for bituminous coated, Class 52 ductile iron pipe unless specified otherwise. Standard cement mortar lining shall meet the requirements of ANSI 21.4 (AWWA C104).

## 2.2 PIPE JOINTS

- A. General. Manufacturer's instructions for making joints shall be followed. The use of joints as specified herein shall not relieve the Contractor of the responsibility of meeting testing specifications.
- B. Concrete Pipe. Pipe joints shall be elastomeric seals (rubber gaskets) conforming to ASTM C 443. All pipe grooves or bells shall have a concrete shoulder to help confine the gasket.
- C. PVC and ABS Composite Pipe. Pipe joints shall be chemically welded conforming to ASTM D2235 and D2564 or elastomeric seals (rubber gaskets) conforming to ASTM F477.
- D. PVC Pipe. Pipe joints shall be chemically welded conforming to ASTM D2564 or elastomeric seals (rubber gaskets) conforming to ASTM F477 and joint assembly conforming to ASTM D3212.
- E. Ductile Iron Pipe. Pipe joints and fittings shall be push-on type or mechanical joint type conforming to ANSI 21.11 (AWWA C111).

## PART 3 CONSTRUCTION METHODS

## 3.1 GENERAL

- A. All construction shall be done in conformance with "Standard Specifications for Sewer and Water Construction in Wisconsin" except as may be modified herein.
- B. Plastic pipe shall be installed in accordance with ASTM D2321.

### 3.2 LINES AND GRADES

- A. All lines and grades will be given on the contract drawings, as directed by the Engineer or as indicated in Special Procedures - Division 01 of these specifications. The Contractor shall be responsible for the preservation of line and grade stakes when set. The Contractor shall keep the Engineer informed reasonably in advance of the times and places that stakes will be required in order that the work may be done without inconvenience to the Engineer or delay to the Contractor.
- B. The Contractor shall at his own expense, furnish and place in position, as directed by the Engineer, all necessary equipment and material for locating the work from the line and grade stakes given by the Engineer consisting of either a laser or batter boards. When batter boards are used, a minimum of three (3) adjacent boards with two (2) string lines shall be used to determine grade. It shall be the Contractor's responsibility to check grade stakes in advance of the excavation reporting any discrepancies to the Engineer.
- C. The Contractor assumes responsibility for pipe laid to non-conforming grade and shall relay same at his expense if ordered by the Engineer.

### 3.3 EXCAVATION

- A. Excavation shall conform to both Trenching and Backfilling and Structural Excavation for Structures - Division 31 except as modified herein.

### 3.4 UNSTABLE SOIL

- A. If in the opinion of the Engineer the trench bottom is of unstable material, the Engineer may direct the Contractor to excavate the unstable material and replace same with 3/4 inch washed stone. Washed stone used in such cases shall be considered incidental and included in the price bid for sanitary sewer unless bid or specified otherwise.
- B. Where the condition is unusually severe, the Engineer may order the placement of a concrete cradle, which shall be paid for at the unit price bid.

### 3.5 EMBEDMENT

- A. Embedment for the sewer pipe shall depend upon whether the pipe is rigid, semi-rigid or flexible.
- B. Rigid pipe, including clay, concrete, and ductile iron pipes, shall be embedded in accordance with ASTM C12, Class B embedment, unless specified otherwise in the Special Procedures or as shown on the Contract Drawings.
- C. Flexible and semi-rigid pipe, including PVC and ABS composite pipes, shall be embedded in accordance with ASTM D2321, Class II embedment, unless specified otherwise in the Special Procedures or as shown on the Contract Drawings. The Class II embedment material shall be placed in maximum lifts of 6 inches and extend a minimum of 12 inches above the top of the pipe.

### 3.6 INSTALLATION

- A. The Contractor shall have sufficient and adequate equipment on the site of the work for unloading and lowering pipe into the trench. Extreme care shall be exercised by the Contractor in handling all

pipe so as to prevent breakage. Under no circumstances shall they be dropped into the trench or so handled as to receive hard blows or jolts when being moved.

- B. Before lowering and while suspended, the pipe or fittings shall be inspected for defects. All materials used in the work must pass field inspection.
- C. Unless otherwise ordered, pipe shall be laid with the bell ends facing upgrade.
- D. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line.
- E. Joints shall be lubricated, cemented, or otherwise made in strict conformance with these specifications and manufacturer's instructions.
- F. Sewers to be stubbed out from new manholes shall end with a pipe bell end and have the end plugged to prevent the entrance of soil and water. The cost of plugs shall be included in the unit price bid of the sanitary sewer.

### 3.7 LATERALS OR CONNECTIONS

- A. Wyes or tee branches for lateral service connections shall be placed to service each building site as directed by the Engineer. All wyes, tees or the end of lateral service lines shall be closed with a stopper until all testing has been completed. Plugs/caps shall be tested against with the maximum air pressure to be used in testing. All deep connections shall be fitted with riser pipes when ordered by the Engineer. Risers shall not exceed a 1:1 slope and shall be paid for per foot of pipe length as sanitary lateral.
  - 1. Sanitary laterals shall be SDR 35. All laterals shall be installed up to the right-of-way line and be embedded in materials in accordance with ASTM C12 or ASTM D2321 for rigid, semi-rigid or flexible as specified.
  - 2. Minimum grade of lateral shall be 1/8 inch per foot. Maximum grade of lateral shall be 1/2 inch per foot.
  - 3. All unconnected sanitary laterals shall be capped and have the ends marked by a metal fence post buried vertically, flush with the ground directly over the end of the lateral. The cost of the fence post and cap shall be included in the unit price bid for sanitary lateral.
  - 4. All sanitary laterals must be insulated if the depth of cover is 5-1/2 feet or less when rock is present. If the depth of hard rock is 4-1/2 feet or less, the rock shall be removed to at least 5-1/2 feet of cover and the service insulated.
- B. Where new sewer is to be installed to replace existing sanitary sewer, service laterals shall be extended from the old sanitary lateral and connected to the new main. Minimum grade of lateral extensions shall be 1/8 inch per foot. Maximum grade of lateral extensions shall be 1/2 inch per foot. Lateral extensions which require a grade in excess of 1/2 inch per foot to connect new sewers to existing service laterals shall be installed with a riser section. Connection to existing laterals shall be made with a Mission, Clow, Fernco, coupling or equal in accordance with State and/or local plumbing code requirements. The cost of all special fittings required to make the connections of service laterals to the new sanitary sewer and the connections to the lateral shall be included in the bid.
  - 1. Approximate locations of existing laterals are shown on the contract drawings. The Contractor shall verify the locations of all existing locations. The Contractor shall coordinate,

with the Engineer, verification that existing laterals that are encountered are live and that all live laterals are connected to the new sewer main.

- C. Cut-in type saddle wyes and tees will be allowed on existing sanitary sewers where service laterals are to be connected to the sewer. The saddle fitting shall be PVC with a gasket for sewer service. This shall be fastened to the existing pipe by means of stainless steel bands, with stainless steel bolts and nuts. Shop drawing submittals required on cut-in saddles.
- D. A complete and accurate tabulation of the length, location, depth, etc., of each lateral installed shall be kept by the Contractor. This record shall be the property of the Owner.

### 3.8 WATER/SEWER LINE CROSSING

- A. Wherever the sewer crosses above water main with less than a clear vertical separation of 18 inches (outside of pipe to outside of pipe) or below the water main with less than a clear vertical separation of 6 inches (outside of pipe to outside of pipe), the sewer shall be constructed equal to water main pipe. One full pipe length shall be centered on the water main crossing and shall be pressure tested.
- B. The type of pipe material and/or joints shall not change between manholes.

### 3.9 STRUCTURE SEALS

- A. Plastic pipe shall be provided with approved water stops where encased in the walls of manholes.

### 3.10 PIPES TO BE CLEANED

- A. The interior of all pipes shall be carefully freed from all dirt, concrete and superfluous material of every description as the work progresses. If, in the opinion of the Engineer, the pipe contains an excess of material, the pipe shall be cleaned by the Contractor at no additional expense to the Owner.

### 3.11 TESTING

- A. General. The following tests shall be performed by the Contractor in the presence of the Engineer. The Contractor shall be responsible for providing all labor, materials and equipment for the testing.
- B. Infiltration Test. The sanitary sewer and all connections and laterals shall be measured for infiltration at points designated by the Engineer. The tests for infiltration shall be conducted in a manner as approved by and under the direction of the Engineer. Infiltration shall be measured using either the water test or the low pressure air test. The sewer and connections shall have a rate of infiltration less than 200 gallons per inch of pipe diameter per mile per day.
  1. Water Test. The test shall be performed using a minimum positive head of 2 feet of water. Maximum allowable exfiltration shall be 200 gallons per inch of pipe diameter per mile per day.
  2. Low Pressure Air Test. Sewer lines shall be air tested in accordance with ASTM F1417, entitled "Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air". The air test shall be made in the presence of the Engineer. All equipment necessary for said air test shall be provided by the Contractor and approved by the Engineer.

- C. Televising. No air test will be required on the new sewer with active lateral installed. All lines not air tested shall be televised with all said televising costs included in the related sanitary sewer item. When sewer line flows are above the minimum requirements (generally not more than 1/4 of the pipe diameter) or inspection of the complete periphery of the pipe is necessary to effectively conduct the inspection and sealing operations, one or more of the following methods of flow control shall be used at no extra cost to the Owner:
1. Plugging or Blocking: A sewer line plug shall be inserted into the line at a manhole upstream from the section to be inspected, tested and/or sealed. The plug shall be so designed that all or any portion of the sewage flows can be released. During the inspection portion of the operation, flows shall be shut off or substantially reduced in order to properly inspect the pipe at the invert. After the inspection is complete, flows shall be restored to normal or not more than 1/3 of the pipe diameter during the joint testing and joint sealing operation.
  2. Pumping and Bypassing: Where pumping is required, in the opinion of the Engineer, to assure completion of the inspection and sealing work, the Contractor will be required to furnish pumping equipment, conduits, etc. All costs for flow control, temporary pumping, etc., shall be inclusive to testing and shall be included in the unit price bid for the related sanitary sewer item. No bypassed wastewaters will be allowed to be discharged to surface drainage facilities.
  3. Liability: Contractor shall be liable for damages to private or public property which may result from sewer flow control operations.
  4. The television camera used for the inspection shall be one specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear picture for the entire periphery of the pipe. The camera shall have a minimum resolution of 650 lines, shall provide a color picture, and have pan and tilt capabilities. Picture quality and definition shall be to the complete satisfaction of the Engineer and if unsatisfactory, equipment shall be removed and no payment made for unsatisfactory inspection. The camera shall be moved through the line in either direction at a uniform slow rate. Contractor shall provide to the Engineer three copies of a DVD (including viewing software) record of the inspection as well as a type written report of the inspection.
  5. Measurement for location of defects shall be at the ground level by means of a meter device. Marking on cable or the like which would require interpolation for depth of manhole, etc., will not be allowed. Measurement meters shall be accurate to 0.2 of a foot. A measuring target (or the sealing packer) in front of the television camera shall be used as an exact measurement reference point and the meter reading shall show this exact location of the measurement reference point.
- D. Deflection Test. All polyvinyl chloride pipe installations shall be tested for deflection by using a rigid ball or mandrel and shall be performed in accordance with ASTM D2321 and without the use of mechanical pulling devices. Deflection may not exceed 5 percent if tested within 30 days of placement of final backfill or 7.5 percent if tested more than 30 days after final backfill is placed. Final backfill must be in place prior to testing.
- E. Alignment. Sewer pipe will be inspected for alignment by the use of mirrors, flashlights or lamps. Sewer lines shall permit a through view of at least half the pipe diameter between manholes.
- F. Acceptance. If any of the tests are not met, the Contractor shall, at his own expense, determine the source of the problem and repair or replace all defective materials.
1. Collapsed, fractured or pipe whose structural integrity is questionable as determined by the Engineer shall be replaced in a manner suitable to the Engineer.

2. The sewer line shall be considered acceptable when all of the above provisions are complied with.

### 3.12 MAINTAINING SANITARY SEWER SERVICE

- A. The Contractor shall provide adequate equipment and facilities to provide bypass pumping for all elements of work requiring interruption to flow in the sanitary sewer. Provide backup or standby capabilities satisfactory to the Owner. The Contractor shall be responsible for damages to private or public property due to sewer backup while controlling sewage flow.
- B. Under no circumstances will bypassing of untreated wastewater to any storm drainage facility or surface water course be allowed.
- C. The Contractor shall notify the Owner seven (7) days in advance of sewer sections which will not be useable in order to allow time for the Owner to notify residents. Interruptions shall then be verified at least 24 hours in advance.
  1. Interruptions of service shall be limited to eight (8) hours.
  2. All existing sanitary laterals shall be permanently reconnected within two days after initial disconnection of the main line sewer bypass. These existing sanitary laterals shall be temporarily reconnected if the permanent reconnection cannot be accomplished immediately after disconnection.
- D. All costs for flow control, temporary pumping, etc., shall be inclusive to the unit price bid for sanitary sewer.
- E. All costs associated with connecting proposed sewers to existing sewers or manholes, manhole removal and abandonment, sanitary sewer removals and abandonment, shall be included in the unit price bid for sanitary sewer.

### 3.13 REPAIR OF DEFECTIVE PIPE FOR SANITARY SEWER REHABILITATION PROJECTS

- A. General. The work includes furnishing all materials, equipment and labor to excavate and repair leaking joints, shears, cracked pipe, etc., for the purpose of eliminating existing or previously observed infiltration of groundwater. All sewer defects shall be repaired watertight and to the satisfaction of the Engineer. All applicable sections of these specification shall apply except as specified below. The Contractor shall locate or make arrangements for locating all structures and underground utilities prior to beginning any excavations. Where existing wyes, tees, risers or service connections are encountered in sewer to be replaced, they shall be replaced with new fittings and piping within the limits of the excavation at no change in the contract price. Where piping is to be removed, excavations shall extend to a depth below the bottom of the pipe, suitable for placement of new bedding.
- B. Pipe Repair. All defective pipe shall be removed. Where the length of defective pipe is noted in the contract drawings, the Contractor shall remove the length of pipe shown along with any other pipe observed to be defective after excavation. The Contractor shall generally remove the entire length of pipe in which the defect occurred. Where joints are to be repaired, a minimum of one-half of the upstream pipe and one-half of the downstream pipe shall be removed. Where pipe shears are located near joints and where shear displacement has occurred, both upstream and downstream sections of sewer shall be replaced.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

- C. Existing pipe 16 inches in diameter and less shall generally be repaired by cutting and removing existing pipe between joints. All cuts shall be made perpendicular to the direction in which the pipe is laid. New sanitary sewer shall be connected to existing sanitary sewer with the use of a Mission, Clow, Fernco, or equal band seal coupling, with stainless steel sleeves. Adjustable stainless steel shear rings shall be provided wherever available. New piping shall be air tested prior to placement of backfill.
- D. Existing pipe larger than 16 inches in diameter shall generally be repaired by removing existing piping at existing joints. Sections of piping shall be removed by cutting off the existing upstream spigot end. The upstream bell end of the pipe shall be removed and the downstream bell end shall remain. Any jointing material shall be removed from the downstream bell. A new plain end piece of pipe shall then be inserted in the existing bell and the pipe joint sealed with Daubert 301, Mastik or equal as per manufacturer's recommendations. The new upstream plain end piece of pipe shall be jointed to existing piping with an external pipe joint wrapping equal to MacWrap as manufactured by the MarMac Manufacturing Company, Inc.; Cadilloc as manufactured by Cadilloc, Inc.; or equal. Whenever any portion of existing concrete cradle or concrete backfill must be removed, piping shall be replaced to the inside of the manhole wall.
- E. Existing pipe that is laid in concrete cradle shall be repaired by cutting and removing existing pipe between joints. Concrete cradle below the repaired pipe shall be removed. The new pipe shall be butted against the existing pipe and repaired as indicated on the detail drawings.

END OF SECTION 333113

## SECTION 333114 – SALT WATER STORAGE SYSTEM

## PART 1 GENERAL

## 1.1 SCOPE

- A. This specification describes an underground Salt Water Storage Containment System.

## 1.2 APPLICABLE PUBLICATIONS (NONE)

## 1.3 DESCRIPTION OF WORK

- A. The work under this section shall cover furnishing and installing an underground storage system for salt water. All equipment and materials required to construct the storage system to the required specifications are included.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Trenching and Backfilling - Division 31
- C. Erosion and Sedimentation Controls - Division 31
- D. Sanitary Sewer Manholes - Division 33
- E. Tracer Wire – Division 33

## 1.5 SUBMITTALS

- A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specification. Information shall be in conformance with requirements of Submittals - Division 01 of these specifications.

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

## PART 2 PRODUCTS AND MATERIALS

## 2.1 REINFORCED POLYETHYLENE PIPE

- A. This specification describes DuroMaxx pipe for use as the underground storage. The products listed are intended to establish a basis for comparison of products of other manufacturers. Approved equals may be permitted but only with the prior written approval of the Engineer.
- B. DuroMaxx is a reinforced polyethylene pipe with a smooth waterway wall and exterior profile that is reinforced with high strength galvanized steel ribs. The continuous reinforcing ribs are completely encased within the polyethylene profile. DuroMaxx is manufactured using a helical winding process that results in a continuously fusion welded lap seam. The pipe profile is manufactured using a high quality stress-rated thermoplastic meeting the requirements of ASTM F2562 “Standard Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure



## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

Drainage and Sewerage” or AASHTO Designation MP-20, Bridge Constuction Section 26 & Design Section 12. For the purpose of hydraulic design, the recommended Manning’s “n” value shall be 0.012 for pipe diameters included within this specification.

- C. Virgin high density polyethylene stress-rated resins are used to manufacture DuroMaxx pipe and complimentary fabricated fittings. Resins shall conform to the minimum requirements of cell classification 345464C as defined and described in the latest version of ASTM D3350 “Standard Specification for Polyethylene Plastics Pipe and Fittings Materials”.

## 2.2 JOINT PERFORMANCE

- A. Pipe lengths shall be joined on site using ElectroFusion designed for DuroMaxx pipe. Welded Coupler Joints (36” – 120”) shall utilize plain ended DuroMaxx pipe welded together with a polyethylene coupler by way of electrofusion welding or extrusion welding technology. The welded connections provide a true, infield watertight system. The field installed welded coupler joints shall remain watertight and can achieve zero leakage rates on appropriate applications. The welded coupler joints have been laboratory tested to 30 psi in accordance with ASTM D3212.

## 2.3 FITTINGS

- A. All fabricated fittings and couplings supplied by the manufacturer shall be constructed to ensure no loss of structural integrity or joint tightness at welded seams and joints. Only those fittings supplied by or recommended by the manufacturer shall be used.

## PART 3 CONSTRUCTION METHODS

### 3.1 INSTALLATION

- A. Installation shall be in accordance with ASTM D2321 “Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications” along with product-specific recommendations.

END OF SECTION 333114

## SECTION 333913 - SANITARY SEWER MANHOLES

## PART 1 GENERAL

## 1.1 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern the work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards:
  - a. ASTM A48 - Specification for Gray Iron Castings, Current Edition.
  - b. ASTM A240 - Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels, Current Edition.
  - c. ASTM A615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, Current Edition.
  - d. ASTM A668 - Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use, Current Edition.
  - e. ASTM C76 - Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, Current Edition.
  - f. ASTM C478 - Specification for Precast Reinforced Concrete Manholes Sections, Current Edition.
  - g. ASTM C913 - Specification for Precast Concrete Water and Wastewater Structures, Current Edition.
  - h. ASTM C923 - Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes, Current Edition.
  - i. ASTM D2146 - Specification for Polypropylene Plastic Injections and Extrusion Materials, Current Edition.
  - j. ASTM F593 - Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs, Current Edition.
  - k. ASTM F783 - Specification for Staple, Handgrab, Handle, and Stirrup Rung, Current Edition.
2. Code of Federal Regulations (CFR), Title 29, Chapter XVII - Occupational Safety and Health Administration (OSHA), Department of Labor, Part 1926 Regulations, Current Edition.
3. Federal Specifications (FS), Specifications and Standards, Current Edition.
4. State Department of Commerce (DOC), Administrative Code of Rules and Regulations, Current Edition.
5. State Department of Natural Resources (DNR), Administrative Code of Rules and Regulations, Current Edition.
6. State Standard Specifications (SSS), for Sewer and Water Construction, Current Edition.

## 1.3 DESCRIPTION OF WORK

- A. The work under this section shall cover furnishing and installing standard manholes constructed of precast concrete sections, circular in horizontal section set on a concrete base and fitted with standard manhole covers, frames, waterproofing, and steps in accordance with the contract drawings and as specified herein.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Submittals - Division 01
- C. Trenching and Backfilling - Division 31
- D. Erosion and Sedimentation Controls - Division 31
- E. Public Sanitary Utility Sewerage Pipe - Division 33
- F. Sanitary Utility Sewerage Force Main - Division 33

## 1.5 SUBMITTALS

- A. Contractor shall submit such product literature and catalog cuts of materials to be supplied. Information shall be in conformance with requirements of Submittals - Division 01 of this specification.
- B. Contractor shall submit submittals and details required for the construction and installation of the materials. Submittals and details shall indicate the intended materials arrangement, dimensions, major support requirements, plot area and intricate or detailed construction requirements.

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

## PART 2 PRODUCTS AND MATERIALS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. The products listed are intended to establish a basis for comparison of products of other manufacturers. Substitutions will be permitted but only with the prior written approval of the Engineer. Catalogue reference numbers stated are those of Neenah Foundry Company and are intended to establish a basis for comparing the products of other manufacturers. Other manufacturers are McKinley Iron Works or Bingham and Taylor.

## 2.2 PRECAST MANHOLE SECTIONS

- A. Precast concrete manhole sections shall have a minimum inside diameter of 48 inches. Clear opening shall match dimensions of castings. The cone section shall be the eccentric type with a minimum clear opening of 24 inches. Clear opening shall match dimensions of castings. Compressive strength of the concrete shall be 4000 psi and shall conform to ASTM C478. Wall thicknesses of manholes will vary with diameter in conformance with ASTM C76, Class B concrete tongue and groove joint pipe. Larger diameter manholes (7 feet +) shall have wall thickness a minimum of one-twelfth the inside diameter of the manhole as specified in ASTM C478.
- B. Steel reinforcement (sq. in./lin. ft.) shall not be less than 0.0025 times the inside diameter of the manhole in inches.

- C. The Contractor shall verify size, invert elevation, and location of all pipes in existing manholes and inform Engineer of any discrepancies before the replacement manhole is constructed.

### 2.3 STEPS

- A. Steps shall be constructed of a 1/2 inch diameter, Grade 60 reinforcing steel bar conforming with ASTM A615 completely encased in polypropylene conforming with ASTM D4101 to obtain a minimum thickness of 1-1/8 inch and minimum width of 12 inches. They shall be securely and permanently set in the manhole wall. Steps shall be set at 16 inches on center and have a 5-3/4 inch projection from the wall. Steps shall conform with ASTM F783.

### 2.4 FRAMES, COVERS AND GRATINGS

- A. Frames, covers and gratings shall be of the type and duty as shown in the Contract Documents. Iron castings shall conform to ASTM A48, Class 20. All castings shall be true to pattern in form and dimensions, free from faults, sponginess, cracks, blow holes, and other defects affecting their strength.

### 2.5 SANITARY SEWER MANHOLE JOINT MATERIALS

- A. Sanitary sewer manhole joint materials shall be plastic gasket material or butyl rubber gasket material. Plastic gaskets shall be preformed, high adhesion material, packaged ready for use between protective paper strips conforming to Federal Spec SS-S-00210, Type I, Rope Form; Ram-Nek by K.T. Snyder Company, Inc.; Kent Seal No. 2 or equal. Butyl rubber gaskets shall be preformed, high adhesion material, packaged ready for use between protective paper strips, conforming to Federal Spec SS-S-210A, Rope Form; by Press Seal Gasket Corporation or equal.

### 2.6 WATERSTOP SEALS

- A. Waterstop seals shall be flexible, watertight, rubber wedge ring or O-ring compression seals for pipe entrance holes. Wedge ring type shall be Press-Wedge II by Press-Seal Gasket Corporation, PSX Boot by Press Seal Gasket Corporation, pipe to manhole connector by KOR-N-SEAL or equal. O-ring type shall have cast iron compression flange, Res-Seal by Scales Manufacturing Corporation or equal.

### 2.7 ADJUSTMENT RINGS

- A. Adjustment rings shall be concrete with steel reinforcement in conformance with ASTM C478. Rings shall be either 2 inches or 4 inches in thickness. The manholes shall be built so that a minimum of two 2 inch rings are installed for adjustment. A maximum of 12 inches of adjustment will be allowed, but the top two rings shall be of 2 inches thickness.
- B. Precompressed butyl gasket, 3/8 inch x 3-1/2 inch shall be used between the manhole, manhole casting, and all adjustment rings. Butyl material shall be E-Z stik or equal.

### 2.8 SANITARY SEWER MANHOLE CHIMNEY SEALS

- A. Sanitary sewer manhole chimney seal shall be internal or external type, rubber sleeve, unless indicated otherwise in the Special Procedures - Division 01 or the Contract Documents. The sleeve and extension shall have a minimum thickness of 3/16 inches and shall be extruded or molded from

a high grade rubber compound conforming to the applicable requirements of ASTM C923, with a minimum 1,500 psi tensile strength, maximum 18 percent compression set and hardness (durometer) of  $48 \pm 5$ . The sleeve shall be doubled pleated with a minimum unexpanded vertical height of 8 inches and be capable of vertical expansion of not less than 2 inches when installed.

- B. The bands used for compressing the sleeve and extension against the manhole shall be fabricated from 16 gauge stainless steel conforming to ASTM A240 Type 304. All screws, bolts or nuts used on this band shall be stainless steel conforming to ASTM F-593 and 594, Type 304.
- C. Sanitary sewer manhole chimney seal shall provide a watertight seal from 2 inches above the bottom of the casting to 2 inches below the top of the manhole cone section or flat top.

### PART 3 CONSTRUCTION METHODS

#### 3.1 MANHOLES, GENERAL

- A. All lift holes on sanitary sewer manholes shall be sealed watertight.

#### 3.2 INVERTS AND BENCHES

- A. Invert channels shall be smooth and accurately shaped and in accordance with the contract drawings.
- B. No horizontal surfaces shall be left on the inside of the manhole. The bench shall be shaped to drain into the floor channel.

#### 3.3 FRAMES AND COVERS

- A. Sanitary sewer manholes shall be built up so that the frames and cover, when placed, will be at the required grade. Mortar shall be used under the frame to adjust the casting to the required grade.

#### 3.4 PROVISION FOR FUTURE CONNECTION

- A. Connections for future sewers, when specified, shall consist of a short piece of sewer terminating with a bell end and stopper or bulkhead not more than one full pipe length outside the manhole wall unless otherwise shown. If no elevation is given for future connections, set the invert 1/2 inch above the main sewer invert.
- B. ABS and PVC pipe shall be fitted with rubber waterstop seals where they pass through the manhole wall.

#### 3.5 DROP CONNECTIONS

- A. Sanitary sewer manhole drop connections shall be outside drops constructed according to detail drawings and the following provisions.
  - 1. The drop assembly shall consist of a tee or wye connecting to the inflowing sewer, a drop pipe of the same diameter as the inflowing sewer, and a 90-degree bend at the bottom, all encased in concrete.

2. Ductile iron pipe used for the drop connection need not be encased in concrete if the drop is free of joints between the 90-degree bend and the tee.

### 3.6 PLUGGING OF ABANDONED LINES

- A. Unless otherwise directed by the Engineer, the Contractor shall remove all abandoned pipe lines from each manhole. Each pipe shall be entirely removed from the manhole wall. All loose or defective mortar, concrete block, or concrete shall be removed. The entire area shall then be plugged with non-shrink mortar, packed in place.

### 3.7 ABANDONMENT OF SEWER AND SANITARY SEWER MANHOLES

- A. Sanitary sewer lines to be abandoned shall be plugged at both ends with concrete or sewer brick and mortar. Where a new manhole is to be built or an existing manhole is to remain, the plugged end of the abandoned sewer line shall end no closer than five feet from the manhole and concrete backing shall be poured between the plug and the manhole. Where the manhole and the sewer are to be abandoned, the sewer shall be blocked and the manhole shall be filled with concrete above the crown of both the inflowing and outflowing sewers to a maximum of 4 feet. Sewers entering the manhole more than 4 feet above the bottom shall be plugged with concrete or brick and mortar. All manholes to be abandoned shall be removed to a minimum of 3 feet below ground level.
- B. Backfill shall conform to the requirements of Trenching and Backfilling - Division 31 of these specifications.

### 3.8 MANHOLE VACUUM TESTING

- A. Conduct vacuum testing on manholes using vacuum testing equipment acceptable to Engineer.
- B. Isolate manhole to be tested by plugging inlet and outlet pipes with inflatable stopper or other suitable test plugs. Securely brace plugs to avoid plugs being drawn into manhole. Plug lift holes with a non-shrink grout.
- C. Place vacuum test equipment inside of top cone section and conduct vacuum test in accordance with manufacturer's recommendations. Operate vacuum pump until 10 inches of mercury is obtained.

- D. Shut off vacuum pump and measure time for vacuum to drop from 10 to 9 inches of mercury. Manhole test is acceptable if the time exceeds the values in the table below, and there is no visible sign of leakage:

<u>Depth/Feet</u>	<u>Test Time/Seconds</u>
8	20
10	25
12	30
14	35
16	40
18	45
20	50
22	55
24	59
26	64
28	69
30	74

- E. If test fails, repair or seal manhole using non-shrink gout or other materials that are approved. Retest until an acceptable test is obtained.
- F. Test may be conducted before or after backfilling.

END OF SECTION 333913

## SECTION 334113 - PUBLIC STORM UTILITY DRAINAGE PIPING

## PART 1 GENERAL

## 1.1 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
  1. American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications, Latest Edition.
  2. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.
  3. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Current Edition at time of bid opening.

## 1.3 DESCRIPTION OF WORK

- A. The work covered under this section shall consist of furnishing all material, equipment, and labor required to install the public storm utility drainage piping for this project.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Structural Excavation for Structures - Division 31
- C. Dewatering - Division 31
- D. Trenching and Backfilling - Division 31
- E. Storm Drainage Manholes, Frames, and Covers - Division 33

## 1.5 SUBMITTALS

- A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specifications. Information shall be in conformance with requirements of Submittals - Division 01 of these specifications.

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)



## PART 2 PRODUCTS AND MATERIALS

## 2.1 CONCRETE PIPE

- A. Reinforced concrete pipe shall conform to the requirements of Sections 608 and 610 of the State of Wisconsin, Department of Transportation, Standard Specifications.
- B. Non-reinforced concrete pipe shall conform to the requirements of Section 607 of the State of Wisconsin, Department of Transportation, Standard Specifications.

## 2.2 CORRUGATED METAL PIPE (CMP)

- A. Corrugated metal pipe shall conform to the requirements of Sections 520 and 521 of the State of Wisconsin, Department of Transportation, Standard Specifications.

## 2.3 HIGH DENSITY POLYETHYLENE PIPE (HDPE)

- A. High density polyethylene pipe shall conform to the requirements of Section 530 of the State of Wisconsin, Department of Transportation Standard Specifications. Pipes which are between 42 inch diameter and 48 inch diameter shall meet the requirements of AASHTO M252 and M294, Type D.
- B. Couplings and fittings for 4-36 inch pipe shall be suitable for the specific project application and as recommended by the pipe manufacturer. The joint for 42-48 inch pipe shall consist of a bell and spigot, integrally welded to the barrel of the pipe, utilizing a suitable profile gasket located on the spigot end.
  - 1. The fittings shall not reduce or impair the overall integrity or function of the pipe line. Fittings may be either molded or fabricated. Common corrugated fittings include in-line joint fittings, such as couplers and reducers, and branch or complimentary assembly fittings such as tees, wyes, and end caps. These fittings may be installed by various methods, such as snap-on, screw-on, bell and spigot, and wrap around.
  - 2. Couplings shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints.
  - 3. Only fittings supplied or recommended by the pipe manufacturer shall be used. Where designated on the contract drawings, a neoprene or rubber gasket shall be supplied.

## 2.4 CONCRETE BRICK OR BLOCK

- A. Concrete brick and block masonry units shall conform to the requirements of Section 519 of the State of Wisconsin, Department of Transportation, Standard Specifications.

## PART 3 CONSTRUCTION METHODS

## 3.1 GENERAL

- A. Construction of the public storm utility drainage piping shall include all excavation, backfilling, compacting of trenches and breaking into existing manholes, inlets or storm sewers required to provide a completed storm sewer at the locations shown on the contract drawings.

## 3.2 PROTECTION OF EXISTING UTILITIES

- A. Utility locations shown on Plans and Profile are approximate. Contractor shall contact all utility companies at least three working days prior to excavation for locations of all buried utilities owned by them. Should utilities be unexpectedly encountered during excavation, consult Engineer immediately for directions as to procedure. Cooperate with the Owner and public and private utility companies in keeping their respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner. Contractor shall be responsible for the cost of repairing damaged utilities.

## 3.3 CONCRETE STORM SEWER

- A. Concrete storm sewer shall be constructed as shown on the contract drawings and in accordance with Sections 607, 608, and 610 of the State of Wisconsin, Department of Transportation, Standard Specifications, with the following exceptions and additions:
1. Joints shall be of flexible watertight rubber gaskets installed as per manufacturer's instructions.
  2. Flexible watertight gaskets will not be required for elliptical storm sewer. Elliptical joints shall be sealed with trowellables "dauber" chemical joint compound, or equal.
  3. Backfill shall be as indicated on the contract drawings and specified in Trenching and Backfilling - Division 31 and Special Procedures - Division 01. Backfill shall be incidental to storm sewer construction.
  4. If no embedment class is specified, then Class B embedment with a shaped subgrade shall be used.
  5. Joint ties shall be installed on apron endwall joints and the adjacent two pipe joints.

## 3.4 CORRUGATED METAL PIPE (CMP) STORM SEWER

- A. Corrugated metal pipe shall be constructed as shown on the contract drawings and in accordance with the Special Procedures and Sections 520, 521, and 607 of the State of Wisconsin, Department of Transportation, Standard Specifications, with the following exceptions and additions:
1. Joints shall be of watertight bolted bands installed as per manufacturer's instructions.
  2. Backfill and embedment shall be as noted in the Special Procedures and shall be incidental to storm sewer construction.
  3. Basis of payment will be per lineal foot in place. Miscellaneous bends, fittings and bands shall be included in the unit bid price of the associated pipe. The footage to be paid for shall not include the construction into or through catch basins, manholes, and inlets.

## CONSTRUCTION OF ARCTIC ANIMAL EXHIBIT AND CONCESSIONS

## 3.5 HIGH DENSITY POLYETHYLENE PIPE (HDPE)

- A. High density polyethylene pipe shall be constructed as shown on the contract drawings and, in accordance with the Special Procedures - Division 01 and Section 607 of the State of Wisconsin, Department of Transportation, Standard Specifications. Standard practice for underground installation of flexible sewer pipe (ASTM D 2321) with the following exceptions and additions:
1. Joints for sewer pipe shall be sealed to be soil tight in accordance with AASHTO Standard Specifications for Highway Bridges, Section 26.4.2.4.
  2. Embedment shall be Class II or as indicated in Special Procedures - Division 01 and shall be incidental to storm sewer construction.
  3. Backfill shall be Type II as specified in Trenching and Backfilling - Division 31 or as indicated in Special Procedures - Division 01. Backfill shall be incidental to storm sewer construction.

## 3.6 LAYING SEWER PIPE FOR CURVES

- A. Sewers laid on curves shall be one of the following types:
1. Deflection of pipe joints will be permitted when the joint opening is less than 1/2 the length of the tongue for mortar joints or 1/4 the length of the tongue with rubber gasket joints; otherwise use cut-off pipe or miter pipe.
  2. Cut-off pipe shall be molded with the difference between the longest and shortest sides, measured along the outside of the pipe, conforming to the values given in Table 1. Lengths of pipe other than that shown may be used only with approval of the Engineer.
  3. Miter pipe shall be manufactured by the removal of a wedge from the center of the pipe to provide for the required angle of deflection. Sufficient additional reinforcement shall be added at the spring lines and top and bottom of the pipe to prevent shearing after installation. Repairs to complete the pipe shall be such that the concrete shall have the same strength as that of the remainder of the pipe barrel and shall not spall or separate. Miter pipe shall be used for all elliptical pipe laid on a curve. Miter pipe for circular sewers shall be used only with the approval of the Engineer.

Table 1  
Cut-Off of Pipe for Curved Sewer (inches)  
(4-foot long pipe sections)

Pipe I.D. Inches	Radius of Curve in Feet							
	40	50	57.3	60	70	80	90	100
21	2-5/8	2-1/8	1-3/4	1-3/4	1-1/2	1-3/8	1-1/4	1/1/8
24	2-7/8	2-3/8	2	2	1-3/4	1/1/2	1-3/8	1-1/4
27	3-1/4	2-5/8	2-1/4	2-1/8	1-7/8	1-5/8	1-1/2	1-3/8
30	3-1/2	2-7/8	2-1/2	2-3/8	2-1/8	1-7/8	1-5/8	1-1/2
36	4-1/4	3-3/8	3	2-7/8	2-1/2	2-1/8	1-7/8	1-3/4
42	--	3-7/8	3-3/8	3-1/4	2-7/8	2-1/2	2-1/4	2
48	--	4-3/8	3-7/8	3-3/4	3-1/4	2-7/8	2-1/2	2-1/4
54	--	--	4-3/8	4-1/8	3-5/8	3-1/8	2-7/8	2-1/2
60	--	--	--	--	4	3-1/2	3-1/8	2-3/4
66	--	--	--	--	4-3/8	3-3/4	3-3/8	3-3/8
72	--	--	--	--	--	4-1/8	3-5/8	3-3/8

78	--	--	--	--	--	4-3/8	4	3-5/8
84	--	--	--	--	--	4-3/4	4-1/4	3-7/8
96	--	--	--	--	--	--	4-7/8	4-3/8

### 3.7 TESTING

- A. Leakage Testing. All storm sewers shall be tested for excessive infiltration and sand leakage. All sand leaks shall be repaired by the Contractor at his expense. If in the judgment of the Engineer the infiltration will cause a continued maintenance problem, the sewer shall be repaired by the Contractor at his expense.
- B. Alignment and Grade shall be checked by lamping method to detect poor alignment, offset joints, sags, kinks, or open joints; defects shall be corrected by the Contractor before final acceptance. If closer inspection is warranted, the Owner may arrange for a televised inspection. The Owner will assume the cost of televised inspection if no serious defect is found. If defects are found which the Engineer attributes to the failure of proper installation or sound materials, the Contractor shall pay for the test. Defects shall be promptly corrected.
- C. Deflection Limitation. Deflections in corrugated metal pipe and HDPE pipe shall be limited to 5 percent of the nominal pipe diameter. If visual inspection indicates a greater deflection, the Contractor shall supply and pull a rigid ball or mandrel with a diameter 5 percent less than the nominal pipe size through the sewer. Failure of the ball to freely pass through shall be cause for rejection of the sewer.

### 3.8 PROTECTING OPENINGS

- A. Fences shall be provided around all openings and whenever required for the protection of the public. They shall be neat and substantial. All openings, fences, and surface obstructions shall be guarded and shall be indicated at night by suitable flashers.

END OF SECTION 334113

## SECTION 33 49 13 - STORM DRAINAGE MANHOLES, FRAMES AND COVERS

## PART 1 GENERAL

## 1.1 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern the work of this section.

## 1.2 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
  1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.
  2. Federal Specifications (FS), Specifications and Standards, Current Edition.
  3. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Current Edition at time of bid opening.

## 1.3 DESCRIPTION OF WORK

- A. The work under this section shall cover furnishing and installing catch basins, storm manholes, inlets and similar structures constructed of precast concrete sections, or solid concrete block, set on a concrete base and fitted with standard structure covers, frames and steps, in accordance with the contract drawings and as specified herein.

## 1.4 RELATED WORK ELSEWHERE

- A. Procurement and Contracting Requirements - Division 00 (All Sections)
- B. Submittals - Division 01
- C. Trenching and Backfilling - Division 31
- D. Erosion and Sedimentation Controls - Division 31
- E. Public Storm Utility Drainage Piping - Division 33

## 1.5 SUBMITTALS

- A. Contractor shall submit such product literature and catalog cuts of materials to be supplied. Information shall be in conformance with requirements of Submittals - Division 01 of this specification.
- B. Contractor shall submit submittals and details required for the construction and installation of the materials. Submittals and details shall indicate the intended materials arrangement, dimensions, major support requirements, plot area and or detailed construction requirements.

## 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

## PART 2 PRODUCTS AND MATERIALS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. The products listed are intended to establish a basis for comparison of products of other manufacturers. Substitutions will be permitted but only with the prior written approval of the Engineer. Catalogue reference numbers stated are those of Neenah Foundry Company and are intended to establish a basis for comparing the products of other manufacturers. Other manufacturers are McKinley Iron Works or Bingham and Taylor.

## 2.2 STRUCTURES

- A. Materials furnished and used in this work shall conform to the requirements of Section 611 of the State of Wisconsin, Department of Transportation, Standard Specifications and details in the contract drawings.

## 2.3 STEPS

- A. Steps shall be constructed of a 1/2 inch diameter, Grade 60 reinforcing steel bar conforming with ASTM A615 completely encased in polypropylene conforming with ASTM D2146 to obtain a minimum thickness of 1-1/8 inch and minimum width of 12 inches. They shall be securely and permanently set in the manhole wall. Steps shall be set at 16 inches on center and have a 5-3/4 inch projection from the wall. Steps shall conform with ASTM F783.

## 2.4 FRAMES, COVERS AND GRATINGS

- A. Frames, covers and gratings shall be of the type and duty as shown on the contract drawings. Iron castings shall conform to ASTM A48, Class 20. All castings shall be true to pattern in form and dimensions, free from faults, sponginess, cracks, blow holes, and other defects affecting their strength.

## 2.5 JOINT MATERIALS

- A. Joint materials shall be plastic gasket material or butyl rubber gasket material. Plastic gaskets shall be preformed, high adhesion material, packaged ready for use between protective paper strips conforming to Federal Spec SS-S-00210, Type I, Rope Form; Ram-Nek by K.T. Snyder Company, Inc.; Kent Seal No. 2 or equal. Butyl rubber gaskets shall be preformed, high adhesion material, packaged ready for use between protective paper strips, conforming to Federal Spec SS-S-210A, Rope Form; by Press Seal Gasket Corporation or equal.

## 2.6 ADJUSTMENT RINGS

- A. Adjustment rings shall be concrete with steel reinforcement in conformance with ASTM C478. Rings shall be either 2 inches or 4 inches in thickness. The manholes shall be built so that a

minimum of two 2 inch rings are installed for adjustment. A maximum of 12 inches of adjustment will be allowed, but the top two rings shall be of 2 inches thickness.

- B. Precompressed butyl gasket, 3/8 inch x 3-1/2 inch or mortar shall be used between the manhole, manhole casting, and all adjustment rings. Butyl material shall be E-Z stik or equal.

### PART 3 CONSTRUCTION METHODS

#### 3.1 STORM DRAINAGE MANHOLES, FRAMES AND COVERS, GENERAL

- A. All lift holes on structures shall be sealed watertight.

#### 3.2 FRAMES AND COVERS

- A. Structures shall be built up so that the frames and cover, when placed, will be at the established required grade. Mortar shall be used under the frame to adjust the casting to the required grade.

#### 3.3 PROVISION FOR FUTURE CONNECTION

- A. Connections for future sewers, when specified, shall consist of a short piece of sewer terminating with a bell end and stopper or bulkhead not more than one full pipe length outside the structure wall unless otherwise shown. Other structure components and requirements are indicated on detail drawings. If no elevation is given for future connections, set the invert 1/2 inch above the main sewer invert.

#### 3.4 ABANDONMENT OF STORM SEWER AND STRUCTURES

- A. Storm sewer lines to be abandoned shall be plugged at both ends with concrete or sewer brick and mortar. Where a new structure is to be built or an existing structure is to remain, the plugged end of the abandoned sewer line shall end no closer than five feet from the structure and concrete backing shall be poured between the plug and the structure. Where the structure and the sewer are to be abandoned, the sewer shall be blocked and the structure shall be filled with concrete above the crown of both the inflowing and outflowing sewers to a maximum of 4 feet. Sewers entering the structure more than 4 feet above the bottom shall be plugged with concrete or brick and mortar. All structures to be abandoned shall be removed to a minimum of 3 feet below ground level.
- B. Backfill shall conform to the requirements of Trenching and Backfilling - Division 31 of these specifications.

END OF SECTION 334913