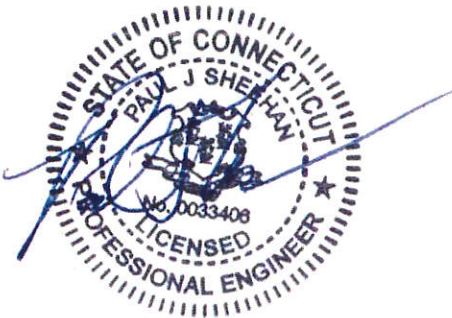


TOWN OF MANSFIELD

Mansfield, Connecticut

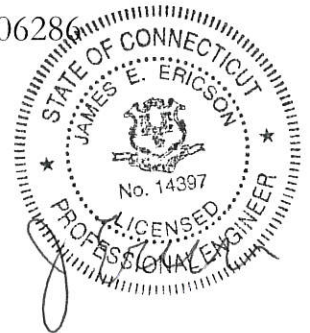
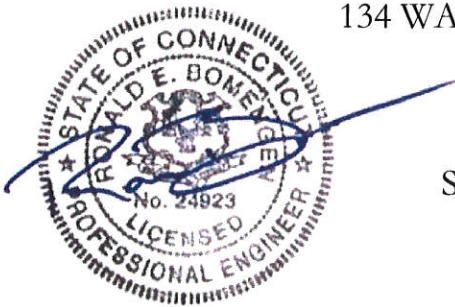


BID DOCUMENT SPECS VOLUME 3 OF 3

MANSFIELD ELEMENTARY SCHOOL

134 WARRENVILLE ROAD, MANSFIELD, CT 06286

STATE PROJECT NUMBER: 078-0068N
PHASE 2 of 3



JANUARY 11, 2021



LIST OF CONSULTANTS

Architect

TSKP STUDIO, LLC
146 Wyllys Street, Suite 1-203
Hartford, CT 06106

Civil Engineers

Fuss & O'Neill, Inc
146 Hartford Road
Manchester, CT 06040

Structural Engineers

Michael Horton Associates, Inc.
151 Meadow Street, #2
Branford, CT 06405

MEP/FP Engineers

Kohler Ronan, LLC
Consulting Engineers
93 Lake Avenue
Danbury, CT 06810

Well Consultant

Lenard Engineering, Inc.
2210 Main Street
P.O. Box 1088
Glastonbury, CT 06033

Owner's HazMat Consultant

Langan Engineering &
Environmental Services, Inc.
Long Wharf Maritime Center
555 Long Wharf Drive
New Haven, CT 06511

Net Zero Consultant

CMTA
10411 Meeting Street
Prospect, KY 40059

Landscape Architect

Richter & Cegan, Inc
8 Canal Court, #B
Avon, CT 06001

Geotechnical

Welti Geotechnical, P.C.
227 Williams Street
P.O. Box 397
Glastonbury, CT 06033

Kitchen & Food Service

Food Service Design Collab., LLC
10 Middle Drive
Windsor Locks, CT 06096

Owner's Commissioning Agent

Consulting Engineering Services
811 Middle Street
Middletown, CT 06457

MANSFIELD ELEMENTARY SCHOOL

BUILDING OFFICIAL	FIRE MARSHALL
HEALTH INSPECTOR	APPOINTED 504 OFFICIAL

TABLE OF CONTENTS

VOLUME 1 OF 3

CONSULTANT

DIVISION 0 – BIDDING/CONTRACTING REQUIREMENTS

000000 – Advertisement for Bids	CPL
000001 – Instructions to Bidders A701-2018	TSKP
000002 – Prevailing Wage Rates	TSKP
000003 – Bid Form 1 of 3 (Stipulated Sum, Alternates, etc.)	TSKP
000004 – Bid Form 2 of 3 (Unit Prices)	TSKP
000005 – Bid Form 3 of 3 (CHRO Statements)	TSKP
000006 – Contractor’s Qualification Statement A305-2020	TSKP
000007 – Bid Bond A310-2010	TSKP
000008 – Form of Agreement A101-2017	CPL
000009 – Insurance and Bonds A101-2017 Exhibit A	CPL
000010 – General Conditions of the Contract A201-2007	CPL
002213 – Supplementary Instructions to Bidders	TSKP
003132 – Geotechnical Data	WELT

DIVISION 01 – GENERAL REQUIREMENTS

007300 – Supplementary General Conditions	TSKP
011000 – Summary	TSKP
012200 – Unit Prices	TSKP
012300 – Alternates	TSKP
012500 – Substitution Procedures	TSKP
012900 – Payment Procedures	TSKP
013100 – Project Management and Coordination	TSKP
013116 – Coordination Drawings Procedure	TSKP
013200 – Construction Progress Documentation	TSKP
013233 – Photographic Documentation	TSKP
013300 – Submittal Procedures	TSKP
014000 – Quality Requirements	TSKP
015000 – Temporary Facilities and Controls	TSKP
015150 – Indoor Air Quality Construction Plan	TSKP
015639 – Temporary Tree and Plant Protection	R&C
015713 – Construction Activity Pollution Protection	F&O
016000 – Product Requirements	TSKP
017300 – Execution	TSKP
017413 – Project Cleanliness	TSKP
017419 – Construction Waste Management and Disposal	TSKP
017700 – Closeout Procedures	TSKP
017823 – Operation and Maintenance Data	TSKP
017839 – Project Record Documents	TSKP
017900 – Demonstration and Training	TSKP
018113 – Sustainable Design Requirements	TSKP
019113 – General Commissioning Requirements	CES
019119 – Facility Shell Commissioning	CES

MANSFIELD ELEMENTARY SCHOOL

DIVISION 02 – EXISTING CONDITIONS

024113 – Selective Site Demolition	F&O
024116 – Structure Demolition	TSKP
028200 – Hazardous Building Materials Abatement & Demolition	LANG
028213 – Asbestos Abatement	LANG
028313 – Lead Based Paint Awareness	LANG
028416 – Universal Waste Removal and Recycling	LANG
028432 – PCBs Greater Than 50 PPM Remediation	LANG

DIVISION 03 - CONCRETE

033000 – Cast in Place Concrete	MHA
034500 – Precast Architectural Concrete	TSKP

DIVISION 04 - MASONRY

042000 – Unit Masonry	TSKP
-----------------------	------

DIVISION 05 – METALS

051200 – Steel	MHA
051213 – Architecturally Exposed Structural Steel Framing	MHA
052100 – Joists	MHA
053000 – Metal Decking	MHA
054000 – Cold Formed Metal Framing	TSKP
055000 – Metal Fabrications	TSKP
055113 – Metal Stairs and Railings	TSKP
055213 – Exterior Pipe and Tube Railings	R&C

DIVISION 06 – WOOD, PLASTIC AND COMPOSITES

061053 – Miscellaneous Rough Carpentry	TSKP
061063 – Exterior Rough Carpentry	R&C
061500 – Wood Roof Decking	MHA
061600 – Sheathing	TSKP
061753 – Pre-Fabricated Wood Trusses	MHA
061800 – Glued Laminated Construction	MHA
064000 – Architectural Woodwork	TSKP

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

070800 – Thermal and Moisture Protection Systems Commissioning	CES
071113 – Bituminous Damproofing	TSKP
071310 – Self-Adhering Sheet Waterproofing	TSKP
072100 – Thermal Insulation	TSKP
072726 – Fluid-Applied Membrane Air Barriers	TSKP
074113 – Standing-Seam Metal Roof Panels	TSKP
074213 – Sheet Metal Panels	TSKP
074600 – Wood Siding	TSKP
074646 – Fiber-Cement Siding	TSKP
075323 – Ethylene-Propylene-Diene-Monomer (EPDM) Roofing	TSKP
076200 – Sheet Metal Flashing and Trim	TSKP

MANSFIELD ELEMENTARY SCHOOL

077123 – Gutters and Downspouts	TSKP
077200 – Roof Accessories	TSKP
078413 – Penetration Firestopping	TSKP
078446 – Fire-Resistive Joint Systems	TSKP
079200 – Joint Sealants	TSKP

DIVISION 08 – OPENINGS

080671 – Door Hardware Schedule	TSKP
080800 – Openings Systems Commissioning	CES
081113 – Hollow Metal Doors and Frames	TSKP
081416 – Flush Wood Doors	TSKP
083113 – Access Doors and Frames	TSKP
083326 – Overhead Coiling Grilles	TSKP
084113 – Aluminum Framed Entrances and Storefronts	TSKP
084413 – Glazed Aluminum Curtain Walls	TSKP
085113 – Aluminum Windows	TSKP
086200 – Unit Skylights	TSKP
086300 – Overhead Doors	TSKP
087100 – Door Hardware	TSKP
088000 – Glazing	TSKP
089000 – Fixed Louver	TSKP

DIVISION 09 - FINISHES

092116 – Gypsum Board Shaft Wall Assemblies	TSKP
092216 – Non-Structural Metal Framing	TSKP
092900 – Gypsum Board	TSKP
093000 – Tiling	TSKP
095113 – Acoustical Panel Ceilings	TSKP
095420 – Linear Wood Ceilings	TSKP
096466 – Wood Athletic Flooring	TSKP
096513 – Resilient Base and Accessories	TSKP
096519 – Resilient Flooring	TSKP
096566 – Synthetic Athletic Flooring	TSKP
096723 – Resinous Flooring	TSKP
096813 – Tile Carpeting	TSKP
097200 – Wall Coverings	TSKP
098433 – Sound Absorbing Wall Panels	TSKP
099120 – Painting	TSKP
099600 – High Performance Coatings	TSKP
099700 – Material List	TSKP

DIVISION 10 – SPECIALTIES

101100 – Visual Display Surfaces	TSKP
101200 – Display Cases	TSKP
101423 – Building Signage	TSKP
101453 – Site Traffic Signage	F&O
102113 – Toilet Compartments	TSKP
102123 – Cubicle Tracks and Curtains	TSKP
102800 – Toilet and Custodial Accessories	TSKP

MANSFIELD ELEMENTARY SCHOOL

104413 – Fire Protection Cabinets	TSKP
104416 – Fire Extinguishers	TSKP
105113 – Metal Lockers	TSKP
105123 – Wood Lockers	TSKP
107516 – Ground Set Flagpoles	R&C

DIVISION 11 – EQUIPMENT

111313 – Loading Dock Bumpers	TSKP
111319 – Stationary Loading Dock Equipment	TSKP
113100 – Residential Appliances & Misc. Equipment	TSKP
114000 – Food Service Equipment	FSD
115213 – Projection Screens	TSKP
116143 – Stage Curtains	TSKP
116623 – Gymnasium Equipment	TSKP
116653 – Gymnasium Dividers	TSKP
116800 – Playfield Equipment and Structures	R&C
116823 – Exterior Court Athletic Equipment	R&C

DIVISION 12 – FURNISHINGS

122413 – Roller Window Shades	TSKP
124816 – Entrance Floor Grilles	TSKP
126600 – Telescoping Stands	TSKP

DIVISION 14 – CONVEYING SYSTEMS

142100 – Electric Traction Elevators	TSKP
--------------------------------------	------

VOLUME 2 OF 3

DIVISION 21 – FIRE SUPPRESSION

210500 – Common Work Results for Fire Suppression	KR
210513 – Common Motor Requirements for Fire Suppression	KR
210517 – Sleeves and Sleeve Seals for Fire Suppression	KR
210518 – Escutcheons for Fire Suppression	KR
210523 – General Duty Valves for Fire Suppression	KR
210529 – Hangers and Supports for Fire Suppression	KR
210548 – Vibration and Seismic Controls for Fire Suppression	KR
210553 – Identification for Fire Suppression	KR
210800 – Fire Protection Systems Commissioning	CES
211100 – Facility for Fire Suppression	KR
211119 – Fire Department Connections	KR
211313 – Wet-Pipe Sprinkler System	KR
211316 – Dry-Pipe Sprinkler Systems	KR
213216 – Diesel Drive Vertical Turbine Fire Pumps	KR
213400 – Pressure Maintenance Pumps	KR
213900 – Controllers for Fire Pump Drivers	KR

DIVISION 22 - PLUMBING

220500 – Common Work Results for Plumbing	KR
---	----

MANSFIELD ELEMENTARY SCHOOL

220513 – Common Motor Requirements for Plumbing	KR
220516 – Expansion Fittings and Loops for Plumbing	KR
220517 – Sleeves and Sleeve Seals for Plumbing	KR
220518 – Escutcheons for Plumbing	KR
220519 – Meters and Gages for Plumbing	KR
220520 – Protective Cover System for Plumbing	KR
220523 – General Duty Valves for Plumbing	KR
220529 – Hangers and Supports for Plumbing	KR
220534 – Heat Tracing for Plumbing Piping – Grease Waste	KR
220548 – Vibration and Seismic Controls for Plumbing	KR
220553 – Identification for Plumbing	KR
220800 – Plumbing Systems Commissioning	CES
221100 – Water System Components	LE
221116 – Domestic Water Piping	KR
221119 – Domestic Water Piping Specialties	KR
221123 – Domestic Water Pumps	KR
221218 – Underground Potable Water Storage Tanks	KR
221223 – Facility Indoor Potable Water Storage Tanks	KR
221300 – Sanitary Sewerage	F&O
221316 – Sanitary Waste and Vent Piping	KR
221319 – Sanitary Waste Piping Specialties	KR
221319.13 – Sanitary Drains	KR
221413 – Facility Storm Drainage Piping	KR
221423 – Storm Drainage Piping Specialties	KR
223300 – Electric Domestic Water Heaters	KR
223600 – Domestic Heat Pump Water Heaters	KR
224213.13 – Commercial Water Heaters	KR
224213.16 – Commercial Urinals	KR
224216.13 – Commercial Lavatories	KR
224216.16 – Commercial Sinks	KR
224716 – Pressure Water Coolers	KR

**DIVISION 23 – HEATING, VENTILATING AND AIR
CONDITIONING**

230000 – General Provisions	KR
230130.51 – HVAC Air Distribution Cleaning	KR
230513 – Common Motor Requirements for HVAC	KR
230516 – Expansion Fittings and Loops for HVAC	KR
230517 – Sleeves and Sleeve Seals for HVAC	KR
230518 – Escutcheons for HVAC Piping	KR
230519 – Meters and Gauges for HVAC Piping	KR
230523 – General Duty Valves for HVAC Piping	KR
230529 – Hangers and Supports for HVAC Piping	KR
230548 – Vibration and Seismic Controls for HVAC Piping	KR
230553 – Identification for HVAC Piping	KR
230593 – Testing Adjusting and Balancing for HVAC	KR
230700 – HVAC Insulation	KR
230800 – HVAC Systems Commissioning	CES
230900 – Instrumentation and Controls for HVAC	KR

MANSFIELD ELEMENTARY SCHOOL

230993 – Sequence of Operations	KR
232113 – Hydronic Piping	KR
232113.33 – Ground Loop Heat Pump Piping	KR
232123 – Hydronic Pumps	KR
232300 – Refrigerant Piping	KR
232520 – Glycol Feed Systems	KR
232913 – Variable Frequency Motor Controllers	KR
233113 – Metal Ducts	KR
233330 – Air Duct Accessories	KR
233423 – HVAC Power Ventilators	KR
233600 – Air Terminal Units	KR
233713 – Diffuser Registers and Grilles	KR
233723 – HVAC Gravity Ventilators	KR
234300 – Electronic Air Cleaners	KR
237433 – Dedicated Outdoor Air Vents	KR
238129 – Variable Refrigerant Volume HVAC System	KR
238146 – Water Source Heat Pumps	KR
238239 – Unit Heaters	KR

VOLUME 3 OF 3

DIVISION 26 – ELECTRICAL

260100 – General Electric Requirements	KR
260500 – Common Work Results for Electrical	KR
260519 – Low Voltage Electrical Power Conductors	KR
260526 – Grounding and Bonding for Electrical	KR
260529 – Hangers and Supports for Electrical	KR
260533 – Raceways and Boxes for Electrical	KR
260543 – Underground Ducts and Raceways for Electrical	KR
260548 – Vibration Controls for Electrical	KR
260553 – Identification for Electrical	KR
260573 – Overcurrent Protective Device Coordination Study	KR
260800 – Electrical Systems Commissioning	CES
262213 – Low Voltage Distribution Transformers	KR
262413 – Switchboards	KR
262416 – Panelboards	KR
262726 – Wiring Devices	KR
262816 – Enclosed Switches and Circuit Breakers	KR
263100 – Photovoltaic Collectors	KR
263213.13 – Diesel Emergency Engine Generators	KR
263600 – Transfer Switches	KR
265100 – Interior Lighting	KR
265600 – Exterior Lighting	KR

DIVISION 27 - COMMUNICATIONS

270500 – Common Work Results for Communications	KR
270526 – Grounding and Bonding for Communications	KR
270528 – Pathways for Communications	KR

MANSFIELD ELEMENTARY SCHOOL

270528.26 – Innerduct for Communications	KR
270536 – Cable Trays for Communications	KR
270537 – Firestopping for Communications	KR
270553 – Identifications for Communications	KR
271100 – Communications Equipment Room Fittings	KR
271116 – Communications Racks Frames and Enclosures	KR
271313 – Communications Copper Backbone Cabling	KR
271323 – Communications Optical Fiber Backbone Cabling	KR
271513 – Communication Copper Horizontal Cabling	KR
272133 – Data Communications Wireless Access Points	KR
274116 – Integrated Audio-Video Systems and Equipment	KR
275126 – Assistive Listening Systems	KR
275313 – Intercommunications Paging and Clock Systems	KR

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

281300 – Access Control Software and Database Management	KR
281353.10 – Video Intercom System	KR
281500 – Access Control Hardware Devices	KR
282000 – Video Surveillance	KR
283100 – Intrusion Detection	KR
283111 – Digital Addressable Fire Alarm System	KR

DIVISION 31 – EARTHWORK

311000 – Site Clearing	F&O
312300 – Earthwork	F&O

DIVISION 32 – EXTERIOR IMPROVEMENTS

321216 – Asphalt Paving	R&C
321313 – Concrete Paving	R&C
321400 – Unit Paving	R&C
321500 – Aggregate Surfacing	R&C
321613 – Precast Concrete Curbing	R&C
321723 – Site Painted Pavement Markings	F&O
321816.13 – Playground Protective Surfacing	R&C
321828 – Athletic Court Surfacing	R&C
323113 – Chain Link Fences and Gates	R&C
323119 – Metal Picket Fences and Gates	R&C
323124 – Solid Cellular PVC Fences and Gates	R&C
323223 – Segmental Retaining Walls	R&C
323300 – Site Furnishings	R&C
329115 – Soil Preparation (Performance Specification)	R&C
329200 – Turf and Grasses	R&C
329300 – Plants	R&C

DIVISION 33 – UTILITIES

333400 – Septic System	F&O
334211 – Stormwater Gravity Piping	F&O
337119 – Electrical Underground Ducts Ductbanks Manholes	F&O

SECTION 260100 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Work of this Division shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install all work of this Division as shown on the drawings, as specified herein, and/or as required by job conditions.
- B. This Section 260100 governs general procedures, materials and workmanship as applicable to the electrical work specified in the other Division 26 sections. Refer to Division 1 sections for additional general requirements.
- C. Perform the work in accordance with the requirements and provisions of all applicable codes and laws.
- D. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable design, measured and documented according to the CT High Performance Building Standard (CTHPB) Mandatory Requirements and minimum required sustainable strategies, as indicated on the Sustainable Matrix.
- E. Equipment, materials, and installation shall conform to applicable standards and requirements of the following organizations and documents:
 - ANSI American National Standards Institute
 - ASTM American Society for Testing and Materials
 - AWS American Welding Society
 - CBM Certified Ballast Manufacturers Association
 - ETL ETL Testing Laboratories
 - FCC Federal Communications Commission
 - FM Factory Mutual
 - FS Federal Specifications
 - ICEA Insulated Cable Engineers Association
 - IEEE Institute of Electrical and Electronic Engineers
 - IESNA Illuminating Engineering Society of North America
 - NEC National Electrical Code
 - NECA National Electrical Contractors Association
 - NEMA National Electrical Manufacturers Association
 - NESC National Electric Safety Code
 - NETA International Electrical Testing Association
 - NFPA National Fire Protection Association
 - OSHA Occupational Safety and Health Administration
 - UL Underwriters Laboratories, Inc.

MANSFIELD ELEMENTARY SCHOOL

1.2 INTENT

- A. It is the intention of the specifications and drawings to obtain finished work, clean, tested, and ready for operation.
- B. Items and services not shown on drawings, but mentioned in specifications, or vice versa, or items and services necessary to render the work complete and ready for operation, even if not specified, shall be provided without additional cost.
- C. Where conflicts occur between drawings and specifications, or within either document, the Contractor shall ask for and obtain a written clarification from the Architect prior to submitting his bid. Otherwise, the items or arrangements of superior quality, greater quantity or higher cost shall prevail and be included in the contract price.

1.3 WORK INCLUDED

- A. The work under this Division shall include all labor, material, equipment, services and administrative tasks required to complete and make operable the electrical work shown on the drawings and specified herein, and including, but not limited to, the following:
 - 1. Preparation and submission of shop drawings, diagrams and illustrations.
 - 2. Procuring all necessary permits and approvals, and paying all required fees and charges in connection with the work of this Division.
 - 3. Coordinating with, and complying with requirements of, the local electric utility, telephone company, and other franchised utility and service companies as applicable to the scope of this work.
 - 4. Record drawings.
 - 5. Operating and maintenance instructions and manuals.
 - 6. Identification labels, tags, charts and diagrams.
 - 7. Final connections to all electrical equipment and devices.
 - 8. All cutting, drilling, and patching required for the work of this Division.
 - 9. Excavation and backfill for underground electrical work.
 - 10. Concrete housekeeping pads for floor-mounted electrical equipment.
 - 11. Temporary light and power for construction purposes.
 - 12. Testing and adjustment of all systems and equipment furnished, installed, and/or connected under this Division.

1.4 APPROVALS

- A. See General Conditions and Division 1 sections, in addition to the following requirements.
- B. Submit for approval a list of manufacturers of equipment proposed for the work. Contractor's intent to use exact make specified does not relieve him of responsibility for submitting such a list.
- C. Where any specific material, process or method of construction, or manufactured article is specified by name or by reference to catalog number of a manufacturer, or other standards, the intent is not to take precedence over the basic duty and performance specified, noted on

drawings, or as required for intended results. In all cases, the Contractor shall verify the duty specified with the specific characteristics of the equipment offered for approval.

- D. If material or equipment is installed before it is approved, the Contractor shall be liable for its removal and replacement with no additional cost.

1.5 SUBMITTALS

- A. See Division 26 equipment sections for specific submittals required. Unless otherwise indicated, submittals are required for all electrical devices, equipment, and systems including basic construction materials such as conduit, 600 volt building wire, and standard fittings and boxes.
- B. Manufacturers' Data
 - 1. If catalog cuts of standard manufactured items show different types, options, finishes, performance requirements, or other variations, those features that the Contractor proposes to furnish shall be clearly identified. If any variations from the catalog description are proposed or required, such variations must be clearly noted on the cut.
- C. Shop Drawings
 - 1. Shop drawings shall clearly indicate all details, sectional views, arrangements, working and erection dimensions, kinds and quality of materials and their finishes, and other information necessary for proper checking and for fabrication and installation of the items, and shall include all information required for making connections to other work.
 - 1. Shop drawings shall be numbered consecutively, and drawings related to various units comprising a proposed assembly shall be submitted simultaneously so that such units may be checked both individually and as an assembly.
 - 2. Contractor shall keep on the site, in good order, a complete up-to-date set of approved shop drawings. Shop drawings shall be made available for inspection by the Architect.
 - 3. The approval of shop drawings will be for general conformance to drawings and specifications, and shall not be construed as permitting any departure from the contract requirements. If the shop drawings show any variations from contract requirements because of standard shop practices or other reasons, such variations shall be clearly identified on the drawings or specifically noted in the letter of transmittal, in order that, if acceptable, suitable action may be taken for proper adjustment in other work affected thereby. If the Contractor fails to so identify such variations, he will not be relieved of responsibility for executing the work in accordance with the contract, even though such shop drawings have been approved and the work installed. Approval shall not relieve the Contractor of responsibility for any error in details, dimensions, etc. that may exist on shop drawings, nor for the furnishing of materials or work required by the contract and not indicated on the shop drawings. Approval shall not be construed as approved departure from details or instructions previously furnished by the Architect.
 - 4. No work for which shop drawings are required shall be executed until the Architect's approval is obtained.

D. Shop Drawing Schedule

1. The Contractor shall submit, within 30 days of the award of his contract, a schedule of all proposed shop drawing submissions.
2. The schedule shall include the following information.
 - a. Item to be submitted
 - a. Date of submission
 - b. Latest date for review
 - c. Manufacturers of the specified item.
3. Items not specifically listed as "approved equal" should be listed for consideration at this time.
2. Shop drawings require a minimum of 10 business days from the date they have been received by the Consulting Engineer's office to adequately review the submittal. If there is any submittal which requires to be expedited sooner than the 10 business days, the Engineer shall be informed in writing at the beginning of construction with a list of those submittals.

E. Operating and Maintenance Instructions

1. Furnish manufacturer's operating and maintenance instructions, parts lists, and sources of supply for replacements.

F. Submittals will be reviewed for conformance with the contract drawings and specifications. The engineer's review stamp will be affixed to submittals. One of the following actions will be taken:

1. Reviewed:
 - a. No comments, corrections, or marks have been made to the submittal. Re-review by the engineer is not required. The submittal is in general conformance with the design concept. Construction, fabrication and/or manufacture can proceed subject to the provision that the work shall be in accordance with the requirements of the Contract Documents. Final acceptance of the work shall be contingent upon such compliance.
2. Furnish As Corrected
 - a. Comments, corrections, or marks made. Re-review is not required. Submission is in general conformance with the design concept subject to notations on the returned Submittal. Construction, fabrication, and/or manufacturer can proceed subject to the provisions that the work shall be carried out in compliance with all annotations and/or corrections indicated on the returned Submittal and in accordance with the Contract Documents. Final acceptance of the work shall be contingent on such compliance.
3. Revise and Resubmit
 - a. Significant issues/discrepancies/incomplete information was provided in the Submittal. Revise or prepare a new submittal in accordance with the notations and Contract Documents. Resubmit without delay.
4. Rejected
 - a. Submittal does not meet Contract document intent. Revise or prepare a new submittal in accordance with the notations and Contract Documents. Resubmit without delay.

MANSFIELD ELEMENTARY SCHOOL

- G. A submittal review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Corrections or comments made on the shop drawings during this review do not relieve the contractor from Compliance with the requirements of the plans and specifications. Approval of a specific item shall not include approval of an assembly of which the item is a component. The contractor is responsible for: dimensions to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of his or her work with that of all other trades; and for performing all work in a safe and satisfactory manner.

1.6 RECORD DRAWINGS

- A. Provide record drawings in accordance with contract requirements, indicating in a neat and accurate manner a complete record of all revisions to the original design of the work. Include all changes and an accurate record, on reproductions of the contract drawings or appropriate shop drawings, of all deviations between the work shown and the work installed.
- B. The contractor shall provide a complete set of as-built drawings. Drawings shall be submitted in both hard copy and electronic (AutoCAD and Revit version as required by the Owner) version or AutoCAD Version 2018 if not specified. Number of copies of each as requested by the Owner.
- C. The as-built drawings shall reflect as installed conditions including all addenda, and miscellaneous revisions. The contractor shall make necessary modifications to the as-built drawings based upon the review submission comments. The final product shall include a copy of all electronic files of all as-built drawings of size and format consistent with the project standards.

1.7 GUARANTEES AND SERVICES

- A. All workmanship, installation materials, and equipment shall be guaranteed as specified in the General Conditions and Division 1.
- B. Contractor shall leave entire system installed under this Contract in proper working order, and shall replace any work or material which develops defects within the guarantee period, including all other work damaged as a result of such defects, without additional cost.

1.8 PERMITS AND CERTIFICATES

- A. Prior to proceeding with any installation, the Contractor shall prepare and submit to the proper authorities for their approval all working drawings required by them, and shall give all necessary notices, obtain all permits, and pay all local, state and federal taxes, fees and other costs in connection with this work.

1.9 EQUIPMENT MANUALS AND OPERATING INSTRUCTIONS

- A. Provide the following:
 - 1. Three complete sets of final and correct shop drawings, maintenance and replacement parts manuals, and operating instructions for the equipment supplied. Bind each set within a common binder. Index, number, and organize with a table of contents to permit quick and convenient reference.
 - 2. Three days of instruction in operation and maintenance of equipment to Owner's maintenance force during a 2-week period. Designate a 2-week period, convenient to the Owner, during which qualified personnel, including manufacturers' technicians and engineers, will be available for Owner's instructions.

1.10 SHORT CIRCUIT AND OVERCURRENT PROTECTION COORDINATION STUDY

- A. The equipment manufacturer shall perform and submit for review and approval (1) a short circuit study and (2) an overcurrent protection coordination study in accordance with IEEE "Red Book" Standard 141 for all service and distribution equipment supplied, including equipment specified in Sections 263213 Emergency Generator, 262413 Switchboards and 262416 Panelboards. Study reports shall accompany submittals for above items of equipment. **Submittals for the above items submitted without study reports shall be rejected.** If the report is not submitted with the equipment submittals then the contractor shall replace any circuit breakers or equipment as required to meet the short circuit and coordination requirements at no additional cost to the Owner.
- B. Manufacturer shall document that overcurrent protection devices will perform in accordance with their U.L. listings and ANSI/IEEE Standard 242.
- C. The contractor shall be responsible for final field adjustment of ground fault, overload and short circuit settings of adjustable circuit breakers and fused devices in compliance with the short circuit and coordination study recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS, EQUIPMENT AND SYSTEMS

- A. Materials and equipment and systems shall be new, bear manufacturer's name and trademark, and comply with applicable standards specified.
- B. The UL label shall be borne on each piece of applicable material or equipment.
- C. Equipment shall be provided with all required hardware for proper installation, assembly, and operation.
- D. The descriptions cover basic equipment and operation but not all the details of design and construction. The use of singular in descriptions does not limit the quantities of items to be furnished to provide the operation specified. Furnish all equipment required to produce specified

MANSFIELD ELEMENTARY SCHOOL

performance under installed conditions. Provide all trim, enclosures and accessories required to make a complete installation.

- E. Follow manufacturers' directions in delivery, storage, protection and installation of equipment and materials. Notify Architect promptly, in writing, of any conflict between requirements of the contract documents and manufacturers' directions, and obtain Architect's written instructions before proceeding with work. Bear all costs to correct deficiencies arising from failure to comply with the manufacturers' directions and instructions.
- F. Deliver equipment and materials to the site and store in original containers, suitably sheltered from the elements. Store items subject to moisture damage in dry, heated spaces. Tightly cover and protect equipment against dirt, water, chemical, and mechanical injury, and against theft.
- G. Equipment and materials of the same general type shall be of the same manufacturer, make and model throughout the work to provide uniform appearance, operation and maintenance.
- H. Where new products or components are indicated to be installed or connected to existing systems or equipment, verify compatibility and performance with the manufacturer of the existing systems or equipment prior to purchase and installation.
- I. Where devices and/or equipment are indicated to be relocated, conductors and raceway shall be extended to the new location and reconnected to provide a complete working system. If there are associated devices with the relocated equipment they shall be relocated as well, unless otherwise noted, and connected into the system.

2.2 EQUIPMENT DEVIATIONS

- A. Where Contractor proposes to use an item of equipment other than that specified or detailed on the drawings, and which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical or electrical layouts, such redesign and new drawings required thereby, with approval of the Architect, shall be prepared by the Contractor without additional cost.
- B. Where such approved deviation requires a different quantity or arrangement of equipment from that specified or indicated on the drawings, the Contractor shall provide any structural supports, controllers, motors, starters, wiring, conduit, and any other additional equipment required by the deviation, at no additional cost.
- C. It is the intent of these specifications that wherever a manufacturer of a product or a catalog number is specified, and terms "or equal" or "or approved equal" are used, a substituted item must conform in all essential respects to the specified item. Consideration will not be given to claims that a substituted item meets performance requirements with lesser construction. Performance as indicated in schedules and in specifications shall be interpreted as minimum acceptable performance.

PART 3 - EXECUTION

3.1 SITE INVESTIGATION

- A. Examine drawings, specifications, and site, and be responsible for the nature and location of work and the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials, availability of labor, electric power, roads, etc.

3.2 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work required. Do not scale the drawings. Consult the Mechanical and Architectural drawings and details for exact locations of equipment.
- B. Drawings shall be used in layout of work. Check reference drawings to verify spaces in which work will be installed, and maintain maximum headroom and space conditions. Where headroom, working clearances or space conditions appear inadequate, Architect shall be notified before proceeding with installation.
- C. If directed by the Architect, make minor modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

3.3 COORDINATION WITH OTHER TRADES

- A. Closely schedule the work so that the work will be installed at the proper time and without delaying the project's completion.
- B. Where the work of this Division is to be installed in close proximity to the work of other trades, or where there is evidence that the work will interfere with the work of other trades, assist in working out space conditions to make a satisfactory arrangement. If the work is installed before such coordination with other trades, make necessary changes in the work as directed by the Architect to correct any conflicts or interferences, without additional cost.

3.4 COORDINATION AND LAYOUT

- A. Study drawings and specifications to ensure completeness of work required. Include supplementary items normal to manufacturers' requirements or standard accepted trade practices as necessary to complete the work, even if not explicitly shown or specified.
- B. Verify measurements and conditions in field before starting work.
- C. Examine materials, surfaces, and structures to which work is to be applied and notify the Architect, in writing, of any conditions which are detrimental to proper and expeditious installation of work. Starting of work shall be construed as acceptance of conditions.

MANSFIELD ELEMENTARY SCHOOL

- D. Confer with other trades to install work to avoid interference with other trades. The necessary adjustments to conform to structural conditions and work of other trades, particularly ductwork and piping layouts, is included under this section. Assist other trades in the preparation of coordinated layout drawings.

3.5 CONNECTIONS TO EQUIPMENT FURNISHED UNDER OTHER DIVISIONS

- A. Provide electrical connections to equipment and fixtures requiring such connections which are supplied under other Divisions.
- B. Provide conduit, wire, fittings, accessories, and trim for final connection of each item of equipment as required for complete assembly and specified operation.
- C. Verify with approved project submittals that power conductor's meet both project as well as manufacturer requirements prior to conductor procurement and installation.
- D. Verify conductor material and specified size are compatible with equipment to be connected to.
- E. Notify architect and design team of identified issues prior to conductor procurement and installation.
- F. Proceed with procurement and installation only after unsatisfactory conditions have been corrected.

3.6 WORKMANSHIP

- A. Perform work in practical, neat, and workmanlike manner, with electricians skilled in the work they are performing, and using the best generally recognized trade practices.
- B. No work shall be covered or hidden from view until it has been inspected and approved by the required Building Department personnel and the Architect.
- C. Workmanship or materials not meeting with requirements of the specifications or drawings, or the satisfaction of the Architect, shall be rejected and shall be immediately replaced in an acceptable manner without additional cost.

3.7 TESTS

- A. Test all wiring, lighting fixtures, switches, controllers, starters, motors, etc., wired under this Division. Leave free from grounds, crosses, shorts, opens, etc., and leave materials and apparatus in proper and satisfactory working condition. Perform additional tests as listed in the other Division 26 specification sections.
- B. Furnish necessary meters, instruments, temporary wiring, and skilled labor to perform tests and adjustments. Measuring instruments shall be properly calibrated.
- C. Prior to energizing, test insulation resistance of all conductors and distribution equipment with a 500VDC megger, both phase-to-phase and phase-to-ground. Do not energize any circuits with a

MANSFIELD ELEMENTARY SCHOOL

reading of less than 50 megohms. Circuits under megger insulation test shall be connected to respective final terminals but with switches and breakers in the "OFF" position.

- D. Prior to energizing, test for continuity and identification of each conductor. Identify both ends of each conductor.
- E. Perform additional tests required by Owner, Architect or any other authorities having jurisdiction.
- F. Correct or replace any circuit, material or equipment which is found to be defective by these tests. Correct defects, whether due to faulty workmanship or material furnished, in a manner acceptable to Engineer without additional cost.
- G. Test for proper operation of emergency lighting equipment under simulated emergency conditions.
- H. Test all distribution equipment, motors, and three phase receptacles for proper phase connections and phase rotation. Correct as required.
- I. Notify Architect, in writing, at least one week prior to tests, of the proposed testing timetables. Perform tests with the approval of and in the presence of the Architect or his representative.

3.8 IDENTIFICATION

- A. Equipment
 - 1. Identify each item and the system or area it serves. Provide an engraved multilayer, multicolor, plastic nameplate in a visible location on each disconnect, switch, control and similar accessory. Provide stencils on all major equipment.
 - 2. All switchboard devices, panels, cabinets, junction boxes, switches, controllers, etc., shall be identified as to systems, voltage, phases, etc., on their exteriors.
- B. Wiring
 - 1. Provide fiber tags for feeders and branch circuits in pull boxes, cabinets, and outlets to identify each feeder and circuit.
 - 2. All cables and branch wiring shall be identified showing phasing, system designations, and items served. Identity is required in switchboards, panels, junction boxes, switches, controllers, cabinets, etc.
- C. Provide complete, accurate, typewritten panelboard and switchboard directories mounted securely to panelboard doors and switchboard faces.

3.9 TEMPORARY LIGHT AND POWER

- A. Contractor shall furnish, install and maintain a temporary light and power system to provide the buildings, field offices, and project site with temporary light to provide safe working conditions throughout, and to supply construction power as required on the job.
- B. The system shall be furnished, installed, and operating at the earliest possible date.

MANSFIELD ELEMENTARY SCHOOL

- C. All work for the system shall be in accordance with NEC Article 305, the requirements of the Utility Company, and as approved by the Owner and authorities having jurisdiction.
- D. The work shall include generally, but not be limited to, the following:
 - 1. Make all arrangements with the utility company or the Owner to furnish and install the temporary light and power service.
 - 2. Review and coordinate the electrical needs of all trades on a continuing basis, until permanent power and light is available and the temporary system is removed and no longer needed.
 - 3. Furnish, install, and maintain all required temporary system equipment, devices, and wiring. Remove when no longer needed, or at the direction of the Owner. Modify, add, or relocate equipment, devices, and wiring as required to suit job conditions.

END OF SECTION 260100

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Section Includes:
 1. Electrical equipment coordination and installation.
 2. Sleeves for raceways and cables.
 3. Sleeve seals.
 4. Grout.
 5. Common electrical installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Procedure: Prepare and make the submissions listed below and in Division 1.
- B. Shop Drawings: Submit shop drawings of all items proposed to be furnished and installed under this Division.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping and conduit installed at required slope.
 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

MANSFIELD ELEMENTARY SCHOOL

- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- E. Upon installation of back boxes for devices but prior to installation of raceway to same the contractor shall notify the Owner, Architect and Engineer at least two weeks prior so that a site visit for review of back box locations may be performed. Contractor shall promptly be given marked up directions indicating which back boxes are to be relocated. Relocation of back boxes as a result of the site review shall be performed at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Plastic. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Equipment Mounting: Install floor mounted equipment on concrete base, 4" height with 1" 45-degree chamfer extended 3" from equipment footprint. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
- F. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

MANSFIELD ELEMENTARY SCHOOL

- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping.

END OF SECTION 260500

MANSFIELD ELEMENTARY SCHOOL

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Section Includes:
 1. Copper building wire rated 600 V or less.
 2. Metal-clad cable, Type MC, rated 600 V or less.
 3. Category 6 Twisted Pair Cable
 4. Fire-alarm wire and cable.
 5. Connectors, splices, and terminations rated 600 V and less.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Alpha Wire Company.
 2. Cerro Wire LLC.

MANSFIELD ELEMENTARY SCHOOL

3. General Cable Technologies Corporation.
4. Okonite Company (The).
5. Southwire Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:

1. Type RHH and Type RHW-2: Comply with UL 44.
2. Type THHN and Type THWN-2: Comply with UL 83.
3. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

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

1. AFC Cable Systems; a part of Atkore International.
2. Belden Inc.
3. General Cable Technologies Corporation.
4. Okonite Company (The).
5. Southwire Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Multi circuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

F. Ground Conductor: Insulated.

MANSFIELD ELEMENTARY SCHOOL

- G. Conductor Insulation:
 - 1. Type TFN/THHN/THWN-2: Comply with UL 83.
- H. Armor: Steel, interlocked.

2.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. Berk-Tek Leviton; a Nexans/Leviton alliance.
 - 3. General Cable; Prysmian Group North America.
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568.2-D for Category 6 cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Shielded twisted pairs (FTP).
- F. Cable Rating: Plenum.
- G. Jacket: White thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6.
 - 2. Comply with TIA-568.2-D, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

2.5 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

MANSFIELD ELEMENTARY SCHOOL

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M Electrical Products.
 - 2. ABB Installation Products
 - 3. AFC Cable Systems; a part of Atkore International.
 - 4. Hubbell Power Systems, Inc.
 - 5. ILSCO.
 - 6. O-Z/Gedney; a brand of Emerson Industrial Automation.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper.
 - 2. Type: One hole with standard barrels.
 - 3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway or Metal-clad cable, Type MC. Homeruns in general shall be THHN-THWN, single conductors in raceway, except for routing above hung ceilings in corridors alongside other trades in which homeruns are permitted to be MC cables. Homerun shall be considered from the panelboard to the area served. Contractor shall provide a junction box in the area served to homerun from and transition to MC cable.

MANSFIELD ELEMENTARY SCHOOL

- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Metal clad cables are permitted for lighting switching legs in dry walls and for whips not exceeding 6 feet in length from a junction box to light fixtures in ceiling.

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72.
- B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."
 - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
 - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
 - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
 - 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is not permitted.
 - 4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess.

Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

3.5 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568.2-D.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated devices.
 - 5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from fittings.
 - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
- C. Open-Cable Installation:
 - 1. Install cabling with horizontal cable guides in spaces with terminating hardware and interconnection equipment.
 - 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

MANSFIELD ELEMENTARY SCHOOL

D. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-E for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

3.6 CONNECTIONS

- A. 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-486B.
- B. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.7 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.8 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.9 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.

- c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
- a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 - c. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
1. Procedures used.
 2. Results that comply with requirements.
 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.
- D. Category 6 Cable Tests and Inspections:
1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1-E.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568.2-D. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- E. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

MANSFIELD ELEMENTARY SCHOOL

- F. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- H. Prepare test and inspection reports.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:
 - 1) Test wells.
 - 2) Ground rods.
 - 3) Ground rings.

MANSFIELD ELEMENTARY SCHOOL

- 4) Grounding arrangements and connections for separately derived systems.
- b. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS.
 - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA. NFPA 70 – National Electrical Code
- B. UL 467 – Grounding & Bonding Equipment
- C. UL 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors
- D. UL 1059 – Terminal Blocks
- E. IEEE / ANSI 142 – Latest edition Recommended Practice for Grounding of Industrial and Commercial Power Systems
- F. ASTM B3 - Solid Conductors
- G. ASTM B8 – Assembly of Stranded Conductors
- H. ASTM B33 – Tined Conductors
- I. NEMA GR1 – Ground Rods and Ground Rod Couplings

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ABB Blackburn Installation Products.
 2. Burndy; Part of Hubbell Electrical Systems.
 3. ERICO; a brand of nVent.
 4. Harger Lightning & Grounding.

5. ILSCO.
6. O-Z/Gedney; a brand of Emerson Industrial Automation.
7. Siemens Industry, Inc., Energy Management Division.

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B3.
 2. Stranded Conductors: ASTM B8.
 3. Tinned Conductors: ASTM B33.
 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Mechanical Connectors: Material – The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lock washers shall be made of silicon bronze and supplied as part of the connector body and shall be two bolted pressure types.
- C. The mechanical connectors shall meet or exceed UL467 and be clearly marked with catalog number, conductor size and manufacturer.
- D. Compression Connectors: Provide Irreversible compression connectors that meet or exceed the performance requirements of IEEE837 and UL467 latest revisions. Compression connectors shall be listed and labeled by a nationally recognized testing laboratory acceptable to Authorities having Jurisdiction for applications in which used and specific types, sizes and combination of conductors and other items connected.
- E. Compression Connectors: Material – The irreversible compression connectors shall be manufactured of pure wrought copper.

MANSFIELD ELEMENTARY SCHOOL

- F. The installation of the connectors shall be made with a hydraulic compression tool and die system clearly showing embossed die stamp on each crimp recommended by the manufacturer of the connectors
- G. The connectors shall be clearly marked with the manufacturer, catalog number and conductor size.
- H. Welded Connectors: Provide exothermic-welding connections for copper to copper and copper to steel, connections to ground rods, ground buses, ground wires and steel beams, kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- I. Welded Connectors: Material – Conductors spliced with exothermic welded connections shall be considered as a continuous conductor, as stated in the noted accompanying NEC Article 250.50, 250.64 and IEEE Standard 80 latest editions.
- J. Procedures outlined in the manufacturer’s installation instructions shall be followed. Molds shall not be modified during installation in field applications.
- K. Welded metals shall be a mixture of copper oxide and aluminum. Only one weld metal mixture shall be required for each grounding connection.
- L. Grounding connections shall be tested and certified in accordance with IEEE837, UL487A and UL467.
- M. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Furseweld Installation Products
 - 2. Burndy Thermoweld Part of Hubbell Electrical Systems
 - 3. Erico Cadweld A Brand of nVent
- N. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- O. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- P. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- Q. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- R. Conduit Hubs: Mechanical type, terminal with threaded hub.
- S. Ground Rod Clamps: Exothermic and or irreversible compression type.
- T. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- U. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with zinc-plated bolts.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet, non-sectional.
 - 1. Chemical-Enhanced Grounding Electrodes: Shall not be acceptable.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generators shall have a ground rod driven local to the generator and shall have a grounding electrode conductor, sized per the NEC, provided from the ground rod to the ground lug on the generator. The grounding electrode conductor shall be installed in a raceway from the generator to the grounding electrode and shall be bonded to the raceway by a method approved by the NEC.

- B. Step down transformers shall have a connection to an NEC approved grounding electrode via a grounding electrode conductor, sized per the NEC. The grounding electrode conductor shall be installed in a raceway to the grounding electrode from the transformer and shall be bonded to the raceway by a method approved by the NEC.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding at Handholes: Install a driven ground rod through handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before handhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into handhole through a waterproof sleeve in handhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Metal-clad cable runs.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

- E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- F. Metallic Fences: Comply with requirements of IEEE C2.
 - 1. Grounding Conductor: Bare copper, not less than No. 8 AWG.
 - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. Use exothermic welds for all below-grade connections.
 - 3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
 - 1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded or irreversible compression type connectors for outdoor locations; if a disconnect-type connection is required, use a mechanical bolted clamp.
- E. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install 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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
 1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches from building's foundation.
- I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- J. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in 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.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

MANSFIELD ELEMENTARY SCHOOL

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without 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.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each test well, 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.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
 5. Pad-Mounted Equipment: 5 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, contractor shall provide additional grounding electrodes until resistance value is achieved.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

MANSFIELD ELEMENTARY SCHOOL

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB Super Strut Installation Products.
 - b. Allied Tube & Conduit: a division of Eaton.
 - c. Cooper B-Line, Inc.; a division of Atkore
 - d. ERICO International Corporation. A division of nVent.
 - e. GS Metals Corp.; a division of Eaton.
 - f. Unistrut A; a division of Atkore.
 - g. Wesanco, Inc.

MANSFIELD ELEMENTARY SCHOOL

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101. MC cable shall be supported and secured by products UL listed for the purpose. Cable ties shall not be allowed for supporting MC cable but shall be allowed for bundling. The use of miscellaneous wire to secure or support MC cable for any reason shall not be allowed. MC cable shall be supported by MCS Series cable supports as manufactured by Caddy a Division of Erico, Inc. or equal. MC cable shall be supported parallel to studs with Colorado Jim supports as manufactured by Caddy a Division of Erico, Inc. or equal.
- C. Conduit and Cable Support Devices: Hot dipped galvanized steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Shall not be acceptable.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Eaton.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded hot dipped galvanized steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. Environment Applications and Finishes
 - 1. Indoor locations: Dry non-corrosive areas channel framing shall be pre-galvanized - electro galvanized steel finished. All hardware shall be pre-galvanized zinc plated steel.
 - 2. Outdoor wet or damp locations: Channel framing shall be hot dipped galvanized or 304 / 316 stainless steel as per drawings. All hardware shall be either hot dipped galvanized or 304 / 316 stainless steel and installed same as channel framing installation.
 - 3. Corrosive locations: In corrosive areas channel framing shall be 316 stainless steel as per drawings all hardware shall be 316 stainless steel.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, [EMT] [RMC] may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

MANSFIELD ELEMENTARY SCHOOL

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Boxes, enclosures, and cabinets.
- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
 - 2. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks and underground utility construction.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB Installation Products
 - b. AFC Cable Systems; a part of Atkore International.
 - c. Allied Tube & Conduit; a part of Atkore International.
 - d. Electri-Flex Company.
 - e. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - f. Robroy Industries.
 - g. Southwire Company.
 - h. Wheatland Tube Company.
 - 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 3. GRC: Comply with ANSI C80.1 and UL 6.
 - 4. ARC: Comply with ANSI C80.5 and UL 6A.
 - 5. EMT: Comply with ANSI C80.3 and UL 797.
 - 6. FMC: Comply with UL 1; zinc-coated steel.
 - 7. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360. Selected appropriate LFMC for each application environment.
- B. Metal Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB Installation Products.
 - b. AFC Cable Systems; a part of Atkore International.
 - c. Allied Tube & Conduit; a part of Atkore International.
 - d. Anamet Electrical, Inc.
 - e. Electri-Flex Company.
 - f. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - g. Robroy Industries.
 - h. Southwire Company.
 - i. Wheatland Tube Company.
 - 2. Comply with NEMA FB 1 and UL 514B.
 - 3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 4. Fittings, General: Listed and labeled for type of conduit, location, and use.
 - 5. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: compression.
 - 6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

- C. Joint Compound for GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB Carlon Installation Products
 - b. AFC Cable Systems; a part of Atkore International.
 - c. Anamet Electrical, Inc.
 - d. Arco Corporation.
 - e. CANTEX INC.
 - f. CertainTeed Corporation.
 - g. Condux International, Inc.
 - h. Electri-Flex Company.
 - i. Lamson & Sessions.
 - j. RACO; Hubbell.
 - k. Topaz Electric; a division of Topaz Lighting Corp.
- 2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 3. RNC: Type EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- 4. LFNC: Comply with UL 1660.
- 5. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB Carlon Installation Products
 - b. AFC Cable Systems; a part of Atkore International.
 - c. Arco Corporation.
 - d. CANTEX INC.
 - e. CertainTeed Corporation.
 - f. Condux International, Inc.
 - g. Electri-Flex Company.
 - h. Lamson & Sessions.
 - i. RACO; Hubbell.
- 2. Fittings, General: Listed and labeled for type of conduit, location, and use.
- 3. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
 - a. Fittings for LFNC: Comply with UL 514B.
- 4. Solvents and Adhesives: As recommended by conduit manufacturer.
- 5. Nonmetallic Combination Expansion / Deflection Fittings: Shall have a neoprene outer jacket with stainless steel straps and shall be ABB NM-XD Series.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business.
 - 2. Hoffman; a brand of nVent.
 - 3. MonoSystems, Inc.
 - 4. Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Steel City & Carlon Installation Products.
 - 2. Crouse-Hinds, an Eaton business.
 - 3. Hoffman; a brand of nVent.
 - 4. Hubbell Incorporated.
 - 5. Hubbell Incorporated; Wiring Device-Kellems.
 - 6. Milbank Manufacturing Co.
 - 7. Oldcastle Enclosure Solutions.
 - 8. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 9. RACO; Hubbell.
 - 10. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, [ferrous alloy], Type FD, with gasketed cover.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal or sheet metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.

MANSFIELD ELEMENTARY SCHOOL

4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- K. Cabinets:
 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 METALLIC EXPANSION/DEFLECTION COUPLING

- A. Fittings shall be galvanized malleable iron or steel with an internal bonding jumper.
- B. Manufacturer:
 1. ABB XD & XJG Series Instillation Products.
 2. Crouse-Hinds Model XD & XJG a division of Eaton.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: Aluminum.
 - 2. Concealed Conduit, Aboveground: Aluminum.
 - 3. Underground Conduit: Refer to Section 260543 - Underground Ducts for Electrical Systems.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Mechanical rooms.
 - c. Gymnasiums.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 6. Damp or Wet Locations: Aluminum.
 - 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

- C. Minimum Raceway Size: 3/4-inch trade size.

- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
 - 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

- G. Install surface raceways only where indicated on Drawings.

- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from ENT to EMT or rigid steel conduit before rising above the floor. EMT or rigid steel conduit shall be selected based on type of area conduit is installed as specified above.
- M. Stub-Ups to Above Recessed Ceilings:
 - 1. Use EMT, or RMC for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- P. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- R. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- T. Surface Raceways:
 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Conduit extending from interior to exterior of building.
 4. Conduit extending into pressurized duct and equipment.
 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 6. Where otherwise required by NFPA 70.
- W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

- X. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints. Refer to architectural/structural drawings for locations.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- CC. Locate boxes so that cover or plate will not span different building finishes.
- DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- FF. Set metal floor boxes level and flush with finished floor surface.

MANSFIELD ELEMENTARY SCHOOL

- GG. Where the installation of backboxes occur in fire rated assemblies fire rated putty shall be installed on the exterior of the backbox. Refer to architectural drawings for fire rated assembly locations.
- HH. Where the installation of backboxes occur in sound isolating walls the backboxes shall be separated by at least one stud bay to avoid the degradation of the sound isolation.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

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. Section Includes:
 - 1. Metal conduits and fittings, including GRC.
 - 2. Rigid nonmetallic duct.
 - 3. Flexible nonmetallic duct.
 - 4. Duct accessories.
 - 5. Polymer concrete handholes and boxes with polymer concrete cover.
 - 6. Utility structure accessories.

1.3 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 - 1. Two or more ducts installed in parallel, with or without additional casing materials.
 - 2. Multiple duct banks.
- D. GRC: Galvanized rigid (steel) conduit.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include duct-bank materials, including spacers and miscellaneous components.
 - 2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Include accessories for handholes and boxes.
 - 4. Include underground-line warning tape.

MANSFIELD ELEMENTARY SCHOOL

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:
 - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include reinforcement details.
 - d. Include frame and cover design.
 - e. Include grounding details.
 - f. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - g. Include joint details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.
 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C858.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.6 MAINTENANCE MATERIALS SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.8 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify Architect, Construction Manager, Owner no fewer than two days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Architect's, Construction Manager's, Owner's written permission.

MANSFIELD ELEMENTARY SCHOOL

- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AFC Cable Systems; a part of Atkore International.
 2. Allied Tube & Conduit; a part of Atkore International.
 3. Anamet Electrical, Inc.
 4. Electri-Flex Company.
 5. O-Z/Gedney; a brand of Emerson Industrial Automation.
 6. Perma-Cote.
 7. Plasti-Bond.
 8. Southwire Company.
 9. Thomas & Betts Corporation; A Member of the ABB Group.
 10. Wheatland Tube Company.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ARNCO Corp.
 2. Beck Manufacturing.
 3. CANTEX INC.
 4. CertainTeed Corporation.
 5. Condux International, Inc.
 6. ElecSys, Inc.
 7. IPEX USA LLC.
 8. Lamson & Sessions.
 9. Manhattan/CDT.
 10. Spiraduct/AFC Cable Systems, Inc.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.3 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. CANTEX INC.
 - c. Carlon; a brand of Thomas & Betts Corporation.
 - d. Underground Devices, Inc.
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.4 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armorcast Products Company.
 - 2. MacLean Highline.
 - 3. NewBasis.
 - 4. Oldcastle Enclosure Solutions.
 - 5. Quazite: Hubbell Power Systems, Inc.
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Green.
- E. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "ELECTRIC."
- I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.5 UTILITY STRUCTURE ACCESSORIES

- A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. BILCO Company (The).
 - 2. Campbell Foundry Company.
 - 3. Carder Concrete Products.
 - 4. Christy Concrete Products.
 - 5. EJ.
 - 6. Elmhurst-Chicago Stone Co.
 - 7. McKinley Iron Works, Inc.
 - 8. Neenah Foundry Company.
 - 9. NewBasis.
 - 10. Oldcastle Precast, Inc.
 - 11. Osburn Associates, Inc.
 - 12. Pennsylvania Insert Corporation.
 - 13. Quazite: Hubbell Power Systems, Inc.
 - 14. Rinker Group, Ltd.
 - 15. Riverton Concrete Products.
 - 16. Underground Devices, Inc.
 - 17. Utility Concrete Products, LLC.
 - 18. Utility Vault Co.
 - 19. Wausau Tile Inc.
- C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.
 - 1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- D. Pulling-in and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- E. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- F. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- G. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
 - 1. Stanchions: Nominal 36 inches high by 4 inches wide, with provisions to connect to other sections to form a continuous unit, with minimum of nine holes for arm attachment.

MANSFIELD ELEMENTARY SCHOOL

2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

- H. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of underground boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 2. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

MANSFIELD ELEMENTARY SCHOOL

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Cables More than 600V: Type EPC-80-PVC, in direct-buried duct bank with 3" sand encasement all around.
- B. Duct for Electrical Feeders and branch circuits 600 V and Less: Type EPC-40-PVC RNC, in direct-buried duct bank with 3" sand encasement all around, unless otherwise indicated.
- C. Underground Ducts Crossing Paved Paths, Walks and Driveways: Type EPC-40 PVC RNC, encased in reinforced concrete.
- D. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
 - 5. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area after construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2.
- C. Slope: Pitch duct a minimum slope of 1:300 down toward handholes and away from buildings and equipment. Slope duct from a high point between two handholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition
- H. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- I. Pulling Cord: Install 200-lbf-test nylon cord in empty ducts.
- J. Concrete-Encased Ducts and Duct Bank:
 - 1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
 - 2. Width: Excavate trench 12 inches wider than duct on each side.
 - 3. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - 4. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 5. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.

6. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - a. Couple RNC duct to GRC with adapters designed for this purpose and encase coupling with 3 inches of concrete.
 - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
 - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.
 7. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 8. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
 9. Concreting Sequence: Pour each run of envelope between handholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
- K. Direct-Buried Duct and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
 2. Width: Excavate trench 12 inches wider than duct on each side.
 3. Width: Excavate trench 3 inches wider than duct on each side.
 4. Set elevation of bottom of duct bank below frost line.
 5. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 7. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.

8. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
 - a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
 - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.
9. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
 - a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.

- L. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF PRECAST CONCRETE HANDHOLES, AND BOXES

- A. Precast Polymer Concrete Handhole Installation:
 1. Comply with ASTM C891 unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
 4. Refer to manufacturer's written instructions for additional installation requirements.
- B. Elevations:
 1. Install handholes with bottom below frost line.
 2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

MANSFIELD ELEMENTARY SCHOOL

- C. Waterproofing: Apply waterproofing to exterior surfaces of handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071310 "Self-Adhering Sheet Waterproofing." After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars.
- D. Hardware: Install removable hardware, including pulling eyes, cable stanchions and cable arms, as required for installation and support of cables and conductors and as indicated.
- E. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
 - 3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of handholes, including sump.
 - 1. Sweep floor, removing dirt and debris.
 - 2. Remove foreign material.

END OF SECTION 260543

SECTION 260548 - VIBRATION CONTROLS FOR ELECTRICAL SYSTEMS

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:
 - 1. Isolation pads.
 - 2. Spring isolators.
 - 3. Restrained spring isolators.
 - 4. Channel support systems.
 - 5. Restraint cables.
 - 6. Hanger rod stiffeners.
 - 7. Anchorage bushings and washers.
- B. Related Sections include the following:
 - 1. Division 26 Section "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

- A. The IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

- A. Refer to structural drawings for wind speed and seismic design criteria.
- B. Importance Factor:
 - 1. The component importance factor, I_p , shall be taken as 1.5 if any of the following conditions apply:
 - a. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.
 - b. The component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.

- c. The component is in or attached to a Risk Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.
 - d. The component conveys, supports, or otherwise contains hazardous substances and is attached to a structure or portion thereof classified by the authority having jurisdiction as a hazardous occupancy.
2. The following system have an importance factor of 1.5:
 3. All other components shall be assigned a component importance factor, I_p , equal to 1.0.
- C. Wind-Restraint Loading:
1. Basic Wind Speed: 110 mph.
- D. Seismic-Restraint Loading:
1. Seismic Design Category (SDC): B
 2. Seismic Risk Category: III

1.5 SUBMITTALS

- A. Product Data: For the following:
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by OSHPD.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- B. Delegated-Design Submittal: For vibration isolation details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, required to select vibration isolators
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 3. Field-fabricated supports.
- C. Welding certificates.
- D. Qualification Data: For professional engineer and testing agency.
- E. Field quality-control test reports.

MANSFIELD ELEMENTARY SCHOOL

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. Ace Mountings Co., Inc.
 - 2. Amber/Booth Company, Inc.
 - 3. California Dynamics Corporation.
 - 4. Isolation Technology, Inc.
 - 5. Kinetics Noise Control.
 - 6. Mason Industries.
 - 7. Vibration Eliminator Co., Inc.
 - 8. Vibration Isolation.
 - 9. Vibration Mountings & Controls, Inc.
- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

MANSFIELD ELEMENTARY SCHOOL

- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - 2. Restraint: limit-stop as required for equipment and authorities having jurisdiction.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by OSHPD.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Section Includes:
 - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
 - 2. Labels. Labels located in plenum spaces shall be plenum rated.
 - 3. Bands and tubes.
 - 4. Tapes and stencils.
 - 5. Tags.
 - 6. Signs.
 - 7. Cable ties.
 - 8. Paint for identification.
 - 9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.

- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for service, feeder and branch-circuit conductors.
 - 1. Color shall be factory applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 4. Color for Neutral: White for 208/120 or 120/240-volt systems and gray for 480/277-volt systems.
 - 5. Color for Equipment Grounds: Green for 208/120-volt systems and Green with a yellow stripe for 480/277-volt systems.
- C. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.
- D. Warning labels and signs shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES." for 208-volt systems and 48" for 480-volt systems.
- E. Equipment Identification Labels:
 - 1. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Not Permitted.

- F. Plastic Labels for Equipment Name Identification
 - 1. Engraved, multilayer, multicolor, plastic labels for engraving, 1/8" thick.
 - 2. Self-adhesive: Not Permitted.
 - 3. Predrilled holes for attachment hardware.
 - 4. Colors: White letters on black background, unless specified otherwise herein or elsewhere in contract documents.
 - 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 6. Minimum letter height shall be 1/2".
 - 7. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2" by 1-1/2". Where multiple lines are required, add 1/2" in height per additional line.
 - 8. Fasteners: Stainless-steel rivets or self-tapping screws.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Marking Services, Inc.
 - c. Panduit Corp.
 - d. Seton Identification Products.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Marking Services, Inc.
 - c. Panduit Corp.
 - d. Seton Identification Products.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Marking Services, Inc.
 - c. Panduit Corp.
 - d. Seton Identification Products.
 - 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Marking Services, Inc.
 - c. Panduit Corp.
 - d. Seton Identification Products.
 - 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Marking Services, Inc.
 - c. Panduit Corp.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Panduit Corp.

2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ideal Industries, Inc.
 - b. Marking Services, Inc.
 - c. Panduit Corp.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. Marking Services, Inc.

- C. Underground-Line Warning Tape:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Ideal Industries, Inc.
 - c. Marking Services, Inc.
 - d. Seton Identification Products.
 2. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 3. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 4. Tag:
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Overall Thickness: 5 mils.
 - d. Foil Core Thickness: 0.35 mil.
 - e. Weight: 28 lb/1000 sq. ft..
 - f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.
- D. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

- A. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Marking Services, Inc.
 - b. Panduit Corp.
 - c. Seton Identification Products.
 2. Polyester Tags: 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment.
 3. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.7 SIGNS

- A. Baked-Enamel Signs:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlton Industries, LP.
 - b. emedco.
 - c. Marking Services, Inc.
 - 2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 3. 1/4-inch grommets in corners for mounting.
 - 4. Nominal Size: 7 by 10 inches.
 - a. Engraved legend with white letters on a dark gray background.
 - b. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - c. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ideal Industries, Inc.
 - 2. Marking Services, Inc.
 - 3. Panduit Corp.
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.
- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.
- D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- I. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- K. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
- L. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- M. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- N. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- P. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- Q. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- R. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- S. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- T. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- U. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- V. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where

- width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- W. Nonmetallic Preprinted Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using general-purpose, UV-stabilized, plenum-rated cable ties as applicable.
- X. Baked-Enamel Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.
- Y. Metal-Backed Butyrate Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- Z. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- AA. Cable Ties: General purpose, for attaching tags, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits: Identify with self-adhesive raceway labels, vinyl tape applied in bands.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 25-foot maximum intervals in straight runs, and at 15-foot maximum intervals in congested areas.

- D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels to identify the phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- H. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- I. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- J. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- K. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- N. Arc Flash Warning Labeling: Self-adhesive labels.
- O. Operating Instruction Signs: Baked-enamel warning signs.

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- P. Emergency Operating Instruction Signs: Baked-enamel warning signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

- Q. Identify PV system equipment and components in accordance with NEC article 690.

- R. Equipment Identification Labels:
 - 1. Indoor Equipment: Baked-enamel signs.
 - 2. Outdoor Equipment: Stenciled legend 4 inches high.
 - 3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchboards.
 - e. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - f. Emergency system boxes and enclosures.
 - g. Emergency system raceways and cables.
 - h. Enclosed switches.
 - i. Enclosed circuit breakers.
 - j. Enclosed controllers.
 - k. Variable-speed controllers.
 - l. Push-button stations.
 - m. Power-transfer equipment.
 - n. Power-generating units.
 - o. Monitoring and control equipment.
 - p. PV system equipment and components.

END OF SECTION 260553

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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 computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. CGI CYME.
 - 2. Power Analytics Corporation.
 - 3. EasyPower, LLC.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

2.3 ARC-FLASH ANALYSIS

- A. Conduct arc flash analysis after acceptance by Engineer of short-circuit study and coordination study. Perform arc flash analysis for each operating mode of the system, in accordance with IEEE 1584 and NFPA 70E.
- B. Document the protection and calculation procedures and coordination review in testing report. Present analysis results in tabular format showing the following:
 - 1. Bus and protection device name.
 - 2. Bolted and arcing fault values.
 - 3. Protective device trip times.
 - 4. Arc flash boundary, working distance, and incident energy.
 - 5. Required protective flame-resistant (FR) clothing class.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled.

3.2 POWER SYSTEM DATA

- A. The contractor shall gather and tabulate the following input data, by performing field surveys and equipment investigation, to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 1. Switchboard bus.
 2. Distribution panelboard.
 3. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241 and IEEE 242.
 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 3. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- F. Equipment Evaluation Report:
 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141, IEEE 241, IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.

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- F. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 260573

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SECTION 260800 - ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

- A. Division 26 – Electrical
- B. Section 019113 – General Commissioning Requirements

1.3 REQUIRMENTS

- A. The Commissioning process requires the participation of Division 26, Electrical, to ensure that all systems fulfill the functional and pre-functional requirements set forth in these construction documents. The general commissioning requirements and coordination are detailed in Section 019113. Division 26, Electrical, shall fulfill commissioning responsibilities assigned to division 26 in accordance with Section 019113.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

- A. Pre-functional checklists assist in the process to document that the equipment and systems are installed properly.
 - 1. The contractor will be provided with construction checklists from the CA for completion. The contractor shall complete the checklists as provide the CA with completed copies in accordance with 019113.
 - 2. See attached for a sample pre-functional performance test checklist, attached is included only to provide sample of a typical process and scope.

3.2 FUNCTIONAL PERFORMANCE TESTING

- A. Intent of functional performance testing is to prove thru functional test procedures proper system operation.
- B. The contractor will be provided with functional performance test procedures to perform while CA witnesses. The contractor shall perform functional tests in accordance with 019113.
- C. See attached for a sample functional performance test checklist, attached is included only to provide sample of a typical process and scope.

3.3 PREFUNCTIONAL CHECKLISTS AND FUNCTIONAL PERFORMANCE TESTING

- A. Pre-Functional Checklists and Functional performance testing procedures will be performed on the following system types. (Pre Functional and Functional performance testing requirements are in addition to and do not replace any testing required elsewhere in Division 26 or by applicable codes.) Equipment specifically marked as such below shall be provided with start-up of equipment by factory-authorized service representative.
 - 1. Emergency Generator and associated transfer panels (if applicable)-Provide with factory authorized start-up.
 - 2. Lighting Control Systems including daylight harvesting

3.4 SAMPLE CHECKLISTS

- A. See Attached.

End of Section

Sample Only – Sequences and Functional Test Sheet to be updated later based on final contract documents.

Contractor Checklist and Functional Test Procedures

Lighting Control Systems

1. Participants

Discipline	Name	Company
CxA	_____	_____
Mechanical	_____	_____
Controls	_____	_____
TAB	_____	_____
Plumbing	_____	_____
Electrical	_____	_____
Date Returned to CxA _____		

Check	Description
<input type="checkbox"/>	The above equipment and systems integral to them are complete and ready for functional testing.
<input type="checkbox"/>	All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.
<input type="checkbox"/>	Test and balance completed and approved for the hydronic systems and terminal units connected
<input type="checkbox"/>	All A/E punchlist items for this equipment corrected.
<input type="checkbox"/>	Safeties and operating ranges reviewed.
	Schedules and reviewed
	<ul style="list-style-type: none"> This checklist does not take the place of the manufacturer’s recommended checkout and startup procedures. Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others). Contractor’s assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.

3. Installation Checks

Check if Okay. Enter comment or note number if deficient.

Check	Equip Tag→	Lighting	Comments
Lighting			
Devices installed per manufacturer’s instructions and specifications		<input type="checkbox"/>	
Lighting control system installed per plans, specifications and manufacturer’s recommendations		<input type="checkbox"/>	
Switches and occupancy sensors installed at correct height and have correct cover / escutcheon plate		<input type="checkbox"/>	

The checklist items all successfully completed for given trade YES NO

4. Operational Checks

Check if Okay. Enter comment or note number if deficient.

Check	Equip Tag→	Lighting	Comments
Operational			
Lights are all functioning. No bulbs are burned out		<input type="checkbox"/>	
Lights are not turning on and off frequently causing a disruptions		<input type="checkbox"/>	

The checklist items all successfully completed for given trade YES NO

5. Functional Testing Record

Lighting Systems

Test#	Mode ID	Test Procedure	Expected Response	Pass Y/N	Note
1	Classroom/Learning Spaces with DL Harvesting				
2	Private Offices, Teach Lounge with DL Harvesting				
3	Private Offices, Teach Lounge w/o DL Harvesting				
4	Conf/Meeting Rms with DL Harvesting				
5	Conf/Meeting Rms w/o DL Harvesting				
6	Gym				
7	Café				
8	Learning Commons				

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9	Stage/Platform				
10	Kitchen, Elec, Mech, Telecom Rms				
11	Restrooms				
12	Closet, Storage, Misc.				
13	Corr, Vest, Lobby and Egress Stair				
14	Flagpole				
15	Exterior/Site				
16	Emergency				

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LIGHTING CONTROL SEQUENCE OF OPERATION			
SPACE TYPE	LIGHTING CONTROL STRATEGY	DETAIL/ DRAWING	TARGET ILLUMINANCE (FOOT-CANDLES)
CLASSROOMS/LEARNING SPACES WITH DAYLIGHT HARVESTING	LIGHTING CONTROLS SHALL HAVE TWO MODES OF ILLUMINATION: GENERAL LIGHTING AND PRESENTATION LIGHTING. CONTROLS SHALL CONSIST OF A LOW VOLTAGE WALL CONTROL STATION, CEILING MOUNTED VACANCY SENSORS (ALL LIGHTING MANUAL ON PER SCENE SELECTION / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY), IF SHOWN ON PLANS. DAYLIGHT SENSOR(S) SHALL AUTOMATICALLY DIM SELECT LIGHTING FIXTURES IN RESPONSE TO DAYLIGHT. THE WALL CONTROL STATION SHALL BE PROGRAMMED AND ENGRAVED AS FOLLOWS: "ON", "50%", "PRESENTATION" AND "OFF". ADDITIONALLY, THE CONTROL STATION SHALL ALLOW FOR INDEPENDENT RAISE/LOWER DIMMING OF THE PRESENTATION AND GENERAL LIGHTING ZONES. SELECTED RECEPTACLES SHALL BE CONTROLLED TO MATCH THE OCCUPANCY CONTROL.	4 / E6.02	50 fc
PRIVATE OFFICES, TEACHERS LOUNGE WITH DAYLIGHT HARVESTING	LIGHTING CONTROLS SHALL CONSIST OF A LOW VOLTAGE SWITCH, A CEILING MOUNTED VACANCY SENSOR (ALL LIGHTING MANUAL ON TO 100% / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY), AND A CEILING MOUNTED DAYLIGHT SENSOR TO AUTOMATICALLY DIM SELECT LIGHTING FIXTURES IN RESPONSE TO DAYLIGHT. THE WALL CONTROL STATION SHALL BE PROGRAMMED AND ENGRAVED AS FOLLOWS: "ON", "50%", "PRESENTATION" AND "OFF". ADDITIONALLY, THE CONTROL STATION SHALL ALLOW FOR INDEPENDENT RAISE/LOWER DIMMING OF THE PRESENTATION AND GENERAL LIGHTING ZONES. SELECTED RECEPTACLES SHALL BE CONTROLLED TO MATCH THE OCCUPANCY CONTROL.	2 / E6.02	50 fc
PRIVATE OFFICES, TEACHERS LOUNGE WITHOUT DAYLIGHT HARVESTING	LIGHTING CONTROLS SHALL CONSIST OF A LOW VOLTAGE SWITCH AND A CEILING MOUNTED VACANCY SENSOR (ALL LIGHTING MANUAL ON TO 100% / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY), OR A WALL SWITCH VACANCY SENSOR (ALL LIGHTING MANUAL ON TO 100% / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY) AS INDICATED ON THE RCP'S. ADDITIONALLY, SELECTED RECEPTACLES SHALL BE CONTROLLED TO MATCH OCCUPANCY/LIGHTING CONTROL.	2 / E6.02	50 fc
CONFERENCE/MEETING ROOMS WITH DAYLIGHT HARVESTING	LIGHTING CONTROLS SHALL CONSIST OF A LOW VOLTAGE WALL CONTROL STATION, A CEILING MOUNTED VACANCY SENSOR (ALL LIGHTING MANUAL ON PER SCENE SELECTION / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY), IF SHOWN ON PLANS. DAYLIGHT SENSOR(S) SHALL AUTOMATICALLY DIM SELECT LIGHTING FIXTURES IN RESPONSE TO DAYLIGHT. THE WALL CONTROL STATION SHALL BE PROGRAMMED AND ENGRAVED AS FOLLOWS: "ON", "50%", "PRESENTATION" AND "OFF". ADDITIONALLY, THE CONTROL STATION SHALL ALLOW FOR INDEPENDENT RAISE/LOWER DIMMING OF THE PRESENTATION AND GENERAL LIGHTING ZONES. SELECTED RECEPTACLES SHALL BE CONTROLLED TO MATCH THE OCCUPANCY CONTROL.	4 / E6.02	50 fc
CONFERENCE/MEETING ROOMS WITHOUT DAYLIGHT HARVESTING	LIGHTING CONTROLS SHALL CONSIST OF A LOW VOLTAGE WALL CONTROL STATION, A CEILING MOUNTED VACANCY SENSOR (ALL LIGHTING MANUAL ON PER SCENE SELECTION / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY), THE WALL CONTROL STATION SHALL BE PROGRAMMED AND ENGRAVED AS FOLLOWS: "ON", "50%", "PRESENTATION" AND "OFF". ADDITIONALLY, THE CONTROL STATION SHALL ALLOW FOR INDEPENDENT RAISE/LOWER DIMMING OF THE PRESENTATION AND GENERAL LIGHTING ZONES. SELECTED RECEPTACLES SHALL BE CONTROLLED TO MATCH THE OCCUPANCY CONTROL.	4 / E6.02	50 fc
GYMNASIUM	LIGHTING CONTROLS SHALL CONSIST OF A LOW VOLTAGE WALL CONTROL STATION, A CEILING MOUNTED VACANCY SENSOR (ALL LIGHTING MANUAL ON PER SCENE SELECTION / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY), AND WALL MOUNTED DAYLIGHT SENSORS TO AUTOMATICALLY DIM SELECT LIGHTING FIXTURES IN RESPONSE TO DAYLIGHT. THE WALL CONTROL STATION SHALL BE PROGRAMMED AND ENGRAVED AS FOLLOWS: "ON", "50%", "PRESENTATION" AND "OFF". ADDITIONALLY, THE CONTROL STATION SHALL ALLOW FOR INDEPENDENT RAISE/LOWER DIMMING OF THE PRESENTATION AND GENERAL LIGHTING ZONES.	2 / E6.02	50 fc
CAFE	LIGHTING SHALL BE CONTROLLED BY THE BUILDING MANAGEMENT SYSTEM (TIME SCHEDULING). TIME SCHEDULING OF LIGHTING SHALL BE DETERMINED BY OWNER. COORDINATE WITH OWNER AND DIVISION 23. OCCUPANCY SENSOR(S) (ALL LIGHTING AUTOMATIC ON TO 100% / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY) SHALL CONTROL LIGHTING AFTER HOURS. IF SHOWN ON DRAWINGS, DAYLIGHT SENSOR(S) SHALL AUTOMATICALLY DIM SELECT LIGHTING FIXTURES IN RESPONSE TO DAYLIGHT. DAYLIGHT DIMMING CONTROLS SHALL BE PROGRAMMED SUCH THAT THE LIGHT LEVEL MEASURED AT THE WALKING SURFACE SHALL NOT BE DIMMABLE TO LESS THAN 1 FC.	7 / E6.02	20 fc
LEARNING COMMONS	LIGHTING SHALL BE CONTROLLED BY THE BUILDING MANAGEMENT SYSTEM (TIME SCHEDULING). TIME SCHEDULING OF LIGHTING SHALL BE DETERMINED BY OWNER. COORDINATE WITH OWNER AND DIVISION 23. OCCUPANCY SENSOR(S) (ALL LIGHTING AUTOMATIC ON TO 100% / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY) SHALL CONTROL LIGHTING AFTER HOURS. IF SHOWN ON DRAWINGS, DAYLIGHT SENSOR(S) SHALL AUTOMATICALLY DIM SELECT LIGHTING FIXTURES IN RESPONSE TO DAYLIGHT. DAYLIGHT DIMMING CONTROLS SHALL BE PROGRAMMED SUCH THAT THE LIGHT LEVEL MEASURED AT THE WALKING SURFACE SHALL NOT BE DIMMABLE TO LESS THAN 1 FC.	7 / E6.02	-
STAGE PLATFORM	LIGHTING CONTROLS SHALL CONSIST OF A LOW VOLTAGE WALL CONTROL STATION, A CEILING MOUNTED VACANCY SENSOR (ALL LIGHTING MANUAL ON PER SCENE SELECTION / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY), THE WALL CONTROL STATION SHALL BE PROGRAMMED AND ENGRAVED AS FOLLOWS: "ON", "50%", "PERFORMANCE" AND "OFF". ADDITIONALLY, THE CONTROL STATION SHALL ALLOW FOR INDEPENDENT RAISE/LOWER DIMMING OF THE PRESENTATION AND GENERAL LIGHTING ZONES.	2 / E6.02	20 fc
KITCHEN, ELECTRICAL, MECHANICAL, AND TELECOM ROOM LIGHTING	LIGHTING SHALL BE CONTROLLED BY EITHER A SINGLE POLE SWITCH (ALL LIGHTING MANUAL ON TO 100% / ALL LIGHTING MANUAL OFF), 3-WAY SWITCHES (ALL LIGHTING MANUAL ON TO 100% / ALL LIGHTING MANUAL OFF), OR 4-WAY SWITCHES (ALL LIGHTING MANUAL ON TO 100% / ALL LIGHTING MANUAL OFF). REFER TO LIGHTING PLANS FOR CONTROL TYPE.	-	-
RESTROOM LIGHTING	LIGHTING IN SINGLE OCCUPANCY RESTROOMS SHALL BE CONTROLLED BY A WALL SWITCH OCCUPANCY SENSOR(S) (ALL LIGHTING AUTOMATIC ON TO 100% / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY). IN MULTI-OCCUPANCY RESTROOMS, LIGHTING SHALL BE CONTROLLED BY A REMOTE SWITCH AND AN OCCUPANCY SENSOR(S) (ALL LIGHTING AUTOMATIC ON TO 100% / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY). REMOTE SWITCH SHALL BE IDENTIFIED WITH ROOM IT CONTROLS AND LED LIGHT SHALL ILLUMINATE WHEN LIGHTING IN CONTROLLED ROOM IS ON. REFER TO LIGHTING PLANS FOR CONTROL TYPE.	5 / E6.02	25 - 30 fc
CLOSET, STORAGE, AND MISC. ROOM LIGHTING	LIGHTING SHALL BE CONTROLLED BY EITHER A WALL SWITCH VACANCY SENSOR(S) (ALL LIGHTING MANUAL ON TO 100% / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY), OR A SWITCH(ES) AND A VACANCY SENSOR(S) (ALL LIGHTING MANUAL ON TO 100% / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY). REFER TO LIGHTING PLANS FOR CONTROL TYPE.	2 / E6.02	20 fc
CORRIDOR, VESTIBULE, LOBBY AND EGRESS STAIR LIGHTING	LIGHTING SHALL BE CONTROLLED BY THE BUILDING MANAGEMENT SYSTEM (TIME SCHEDULING). TIME SCHEDULING OF LIGHTING SHALL BE DETERMINED BY OWNER. COORDINATE WITH OWNER AND DIVISION 23. OCCUPANCY SENSOR(S) (ALL LIGHTING AUTOMATIC ON TO 100% / ALL LIGHTING AUTOMATIC OFF AFTER 20 MINUTES OF NO OCCUPANCY) SHALL CONTROL LIGHTING AFTER HOURS. IF SHOWN ON DRAWINGS, DAYLIGHT SENSOR(S) SHALL AUTOMATICALLY DIM SELECT LIGHTING FIXTURES IN RESPONSE TO DAYLIGHT. DAYLIGHT DIMMING CONTROLS SHALL BE PROGRAMMED SUCH THAT THE LIGHT LEVEL MEASURED AT THE WALKING SURFACE SHALL NOT BE DIMMABLE TO LESS THAN 1 FC.	7 / E6.02	15 - 20 fc
FLAGPOLE LIGHTING	LIGHTING SHALL BE CONTROLLED BY A PHOTOCELL. A MAINTENANCE SWITCH MAY BE USED TO OVERRIDE THE LIGHTING TO ON FOR MAINTENANCE PURPOSES. THE PHOTOCELL CONTACT SHALL CLOSE WHEN THERE IS INSUFFICIENT SUNLIGHT TO ILLUMINATE THE SITE. THE SUNLIGHT LEVEL SHALL BE DETERMINED IN FIELD.	6 / E6.02	-
EXTERIOR AND SITE LIGHTING	LIGHTING SHALL BE CONTROLLED BY A PHOTOCELL AND THE BUILDING MANAGEMENT SYSTEM (TIME SCHEDULING). WHEN ENABLED THROUGH THE BMS AND PHOTOCELL, SITE LIGHTING FIXTURES SHALL BE CONTROLLED USING HIGH/LOW MOTION SENSORS PROVIDED INTEGRAL TO THE FIXTURES (EXCLUDED FOR BUILDING MOUNTED LIGHTING FIXTURES). BASED ON DETECTION (100% IF MOTION IS DETECTED, 10% IF NO MOTION IS DETECTED AFTER 20 MINUTES) INTEGRAL SENSORS SHALL REDUCE LIGHTING LEVELS TO 10% OUTPUT AFTER 20 MINUTES OF NO OCCUPANCY. A MAINTENANCE SWITCH MAY BE USED TO OVERRIDE THE LIGHTING TO FULL ON FOR MAINTENANCE PURPOSES. THE PHOTOCELL CONTACT SHALL CLOSE WHEN THERE IS INSUFFICIENT SUNLIGHT TO ILLUMINATE THE EXTERIOR AND SITE. THE SUNLIGHT LEVEL SHALL BE DETERMINED IN FIELD. THE BMS INTERFACE MODULE SHALL BE PROGRAMMED TO TURN OFF THE EXTERIOR AND SITE LIGHTING FIXTURES AT A TIME DETERMINED BY THE OWNER. COORDINATE WITH OWNER AND DIVISION 23.	6 / E6.02	-
EMERGENCY LIGHTING	EMERGENCY LIGHTING FIXTURES SHALL BE CONTROLLED BY BYPASS RELAYS. BYPASS RELAYS SHALL ENERGIZE THE EMERGENCY FIXTURES IN A LIGHTING ZONE ACCORDING TO THE OPERATION OF THE NORMAL LIGHTING FIXTURES IN THE SAME LIGHTING ZONE. DIMMING BYPASS RELAY SHALL DIM THE EMERGENCY LIGHTING FIXTURES IN A LIGHTING ZONE ACCORDING TO THE DIMMING LEVEL OF THE NORMAL LIGHTING FIXTURES IN THE SAME LIGHTING ZONE. REFER TO LIGHTING PLANS FOR BYPASS RELAY TYPE. ALL BYPASS RELAYS SHALL ENERGIZE LIGHTING FIXTURES TO 100% UPON SENSING A LOSS OF NORMAL POWER.	1 / E6.02	-

The functional tests have all passed for given trade YES NO

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

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. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.
 - 1. Distribution transformers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

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1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace parts that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Six years from date of energization.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Square D; a brand of Schneider Electric or comparable product by one of the following manufacturers in the next paragraph.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 - 1. Acme Electric Corporation.
 - 2. Eaton.
 - 3. GE by ABB.
 - 4. Hammond Power Solutions Inc.
 - 5. Lincoln Electric Products Co., Inc.

- C. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Transformers Rated 15 kVA and Larger:
 - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 - 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 - 1. One leg per phase.
 - 2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
 - 3. Grounded to enclosure.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Coil Material: Aluminum.
 - 2. Internal Coil Connections: Brazed or pressure type.
 - 3. Terminal Connections: Welded.
- D. Enclosure: Ventilated.
 - 1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
 - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
 - 4. Finish: Comply with NEMA 250.
 - a. Finish Color: ANSI 49 gray weather-resistant enamel.
- E. Taps for Transformers 3 kVA and Smaller: None.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

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- H. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- J. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- K. Wall Brackets: Manufacturer's standard brackets
- L. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
 - 1. 9.00 kVA and Less: 40 dBA.
 - 2. 9.01 to 30.00 kVA: 45 dBA.
 - 3. 30.01 to 50.00 kVA: 45 dBA for K-factors of 1, 4, and 9 48 dBA for K-factors of 13 and 20.
 - 4. 50.01 to 150.00 kVA: 50 dBA for K-factors of 1, 4, and 9 53 dBA for K-factors of 13 and 20.
 - 5. 150.01 to 300.00 kVA: 55 dBA for K-factors of 1, 4, and 9 58 dBA for K-factors of 13 and 20.
 - 6. 300.01 to 500.00 kVA: 60 dBA for K-factors of 1, 4, and 9 63 dBA for K-factors of 13 and 20.
 - 7. 500.01 to 700.00: 62 dBA for K-factors of 1, 4, and 9 65 dBA for K-factors of 13 and 20.
 - 8. 700.01 to 1000.00: 64 dBA for K-factors of 1, 4, and 9 67 dBA for K-factors of 13 and 20.

2.4 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
 - 1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
 - 2. Ratio tests at rated voltage connections and at all tap connections.
 - 3. Phase relation and polarity tests at rated voltage connections.
 - 4. No load losses, and excitation current and rated voltage at rated voltage connections.
 - 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
 - 6. Applied and induced tensile tests.
 - 7. Regulation and efficiency at rated load and voltage.
 - 8. Insulation-Resistance Tests:
 - a. High-voltage to ground.
 - b. Low-voltage to ground.

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- c. High-voltage to low-voltage.
9. Temperature tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. 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-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.
- D. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
 - 2. Electrical Tests:
 - a. Measure resistance at each winding, tap, and bolted connection.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

- E. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
 - 2. Electrical Tests:
 - a. Measure resistance at each winding, tap, and bolted connection.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform power-factor or dissipation-factor tests on all windings.
 - d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - e. Perform an excitation-current test on each phase.
 - f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
 - g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- F. Remove and replace units that do not pass tests or inspections and retest as specified above.
- G. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
 - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- H. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

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- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262413 - SWITCHBOARDS

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. Section Includes:
 - 1. Service and distribution switchboards rated 600 V and less.
 - 2. Surge protection devices.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Instrumentation.
 - 5. Accessory components and features.
 - 6. Identification.
- B. Related Requirements
 - 1. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.3 ACTION SUBMITTALS

- A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
 - 1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of barriers specified for electrical insulation and isolation.
 - 6. Detail utility company's metering provisions with indication of approval by utility company.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

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8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

- C. Delegated Design Submittal:
 1. For arc-flash hazard analysis.
 2. For arc-flash labels.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, testing agency.
- B. Field Quality-Control Reports:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Arc Flash Study
 1. An arc flash study shall be performed on all new electrical switchboards and panelboards and labels shall be affixed to the front of the equipment indicating the proper clothing to wear as a result of the study.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Routine maintenance requirements for switchboards and all installed components.
 - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Accredited by NETA.
 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

MANSFIELD ELEMENTARY SCHOOL

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Handle and prepare switchboards for installation according to NECA 400, NEMA PB 2.1.

1.8 FIELD CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- C. Unusual Service Conditions: NEMA PB 2, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.

1.9 COORDINATION,

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices 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 SWITCHBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Square D; by Schneider Electric, QED-2 style switchboard. or comparable product by one of the following manufacturers in the next paragraph.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 - 1. Eaton.
 - 2. Siemens Industry, Inc., Energy Management Division.
 - 3. ABB
- C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.
- H. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Panel mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- I. Nominal System Voltage: As indicated on the drawings.
- J. Main-Bus Continuous: As indicated on the drawings.
- K. Indoor Enclosures: Steel, NEMA 250, Type 1.
- L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- M. Barriers: Between adjacent switchboard sections and separation of utility compartments.
- N. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

MANSFIELD ELEMENTARY SCHOOL

- O. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- P. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- Q. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- R. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
 - 2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity.
 - 3. Copper feeder circuit-breaker line connections.
 - 4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 5. Ground Bus: 1/4-by-2-inch-hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
 - 6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- S. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 SURGE PROTECTION DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Square D; by Schneider Electric or comparable product by one of the following manufacturers in the next paragraph.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 - 1. Eaton.
 - 2. General Electric Company.
 - 3. Siemens Industry, Inc., Energy Management Division.
- C. SPDs: Comply with UL 1449, Type 1.

- D. Features and Accessories:
 - 1. Integral disconnect switch.
 - 2. Indicator light display for protection status.
 - 3. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - 4. Surge counter.
- E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
 - 1. Line to Neutral: 1200 V for 480Y/277 V.
 - 2. Line to Ground: 1200 V for 480Y/277 V.
 - 3. Line to Line: 2000 V for 480Y/277 V.
- G. SCCR: Equal or exceed 100 kA.
- H. Nominal Rating: 20 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 100 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers with rms sensing: Refer to contract drawings for electronic trip circuit breakers; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Energy Reduction Maintenance Switch (ERMS); with lockable switch and indicator light for activating the ERMS and confirming its activation; for circuit-breaker frame sizes 1,200 A and larger. The switch shall have a dry contact for connection to the BMS system to indicate a notification signal when the ERMS is activated. Purpose of the signal is to notify the Owner that after the maintenance work is completed the circuit breaker should be put back into normal operation mode.
 - 5. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).

MANSFIELD ELEMENTARY SCHOOL

7. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching LED lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

2.4 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.5 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
 - 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
 - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
 - 3. Protect from moisture, dust, dirt, and debris during storage and installation.
 - 4. Install temporary heating during storage per manufacturer's instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NECA 400.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
 - 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 concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to switchboards.
 - 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

MANSFIELD ELEMENTARY SCHOOL

- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, surge protection devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Comply with NECA 1.

3.3 CONNECTIONS

- A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.
- B. Support and secure conductors within the switchboard according to NFPA 70.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Tests and Inspections:
 - 1. Acceptance Testing:
 - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
 - b. Test continuity of each circuit.
 - 2. Test ground-fault protection of equipment for service equipment per NFPA 70.

MANSFIELD ELEMENTARY SCHOOL

3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 5. Perform the following infrared scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Switchboard will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

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. Section Includes:
 1. Distribution panelboards.
 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge protective device.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, surge protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 3. Detail bus configuration, current, and voltage ratings.
 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 5. Include evidence of NRTL listing for series rating of installed devices.
 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 7. Include wiring diagrams for power, signal, and control wiring.
 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
- C. Qualification Data: For qualified testing agency.
- D. Field Quality-Control Reports:
 1. Test procedures used.

MANSFIELD ELEMENTARY SCHOOL

2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
- G. Arc Flash Study
1. An arc flash study shall be performed on all new electrical switchgear, switchboards and panelboards and labels shall be affixed to the front of the equipment indicating the proper clothing to wear as a result of the study.
- H. Panelboards shall not be submitted for generator power distribution when distributing to life safety and standby automatic transfer switches. Switchboards shall be submitted for this purpose.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

MANSFIELD ELEMENTARY SCHOOL

- B. Handle and prepare panelboards for installation according to NECA 407, NEMA PB 1.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.

1.8 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace parts that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 5. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - 6. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- C. Incoming Mains Location: As per project requirements.
- D. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Square D; a brand of Schneider Electric or comparable product by one of the following manufacturers in the next paragraph.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. GE by ABB.
 - 3. Siemens Energy & Automation, Inc.
- C. Panelboards: NEMA PB 1, power and feeder distribution type.
- D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- E. Mains: As per the contract drawings.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- G. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Square D; a brand of Schneider Electric or comparable product by one of the following manufacturers in the next paragraph.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. GE by ABB.
 - 3. Siemens Energy & Automation, Inc.
- C. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- D. Mains: As per the contract drawings.

MANSFIELD ELEMENTARY SCHOOL

- E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

Panelboard Multifunction Digital Meter (Schneider Electric EM3560 or equivalent): Microprocessor-based unit suitable for three or four wire system and with the following features:

1. The power meter shall be fully electronic with multi-line backlit LCD display showing measured parameters as well as alarm functions and pulse output.
2. The power meter shall perform the following measurements:
 - a. Accumulated Real Energy (kWh) for each phase and total of all phases.
 - b. Accumulated Reactive Energy (kVARh) and Apparent Energy (kVAh) totals for all phases.
 - c. Net Present Demand for Real (kW), Reactive (kVAR) and Apparent (kVA) Power over a user-specified interval (block or sliding window).
 - d. Maximum (Peak) Real (kW), Reactive (kVAR) and Apparent (kVA) Demand Intervals
 - e. Instantaneous Real (kW), Reactive (kVAR) and Apparent (kVA), by phase and in total.
 - f. Current (amps) for each phase and average of all phases.
 - g. Phase-to-phase voltage for each phase and average of all phase pairs.
 - h. Phase-to-neutral voltage for each phase pair and average of all phases.
 - i. Power factor for each phase and average of all phases.
 - j. AC frequency.
3. The power meter shall communicate using the BACnet MS/TP protocol at speeds from 9600 to 115,200 baud (no parity). The meter shall provide a BACnet Device object, a set of writable Analog Value objects for remote configuration, a set of Analog input objects to provide access to scaled 32-bit measurement values and their unit types, and a set of Binary Input objects for indicating individual alarm conditions.
4. The meter shall be UL/CUL listed to the latest applicable safety standards.
5. Power meter models must be available to directly accept voltage input over the range of 90 to 600 VAC (60Hz).
6. The measured energy consumption shall be retained in non-volatile ferromagnetic memory for the life of the product warranty.
7. The power meter shall have demand measurement programmable for up to 6 sub-intervals of 10 seconds to 546 minutes duration.
8. Meter shall be optionally available in an separate enclosure.
9. The power meter shall meet both ANSI C12.20 .5% and IEC 62053-22 Class .5S real power and energy accuracy specifications.
10. The power meter shall meet IEC 62053-22 Class 2 reactive power and energy accuracy specifications.
11. The power meter shall have automatic phase reversal compensation such that it is insensitive to the CT's load orientation.
12. The power meter shall have a configurable pulse weight in units of 10, 100, 1000, 10000 Wh.
13. The power meter shall calculate a maximum theoretical system power using the configuration parameters set by the user and use this value to set the slowest pulse duration that will keep up with this power level. If the selected pulse weight doesn't allow the meter to find a pulse duration that can keep up, the meter shall warn the user.

14. The power meter shall support warnings for low power factor (phase current or voltage miss-wired), current over range, voltage over range, and frequency out of range, pulse output overrun and pulse output configuration.
15. The power meter shall log and retain in non-volatile memory up to 5760 (up to 60 days at 15 minute intervals) measurement records at time intervals determined by the Demand Interval duration setting. These records shall contain any three 32-bit data values that the user selects from the list of supported Analog_Input objects. These logged data records shall be readable over BACnet via three Trend_Log objects.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Square D, a brand of Schneider Electric or comparable product by one of the following manufacturers in the next paragraph.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. GE by ABB.
 3. Siemens Energy & Automation, Inc.
- C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 100 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip for circuit-breaker frame sizes 400 A and larger; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Energy Reduction Maintenance Switch (ERMS); with lockable switch and indicator light for activating the ERMS and confirming its activation; for circuit-breaker frame sizes 1,200 A and larger. The switch shall have a dry contact for connection to the BMS system to indicate a notification signal when the ERMS is activated. Purpose of the signal is to notify the Owner that after the maintenance work is completed the circuit breaker should be put back into normal operation mode.
 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip).
 6. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching LED lighting loads.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - f. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
 - h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 PANELBOARD SUPPRESSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Square D, a brand of Schneider Electric or comparable product by one of the following manufacturers in the next paragraph.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer.
 1. Current Technology; a subsidiary of Danahar Corporation.
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 3. GE by ABB.
 4. Liebert Corporation.
 5. Siemens Energy & Automation, Inc.
- C. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
 1. Accessories:
 - a. LED indicator lights for power and protection status.
 - b. Audible alarm, with silencing switch, to indicate when protection has failed.
 - c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- D. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
 1. Accessories:
 - a. Fuses rated at 200-kA interrupting capacity.

- b. Fabrication using bolted compression lugs for internal wiring.
 - c. Integral disconnect switch.
 - d. Redundant suppression circuits.
 - e. Redundant replaceable modules.
 - f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - g. LED indicator lights for power and protection status.
 - h. Audible alarm, with silencing switch, to indicate when protection has failed.
 - i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - j. Six-digit, transient-event counter set to totalize transient surges.
- 2. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.
 - 3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
 - a. Line to Neutral: 70,000 A.
 - b. Line to Ground: 70,000 A.
 - c. Neutral to Ground: 50,000 A.
 - 4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. Surges with less than 5 percent change in clamping voltage.
 - 5. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 or 208Y/120-V, three-phase, four-wire circuits shall be as follows:
 - a. Line to Neutral: 800 V for 480Y/277 400 V for 208Y/120.
 - b. Line to Ground: 800 V for 480Y/277 400 V for 208Y/120.
 - c. Neutral to Ground: 800 V for 480Y/277 400 V for 208Y/120.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407, NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407, NEMA PB 1.1.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- J. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor shall perform tests and inspections.

MANSFIELD ELEMENTARY SCHOOL

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- F. Panelboards will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

MANSFIELD ELEMENTARY SCHOOL

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

MANSFIELD ELEMENTARY SCHOOL

SECTION 262726 - WIRING DEVICES

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:
 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 2. Twist-locking receptacles.
 3. Snap switches.
 4. Wall-switch sensors
 5. Occupancy & vacancy sensors.
 6. Cord and plug sets.
 7. Floor service outlets and poke-through assemblies.

1.3 DEFINITIONS

- A. EMI: electromagnetic interference.
- B. GFCI: ground-fault circuit interrupter.
- C. Pigtail: short lead used to connect a device to a branch-circuit conductor.
- D. RFI: radio-frequency interference.
- E. TVSS: transient voltage surge suppressor.
- F. UTP: unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For Each Type of Product Indicated.
- B. Shop Drawings: List of Legends and Description of Materials and Process Used for Premarking Wall Plates.
- C. Samples: One for Each Type of Device and Wall Plate Specified, In Each Color Specified.
- D. Field quality-control test reports.

MANSFIELD ELEMENTARY SCHOOL

- E. Operation and maintenance data: for wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.
- F. Contractor shall perform a coordination review with the lighting fixture vendor and the wiring device submittal to ensure that the wiring devices are compatible with the lighting fixtures they are controlling and shall submit a letter with the shop drawing. If letter is not included, then shop drawing shall be automatically rejected.

1.5 QUALITY ASSURANCE

- A. Source limitations: obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. 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.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for owner-furnished equipment: match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

1.7 WARRANTY

- A. Special warranty: manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Service Outlet Assemblies: One for every 10, but no less than one.
 - 2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' names: shortened versions (shown in parentheses) of the following manufacturers' names are used in other part 2 articles:
1. ABB Installation Products.
 2. Cooper Wiring Devices; a division of Eaton.
 3. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 4. Leviton Mfg. Company Inc. (Leviton).
 5. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience receptacles, 125 V, 20 A: comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton; 1877 (single), CR20 (duplex).
 - b. Hubbell; HBL5358 (single), HBL5362 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5381 (single), 5352 (duplex).
- B. Controlled (switched) convenience receptacles, 125 V, 20 A: comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton; 5362CD for both outlets marked and the 5362CH for one outlet marked.
 - b. Hubbell; SNAP5362C2 for both outlets marked and SNAP 5362C1 for one outlet marked.
 - c. Leviton; 5362-S2.
 - d. Pass & Seymour; 5362CD.
- C. Tamper-resistant convenience receptacles, 125 V, 20 A: comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton; TRBR20.
 - b. Hubbell; BR20TR.
 - c. Leviton; 8300-SGG.
 - d. Pass & Seymour; 63H.

2.3 GFCI RECEPTACLES

- A. General description: straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

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- B. Duplex GFCI convenience receptacles, 125 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton; SGF20.
 - b. Hubbell GFRST20SNAP
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7899
- C. Weather resistant, duplex GFCI convenience receptacles, 125 V, 20 A: comply with UL WC-596.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton; WRSGF20.
 - b. Hubbell; GFWRST20.
 - c. Leviton; WR899.
 - d. Pass & Seymour; WR5362.
 - 2. To be provided where “WP” is indicated next to a receptacle.

2.4 TWIST-LOCKING RECEPTACLES

- A. Single convenience receptacles, 125 V, 20 A: comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, AND UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton; L520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

2.5 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.

2.6 SNAP SWITCHES

- A. Comply with NEMA WD 1 AND UL 20.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton; CSB120 (single pole), CSB220 (two pole), CSB320 (three way), CSB420 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).

MANSFIELD ELEMENTARY SCHOOL

- c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Pilot light switches, 20 A:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton; 1201 for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-CPL for 120 V, PS20AC1-CPL7 for 277V.
 - 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
- D. Illuminated switches, 20 A:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton; 1221 for 120 V and 277 V.
 - b. Hubbell; HPL1221IL for 120 V and 277 V.
 - c. Leviton; 1221-LHW for 120 V, 1221-7LW for 277 V.
 - d. Pass & Seymour; PS20AC1-CSL for 120 V and 277 V.
 - 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "OFF."
- E. Key-operated switches, 120/277 V, 20 A:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Eaton; AH1221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 - 2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.7 LOW VOLTAGE WALL-BOX CONTROL DEVICES

- A. Low voltage switches:
 - 1. Refer to drawings.
- B. Low voltage dimmers:
 - 1. Refer to drawings.
- C. Low voltage scene control stations:
 - 1. Refer to drawings.

2.8 COMBINATION OCCUPANCY/VACANCY SENSORS

- A. Wall-switch sensors:
 - 1. Products: Subject to compliance with requirements, provide the following or equivalent:
 - a. Douglas-Diversa; WVSSDU1-P-VX
 - 2. Description: Dual-technology, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 1,000 sq. ft.

3. Contractor shall provide a relay above the ceiling in an enclosure that shall be controlled by the wall switch and is intended for use with the BMS system.
- B. Wall-dimmer sensors:
1. Products: Subject to compliance with requirements, provide the following or equivalent:
 - a. Douglas; SWX-124-D
 2. Description: Dual-technology, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 1,000 sq. ft.
 3. Contractor shall provide a relay above the ceiling in an enclosure that shall be controlled by the wall switch and is intended for use with the BMS system.
- C. Wall-mounted sensors:
1. Dual-technology type. Refer to drawings.
 2. Detector shall have an auxiliary contact output for coordination with the BMS system.
- D. Ceiling mounted occupancy sensors:
1. Dual-technology type. Refer to drawings.
 2. Detector shall have an auxiliary contact output for coordination with the BMS system.
- E. Daylight sensors:
1. Refer to drawings.

2.9 EMERGENCY BYPASS RELAY

- A. Manufacturer:
1. Douglas; WUL-3924
 2. Hubbell; UL924EPC1-UNV
 3. LVS; EPC-2
 4. Legrand; AD-RRU-X-UNV
 5. Greengate; CEPC-2
- B. Description:
1. Control module that monitors the standby power and normal power circuits local to the area as indicated on the drawings. Module will allow switching of emergency light fixture with normal power light fixtures.
 2. Upon loss of normal power module will energize emergency light fixture.
 3. Module shall be 277 volt rated, 20 ampere capacity. Module shall be installed above associated room light switch.
 4. All switches shall have a related module even if not shown on the drawings.
 5. Modules shall be indicated on the drawings with an "R" in a box.
 6. Relay shall be UL924 listed.

2.10 EMERGENCY DIMMING BYPASS RELAY

- A. Manufacturer:
1. Douglas; WUL-3924
 2. Hubbell; UL924EPC1D-UNV
 3. LVS; EPC-2-D

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4. Greengate; CEPC-2-D

B. Description:

1. Control module that monitors the standby power and normal power circuits local to the area as indicated on the drawings. Module will allow switching of emergency light fixture with normal power light fixtures.
2. Upon loss of normal power module will energize emergency light fixture.
3. Module shall be 277 volt rated, 20 ampere capacity. Module shall be installed above associated room light switch.
4. All switches shall have a related module even if not shown on the drawings.
5. Modules shall be indicated on the drawings with an "RD" in a box and connected to dimming switches.
6. Relay shall be UL 924 listed.

2.11 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-location, weatherproof "in-use" cover plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.12 FLOOR SERVICE FITTINGS

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

1. ABB Steel City Installation Products
2. FSR FL-500P Series
3. Hubbell System One Series
4. Wiremold RFB Series a division of Legrand

B. Type: modular, recessed, dual-service units suitable for wiring method used.

C. Compartments: barrier separates power from voice and data communication cabling.

D. Service plate: round, solid brass with satin finish.

E. Power receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

F. Voice and Data Communication Outlet: space for two Modular, Keyed, Color-Coded, RJ-45 Category 5e Jacks for UTP Cable.

G. Electrical contractor shall review the structural drawings to determine which specified box is appropriate for the depth of the slab.

MANSFIELD ELEMENTARY SCHOOL

2.13 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Steel City Installation Products.
 - 2. Hubbell Incorporated; Wiring Device-Kellems.
 - 3. Wiremold a division of LeGrand.

- B. Description: factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
 - 1. The device shall be listed in accordance to UL 514A.
 - 2. The minimum spacing of 2 feet on center and not more than one unit per each 65 square feet of floor area in each span.
 - 3. UL File Number: E2969.
 - 4. UL Fire Resistance Directory: R9140.
 - 5. Provide City of Chicago approved base units where scheduled or required for poke through style specified.

- C. Fire rating application:
 - 1. 1-Hour Rated Floor:
 - a. 2-1/4 inches minimum concrete over steel decking required.
 - b. 3 inches minimum concrete for reinforced slab required.
 - c. 7-1/2 inches maximum concrete thickness required.
 - 2. 2-Hour Rated Floor:
 - a. 3-1/4 inches minimum concrete over steel decking.
 - b. 4 inches minimum concrete for reinforced slab.
 - c. 7-1/2 inches maximum concrete thickness.

2.14 BATHROOM EMERGENCY CALL SYSTEM

- A. Provide complete bathroom call system in handicap accessible bathrooms as shown on the drawings and as required by code.

- B. The complete 110 Volt A.C. system kit #6538-G5 shall be manufactured by Edwards or approved equal and include the following components:
 - 1. Pull cord shall be single gang, 2 pole mechanically locking switch and 6 foot long pull cord with pendant.
 - 2. Corridor station shall be 110 volt, single dome light and buzzer.
 - 3. Low voltage Transformer

2.15 FINISHES

- A. Color: wiring device catalog numbers in section text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with other trades:
 - 1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted provided the outlet box is large enough.
- D. Device installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

MANSFIELD ELEMENTARY SCHOOL

- E. Receptacle orientation:
 - 1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
- F. Device plates: do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of devices: unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification For Electrical Systems."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use press on label, black lettering on white background on face of plate and in easily readable location inside device backbox, and durable wire markers or tags on conductors inside outlet boxes.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for convenience receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Nonfusible switches.
 - 2. Shunt trip switches.
 - 3. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include wiring diagrams for power, signal, and control wiring.

MANSFIELD ELEMENTARY SCHOOL

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with NFPA 70.

2.2 NONFUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Square D; by Schneider Electric or comparable product by one of the following manufacturers in the next paragraph.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 - 1. ABB Inc.
 - 2. Eaton.
 - 3. Siemens Industry, Inc., Energy Management Division.
- C. Type HD, Heavy Duty, Three Pole, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 4. Service-Rated Switches: Labeled for use as service equipment.

2.3 SHUNT TRIP SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Bussmann, an Eaton business or comparable product by one of the following manufacturers in the next paragraph.

- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 - 1. Littelfuse, Inc.
- C. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.
- D. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 240 or 600-V ac, UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- E. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight white ON pilot light.
 - 3. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 4. Form C alarm contacts that change state when switch is tripped.
 - 5. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
 - 6. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 7. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 8. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 9. Service-Rated Switches: Labeled for use as service equipment.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

MANSFIELD ELEMENTARY SCHOOL

- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect, Construction Manager, Owner no fewer than [seven] days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Architect's, Construction Manager's, Owner's written permission.
 - 4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Comply with NFPA 70 and NECA 1.
- E. Elevator fusible shunt trip disconnect switch shall be connected to the fire alarm system for elevator recall and shall have derive their own 120 volt shunt trip power.

3.5 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - f. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.

- g. Verify correct phase barrier installation.
 - h. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- C. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.
 - d. Verify that the unit is clean.
 - e. Operate the circuit breaker to ensure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
 - h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar

- connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
 - f. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
 - g. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
 - h. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 4. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

MANSFIELD ELEMENTARY SCHOOL

- c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
 - 1. Test procedures used.
 - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in "Coordination Studies."

END OF SECTION 262816

SECTION 263100 - PHOTOVOLTAIC COLLECTORS

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.
- B. Related Specifications:
 - 1. Include Division 26 (Electrical Work) Sections.
 - 2. 075323 – Ethylene-Propylene-Diene-Monomer (EDPM) Roofing.
 - 3. Structural drawings and specs for wind loading requirements and snow drift loads.

1.2 SUMMARY

- A. Section Includes:
 - 1. PV system description.
 - 2. Manufactured PV units.
 - 3. PV module framing.
 - 4. PV array construction.
 - 5. Inverters.
 - 6. System overcurrent protection.
 - 7. Mounting structures.
- B. Intent: The intent of these specifications are to list the minimum requirements for the furnishing and installation of Grid-Connected (typical) Photovoltaic (solar electric) systems as specified here within, and to ensure and to ensure the solar electric system is consistent with, and adheres to any and all of the latest publications governing photovoltaic systems including Connecticut State Building Codes, NFPA 70, NECA 1 (standard practices for good workmanship in electrical construction) and NETA (applicable testing standards).
- C. Project Description: Provide an interactive rooftop solar photovoltaic system capable of meeting the performance requirements specified herein. System shall be UL listed for rapid shutdown. Include all solar modules, inverters, combiners, as well as all appurtenances required for a complete rooftop Photovoltaic System. Modules are to be mounted on tilted racks with ballast systems for flat roofs and non-ballast systems for pitched roofs.
- D. PV system shall be designed and stamped by a Connecticut licensed professional engineer. Drawings shall show the location of all equipment, ratings of equipment, and installation details as needed to comply with requirements.

- E. Scope: Contractor shall coordinate with specified manufacturers to provide a system design to meet the minimum performance requirements specified herein. Provide and install complete Photovoltaic System in accordance with the Contract Documents and specified requirements. The work of this section shall include, but not be limited to, the following:
 - 1. Provide PV Modules, via a ballasted racking system for flat roofs and an attached system for pitched roofs, and electrically connected to the buildings electrical distribution system as defined by construction documents.
 - 2. Balance of System Components including: Combiner Boxes, DC Disconnects, Inverters, conduit and wire from each inverter to panelboard SPB-1, SPB-1 branch circuit breakers, transition boxes, pull boxes, wireway, and necessary electrical appurtenances.
 - 3. SPB-1 panelboard, main circuit breaker, conduit and wire from SPB-1 to MDB, disconnect switch between SPB-1 and MDB shall be provided by the electrical contractor as per the contract documents.
 - 4. Electrical wiring, conduit, junction boxes, cable management, and support structures.
 - 5. Data Acquisition and Monitoring System including: Data logger and RS485 data connections.
 - 6. Weather Station including: pyranometer, anemometer and, temperature sensors.
 - 7. Permits, Agreements and Fees: To include necessary building permits electrical inspections and local utility connection and rebate agreements and coordination.

- F. Mandatory pre-installation meeting: Contractor shall organize and coordinate with the Owner, General Contractor, Architect and Engineer for a pre-installation meeting at a time and location convenient for all parties. Time and location of meeting to be determined. Owner, Architect and Engineer shall be given at least two weeks advance notice.

1.3 DEFINITIONS

- A. CEC: California Energy Commission.
- B. ETFE: Ethylene tetrafluoroethylene.
- C. FEP: Fluorinated ethylene propylene.
- D. IP Code: Required ingress protection to comply with IEC 60529.
- E. MPPT: Maximum power point tracking.
- F. PTC: PVUSA Test Condition. Commonly regarded as a "real-world" measure of PV output. See below for definition of "PVUSA."
- G. PV: Photovoltaic.
- H. PVUSA: Photovoltaics for Utility Systems Applications.
- I. STC: Standard Test Conditions defined in IEC 61215.
- J. Solar Photovoltaic System: Includes all equipment, material, electrical appurtenances, programming, and software necessary for a complete operating system
- K. Solar Module: The physical device used to convert sunlight into energy.

- L. Solar Array: A grouped collection of solar modules.
- M. Inverter: An electrical device used to convert direct current (DC) energy from the solar module into alternating current (AC) energy to be distributed throughout the facility.
- N. Balance of Plant: Consists of the remaining systems, components, and structures that comprise a complete power plant or energy system that are not specified as primary system components.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For PV modules.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Detail fabrication and assembly.
 - 4. Include diagrams for power, signal, and control wiring.
 - 5. Professional Engineer Letter: A final letter stamped by a registered professional engineer licensed in the State of Connecticut accompanying the full schematics will be required prior to construction.
 - 6. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 7. Roof Penetration Detail: As necessary, provide Detail Drawing showing roof penetration and sealing method.
 - 8. Data Acquisition & Monitoring: Address all pending questions they pertain to data monitoring, notification and acquisition. Highlight the type of monitoring system selected, and any deviation in capabilities from those specified in Section II.
 - 9. Roof or Structure Layout: Show final layout of PV modules on an "As-Built" Roof Plan. Indicate arrangement of components and clearance and access requirements. Prior to construction PV layout must be certified by PV Module or PV racking system Manufacturer for specific site wind loading, turbulence and attachment correctness
 - 10. PV Racking and Mounting: Detail exact mounting structure and practice. Prior to construction a sealed Drawing from a CT Structural Professional Engineer is required.
 - 11. Surge suppressors: Data for each device used and where applied.
 - 12. Project Timeline: Provide updated schedules periodically showing status of project phases including design, material procurement, installation, final testing and commissioning.

1.5 QUALITY ASSURANCE / DESIGN CRITERIA

- A. General: Photovoltaic system shall be as designed and installed by contractor with following requirement.
 - 1. NABCEP Certification: A minimum of two (2) NABCEP Certified solar installers on staff, at least one of which must be a company principle.
 - 2. Experience:
 - a. Solar Contractor shall have local representation and shall have been actively engaged in the assembly, installation and service of this equipment for a period of not less than 5 years. Evidence of such experience shall be provided in the form of project lists with owner contact information.
 - b. Contractor must have a minimum of 5 years experience of installing solar PV systems within the utility company service area (Eversource).
 - c. Contractor has installed five (5) or more systems over 50 kW in capacity.
 - 3. Service Response Availability: Solar Contractor shall have full consumable parts backup and one-day service response availability for this equipment.

- B. General Design Criteria: The Contractor shall be responsible for the engineering design of all custom parts and equipment (as applicable), including mechanical and welded connections.
 - 1. Electrical System
 - a. Final Schematics PE Endorsement: Following contract signing, Solar Contractor shall be provided general design conditions by Owner's Engineering firm. Solar Contractor shall generate final schematics, stamped by a Professional Engineer with experience designing solar photovoltaic systems.
 - 2. Structural System
 - a. The PV Panels are to comply with all local Construction Codes.
 - b. Withstand gravity loads
 - c. Withstand all other superimposed loads, as indicated on Architectural drawings and all within the deflection limitations, governed by the design of the supporting structure.
 - d. Exterior panels to withstand wind load per local requirements.
 - e. Allow for temperature expansion and/or contraction, without harmful effect to the glass, connections, joint seals, or adjoining construction.
 - f. Withstand seismic forces.

- C. Specific Equipment Qualifications & Compliance: Except as modified by governing codes and the Contract Documents comply with the latest applicable provisions and latest recommendations of the following:
 - 1. General
 - a. Most Current Version of the National Electrical Code (NEC)
 - b. All local authorities having jurisdiction.
 - c. IEEE 1547 - Standard for Interconnecting Distributed Resources with Electric Power Systems
 - d. ANSI/NFPA 70
 - e. Local Fire Marshal and/or authority having jurisdiction.
 - 2. Inverter
 - a. Photovoltaic inverters must be Listed and in compliance with Underwriters Laboratory (UL) Standard 1741, Standard for Static Inverters and Charge Controllers for use with Photovoltaic Systems. A standard for Inverters, Converters, and Controllers for Use in Independent Power Systems
 - b. IEEE 929 – Recommended practice for utility interface of PV Systems.

- c. IEEE 519 – Guide for harmonic control and Reactive Compensation of Static Power Controllers
 - d. FCC part 15
 - e. ANSI/NFPA 70
 - f. Power Inverter Manufacturer Qualifications: The power inverter manufacturer shall be a company specializing in the manufacturing of DC to AC power inverters and have at least 5 years of documented experience with power inverter hardware in commercial applications in the field.
3. PV Module & Racking
- a. Photovoltaic modules must be Listed and in compliance with Underwriters Laboratory (UL) Standard 1703, Standard for Safety: Flat-Plate Photovoltaic Modules and Panels. Preferred Standard for Flat-Plate Photovoltaic Modules and Panels
 - b. ASCE 7-10 - American Society of Civil Engineers (Minimum Design Loads for Buildings and Other Structures
 - c. IEC 1215 Design Qualification and Type Approval for Crystalline Silicon Terrestrial Photovoltaic (PV) Modules
 - d. CEC 503 European Solar Test Installation
 - e. IEEE 1262 PV Module Qualification for performance and reliability
 - f. ANSI Z97.1 Performance Specifications and Methods of Test for Safety Glazing Material used in Buildings.
 - g. ASTM C 1036 Standard Specification for Flat Glass
 - h. ASTM C 1048 Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass.
 - i. PV Module Manufacturer Qualifications: The PV module manufacturer shall be a company specializing in the manufacturing of PV modules and have at least 5 years of documented experience with PV hardware in commercial applications in the field.
4. Balance of System: All balance of system components including combiner box, pipe/conduit, wire and incidental electrical products shall be UL listed and meet the current requirements (relating to date of installation) of the National Electrical Code, authorities having jurisdiction and the local power utility.
- D. Field Certification: The engineer/owner may require an independent testing agency inspect and provide Field Certification of the system. Consult client/engineer whether costs should be included in proposal.
1. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 2. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
 3. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

MANSFIELD ELEMENTARY SCHOOL

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special materials and workmanship warranty and minimum power output warranty. In an organized appendix include information for all major components and parts as follows.
 - 1. Parameters
 - a. Warranty information
 - b. Operation and maintenance procedures
 - c. Performance and/or catalog data / cut sheets
 - d. MSDS
 - e. Name and location of certified testing agency
 - f. Detailed shop drawings and any other pertinent data.
 - 2. Equipment: Such information may include, but is not limited to:
 - a. Solar PV Modules
 - b. Inverters
 - c. Common Connections Enclosures
 - d. Disconnect Switch
 - e. Data Monitoring Systems

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For PV modules to include in operation and maintenance manuals.
- B. Post Commissioning Submittals
 - 1. As Builts & Final Information: Provide "As-Built" drawings. Provide any other "turnover" information requested by client.
 - 2. Updated Equipment Warranty Information: Provide updated equipment warranty information based on final equipment selection.

1.8 COORDINATION

- A. Coordinate layout and installation of panel boards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, anchor-bolt inserts, reinforcements, formwork, and other structural components as they are constructed.
- C. Coordinate arrangement, mounting, and support of electrical equipment
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

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3. To allow right of way for piping and conduit installed at required slope.
 4. So connecting raceways, cables, wire-ways, cable trays, and bus-ways will be clear of obstructions and of the working and access space of other equipment.
- D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
 - E. Coordinate sleeve selection and application with selection and application of firestopping.
 - F. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components. Match components and interconnections for optimum performance of specified functions.
 - G. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.9 FEES

- A. Application Fees for Roof Warranty: Bidders will be required to furnish and submit application to roof manufacturer for warranty with solar photovoltaics. Bidders must include application fees as part of their bid, if applicable.
- B. Utility Interconnection Application: Bidders will be required to furnish and submit an interconnection application with the Utility Company. Bidders are required to absorb all costs associated with modifying the design drawings as required by the utility company for purposes of submitting and receiving interconnection approvals.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of PV system that fail in materials or workmanship within specified warranty period.
 1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:
 - a. Faulty operation of PV modules.
 - b. Inverters
 - c. Overcurrent protection devices
 - d. Distribution components
 2. Warranty Period: Five years from date of Substantial Completion and after the complete startup has been reviewed and approved by the commissioning authority.
- B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.
 1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion and after the complete startup has been reviewed and approved by the commissioning authority:
 - a. Specified minimum power output to 80 percent or more, for a period of 25 years.

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1.11 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide full maintenance by skilled employees of manufacturer's designated service. Include appropriate exercises to check for proper securing load transfer, restarting, and normal operation.
- B. Subsequent Maintenance: Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by SunPower Corporation, module type SPR-A450-COM, commercial A-Series panels or comparable product by one of the following manufacturers in the next paragraph.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer provided that they meet the performance requirements specified herein. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 - 1. LG Electronics.
 - 2. Trina Solar.
- C. Listing/Standards: Modules must meet or exceed the requirements set forth by UL1703 for PV Modules. This UL Standard covers flat-plate photovoltaic modules and panels intended for installation on buildings or to be freestanding.

2.2 PERFORMANCE REQUIREMENTS

- A. System shall be capable of producing an annual energy output of not less than 490,000 kWh/yr.
- B. Whole System Listing: Provide PV Modules and equipment as described herein. PV Module shall be compatible with the Balance of System (BOS) components and support system structure and be approvable by the Underwriter's Laboratory and the local authorities having jurisdiction.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- D. Environmental Conditions: The photovoltaic system and accessories described herein shall be fully capable of operation as specified in the following environmental conditions:
 - 1. System designed for outdoor installation. Outdoor components should be suitable for the ice, snow, rain, wind loading and temperature variations of the Project related location.
 - 2. Maximum ambient temperature: 110°F
 - 3. Minimum ambient temperature: -20°F
 - 4. Wind Loading: Wind Loading: PV array and roof mounted equipment shall be fabricated and installed in a manner suitable for the worse case wind loading and turbulences for the specific Project area location/exact roof mounted equipment location, these criteria shall be calculated, certified and submitted for the specific equipment location and shall cover a system life expectancy of 25 years.

2.3 SUPPORT RACKING & MOUNTING ATTACHMENTS

- A. Provide low profile, light weight, PV Module racking and mounting system, non-penetrating for flat roofs, mechanically fastened for pitched roofs.
- B. Manufacturer of racking system:
 - 1. For flat roof areas: Unirac Inc., or equivalent.
 - 2. For pitched roof areas: Sunpower, Helix Roof Solutions, or equivalent.
- C. Manufacturer of mechanical fasteners for pitched roofs: OMG Roofing Products, PowerGrip Universal 7 Roof Mount Systems.
- D. Utilize mechanical fasteners designed for use with both ballasted and non-ballasted racking systems. Utilize rooftop conduit and pipe supports from same manufacturer.
- E. Entire interconnected racking system shall withstand stress due to winds up to 130 miles per hour.
- F. Tilt angle shall not exceed 5 deg.
- G. Racking manufacturer shall provide and / or acknowledge in writing that the PV module racking system, as laid out on structure, shall withstand wind and wind turbulence as experienced at the Project Location.
- H. All metallic racking material shall be highly corrosive resistant. Epoxy coated systems shall be capable of touch-up remedies from a manufacturer supplied coating product.
- I. All fasteners utilized for the PV Module racking / mounting system shall be 304 stainless steel.
- J. Racking weight and PV panels combined shall not exceed 8 pounds per square foot.
- K. Racking system shall be open under supports to provide for adequate roof drainage in all directions to eliminate ponding and provide free flow to roof drainage systems. Rack system installation must maintain a minimum of 4-3/16" clear space between the bottom rail assembly and the surface of the roof deck to facilitate drainage.
- L. Warranty: Racking system shall have a 25 year warranty.

- M. Environmental Conditions: The surface temperature ranges of the equipment shall be capable of temperatures between -20 °C to +50 °C
 - 1. The assembly shall accommodate changes in dimension resulting from changes in temperature in any of its part, its supporting bracketry and without any reduction in the performance below the minimum levels required herein.
 - 2. Equipment surfaces and coatings shall be capable of withstanding surface temperature variation.

2.4 PV CAPACITIES AND CHARACTERISTICS

- A. Minimum Electrical Characteristics:
 - 1. Rated Open-Circuit Voltage: 51.9 V.
 - 2. Maximum System Voltage: 600 V.
 - 3. Maximum Power at Voltage (V_{pm}): 450 W
 - 4. Short-Circuit Temperature Coefficient: 5.7 mA/deg C
 - 5. Rated Short-Circuit Current (I_{sc}): 11 A.
 - 6. Rated Operation Current (I_{mp}): 10.2 A.

2.5 MANUFACTURED PV UNITS

- A. Manufacturers
 - 1. Basis of Design: SunPower SPR-A450-COM.
 - 2. Submit all comparable manufacturers and products that meet or exceed the following Specifications.
- B. Contractor Design Information: Typical PV Module Specifications at Standard Test Conditions. A PV module may produce more current and/or voltage than reported at STC. Sunny, cool weather and reflection from snow or water can increase current and power output. Therefore, the values of I_{sc} and V_{oc} marked on the module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor ampacities, fuse sizes, and size of controls connected to PV output. An additional 1.25 multiplier may be required by the National Electrical Code (NEC) for sizing fuses and conductors as described in the NEC Section 690-8.
- C. Listing/Standards: Modules must meet or exceed the requirements set forth by UL1703 for PV Modules. This UL Standard covers flat-plate photovoltaic modules and panels intended for installation on buildings or to be freestanding.

2.6 TRANSITION BOX

- A. Supply: Provide transition Boxes as deemed necessary for Solar Photovoltaic System efficiency/effectiveness.
- B. Specifications: Transition Boxes shall be in a NEMA 4X, UL Listed, lockable enclosure and shall be sized as directed by the NEC, Section 314.16.

2.7 INVERTER

- A. Manufacturers
 - 1. Basis of Design: SMA Core-1 STP-33/50/62-US-4.
 - 2. Submit all comparable manufacturers and products that meet or exceed the following Specifications.
- B. Minimum Electrical Characteristics:
 - 1. Maximum Rated Power (STP-33-US-41): 33KW (AC)
 - 2. Maximum Rated Power (STP-50-US-41): 50KW (AC)
 - 3. Maximum Rated Power (STP-62-US-41): 6KW (AC)
 - 4. Nominal AC System Voltage (line-to-line): 480 V.
- C. General Description
 - 1. The inverter shall be non-self-commutated and suitable for meeting the specifications delineated herein.
 - 2. Compatibility: Inverters shall be compatible with the PV system array output and with the local utility company Power. The inverters shall be capable of operating in parallel with other inverters and be suitable for grid-connection operations.
 - 3. The inverter shall be listed as PV Rapid Shutdown Equipment according to UL 1741.
 - 4. The inverter shall be clearly marked and labeled in accordance with the National Electrical Code.
 - 5. Capacity: The kW capacity shall be as noted by basis of design inverter.
 - 6. Function: Converts DC output from associated solar PV arrays into a 3-phase AC power using reliable highly efficient insulated gate bipolar transistors (IGBT)
 - 7. Autonomy: The PV and inverter system shall be capable of completely automatic unattended operation including start-up, synchronization and disconnection.
 - 8. Harmonic Distortion: Shall meet or exceed IEEE 519-1992 harmonic distortion levels.
 - 9. Grid Compatibility Inverter: Shall include and isolation transformer which will precisely match the utility provided voltage.

2.8 DATA ACQUISITION, MONITORING & INTERACTIVE INTERFACE

- A. Equipment Supply: Provide a Data Acquisition and Monitoring System to collect, monitor, store and communicate data from the PV System and weather station. PV contractor to ensure compatibility with inverter and weather equipment as well as communication interfaces. SunPower EnergyLink with PVS5x or equivalent.
- B. BMS Interface: Data Acquisition and monitoring system may be required to interact with Building Monitoring System (BMS).
- C. Website Data Accessibility: The system selected shall be capable of outputting data and information to a website accessible through the internet. Manufacturer shall appropriately configure the monitoring website for public accessibility. System functionality shall be equivalent or better than the "Sunny Portal" type system.
- D. Production Reports: Contractor shall appropriately configure the data monitoring system to provide regular production reports (via email) and alerts, in the event of warnings or malfunction.

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- E. Warnings & Malfunction: System shall be capable of communicating warning/malfunction information via email to specified operator and maintenance personnel.
- F. Weather Data: A pyranometer shall be installed, capable of outputting data to said system. Outdoor weather & module temperature shall also be collected. System functionality shall be equivalent or better than the Sunny Sensorbox type system.
- G. Cabling & Conduit: An Ethernet connection will be made available at an appropriate location in the building structure. Contractor is required to provide appropriate data cable. Conduit shall be provided from rooftop structure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Do not begin installation until mounting surfaces have been properly prepared.
- C. If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.
- E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL

- A. Workmanship: Provide the entire solar photovoltaic system as shown on the drawings, as indicated in all of the various system components manufacturer's instructions and as required for a neat, workmanlike and fully integrated and operational system. Ensure that all required and recommended clearances are maintained.
- B. Pre-installation Conference: Before beginning PV module and wiring installation, conduct a pre-installation conference at the project site with the manufacturer of the major components or their representatives, installer, Architect, Owner and other interested parties to review procedures schedules, and coordination of the installation with other elements of the Work.
- C. Waste Management: Establish a waste management program in conjunction with rules instituted during the duration of this project.

- D. Contractor shall initiate, coordinate, file and incur all fees regarding necessary building permits, electrical / structural inspections, utility company agreements, system grid interconnections and utility rebate documents.
 - 1. Obtain all required local and state permits, certificates and / or approvals as necessary for Solar PV System installation / interconnection by local and state jurisdiction.
 - 2. The Contractor shall request and coordinate necessary inspections for the installation and commissioning from the respective authorities.
 - 3. The Contractor shall submit all necessary documents for utility company rebates.

3.3 PROJECT SITE WORK

- A. Section Scope: This section pertains to the scope of work required in mounting and wiring of the photovoltaic panels and the mounting and wiring of all Balance of System Components (BOS).
- B. Work Included
 - 1. PV module installation & wiring
 - 2. Combiner Box installation & wiring
 - 3. Inverter installation and wiring
 - 4. Data systems and wiring
- C. Minimum Tools Required: Safety helmet, safety goggles, protective strapping for working at heights above 6 feet, screwdrivers, wire cutters, wire strippers for stranded wire from 2 A. AWG to 12 AWG, AC and DC Electrical Meters with clamp on leads, drills, hole saws, wire snake, hands free flashlight, insulated 6000 volt gloves, ethyl alcohol, clean rags, wire grease, termination sealant, UL listed electrical tape in required colors (reference the Construction Documents).
- D. PV Module Mounting & Wiring
 - 1. See PV Manufacturer Specifications
 - 2. Crimping: Crimp using special tools as required any connectors using proper crimping tools and following manufacturer's requirements.
 - 3. Array Grounding: **GROUND ALL NON-CURRENT CARRYING METAL PARTS OF THE PV ARRAY TO BUILDING STEEL/EARTH GROUND.** To avoid electrical shock, ground the frame/mullion of the unit assembly before wiring the circuit. Reference the Construction Documents for grounding point location and conductor diameter; a grounding "lay-in" lug is also required. A thread-forming 10-32 stainless steel screw is required when using a self-drilling type screw to make the curtain wall unit mullion ground connection. A "continuous" bare copper wire must run across each floor through the "lay-in" lug screwed into each wall unit's lower horizontal mullion and then connect to building steel/earth ground. Verify with Engineer and AHJ alternate module and racking grounding methods.
 - 4. Combiner Box Mounting: Mount Combiner Boxes in a central location, according to Engineer specifications, relative to the PV array. Connect conduit to Combiner Box so only minimal penetrations are required for positive and negative leads coming from the various sub-arrays or series strings. Connect ground wire first, then positive leads and negative leads last. Install appropriately sized fuses.
 - 5. Parallel Connections & String Fusing Requirements: The ungrounded leads of each PV series string are to be connected to the fused connection points of the Combiner Box (See Combiner Box Wiring diagram for specific wiring detail). Connect the negative leads to

the negative bus of the Combiner Box. See drawings and manufacturer specifications which describe the maximum fuse size allowed. Refer to the National Electrical Code Article 690 for additional fusing requirements.

- E. Inverter/Power Conditioning Unit (PCU) Installation and wiring
1. Read the inverter manufacturers installation directions before attempting any work.
 2. Ventilation and Clearances: Unless otherwise specified, a minimum of 48” of clearance shall be maintained in front of the Inverter and Magnetic cabinet doors and in front of the Control cabinet door and 30” of clearance behind the enclosure. It is recommended that some space be maintained to the right of the enclosure. Reference the Contract Documents for exact inverter location.
 3. Lifting and Moving: Due to the size and weight of the inverter/PCU, it is recommended that it remain on the pallet it was shipped on until ready for installation.
 - a. CAUTION: Extra care must be used when moving the inverter/PCU and Isolation Transformer because the weight of the inverter is not evenly distributed within the enclosure.
 - b. Use Lift Points: Use existing slots for moving the Equipment with a forklift or palette jacks.
 4. Wiring and Torque Specifications: The required torque settings and acceptable wire sizes are to be used when making connections to the inverter. Terminal Block or Bolt Torque Setting
 5. Mounting the Inverter: The following general procedure should be used for each inverter installation.
 - a. Drill or punch appropriate conduit knockouts.
 - b. Secure the inverter/PCU to the foundation or wall. Provide and install appropriate anchors.
 - c. Connect the grounding-electrode conductor to the facility grounding system.
 - d. It is the responsibility of the Contractor to ensure that the input and output circuits are isolated from the enclosure.
 - e. Sections 690.41 and 690.42 of the National Electrical Code require that the PV array be earth grounded. The DC negative (or positive, depending on module requirements and inverter type) conductor input into the inverter is grounded internally in the inverter by the GFCI circuit. Do not ground the negative PV conductor at any other place on the DC circuits. The chassis of the inverter/PCU is also bonded to the PV ground bus bar.
 - f. Connect the AC Neutral phase conductor to the neutral output terminal. This terminal is purposely isolated from ground in the inverter. Grounding of the AC output neutral conductor must be accomplished outside the inverter/PCU.
 - g. Connect the three AC phase wires to terminals A, B and C. Be sure that the breaker is turned OFF at the sub-panel and to observe proper phasing when connecting these wires.
 - h. Torque all wire terminations as required by the manufacturer’s recommendations.
 6. Inverter/PCU Cautions & Warnings
 - a. CAUTION: It is the responsibility of the installer to see to it that the input and output circuits are isolated from the enclosure, if required by sections 690.41 and 690.42 of the National Electrical Code, ANSI/NFPA 70, and to assure that the system is properly grounded
 - b. CAUTION: Sections 690.41 and 690.42 of the National Electrical Code require that the PV array be earth grounded. The DC negative (or positive, depending on module requirements and inverter type) conductor input into the inverter is grounded internally in the inverter by the GFDI circuit. Do not ground the negative

PV conductor at any other place on the DC circuits. The chassis of the inverter/PCU is also bonded to the PV ground bus bar.

- c. CAUTION: The AC output circuit for the inverter/PCU should be sized for the maximum continuous output current rating and in compliance with NEC.
- d. WARNING: The PV array will produce high voltages when exposed to sunlight.
- e. WARNING: To prevent electrical shock or other injury, verify that the AC and DC wires are not energized during installation.

3.4 INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of PV panels with support assembly and other construction.
- C. Support PV panel assemblies independent of supports for other elements such as roof and support assemblies, enclosures, vents, pipes, and conduits. Support assembly to prevent twisting from eccentric loading.
- D. Install PV inverters, rapid shutdown, and system control in locations indicated on Drawings and/or as recommended by manufacturer.
- E. Install weatherseal fittings and flanges where PV panel assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Section 07 for materials and application.
- F. Wiring Method: Install cables in raceways.
- G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.5 CONNECTIONS

- A. Coordinate PV panel cabling to equipment enclosures to ensure proper connections.
- B. Coordinate installation of utility-interactive meter with utility.
- C. 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-486B.
- D. Make splices, terminations, and taps that are compatible with conductor material [and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors].

3.6 IDENTIFICATION

- A. Identify equipment, components, conduit and cable according to Division 26 Section "Identification for Electrical Systems."

- B. Identify Solar PV System safety disconnect switches as per NEC Section 690.

3.7 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Coat all exposed, scratched or chipped metallic materials with the appropriate manufacturer endorsed protectorate.

3.8 INITIAL START UP AND ACCEPTANCE TEST/COMMISSIONING

- A. Notifications & Upon Completion: The contractor shall notify the Architect and Engineer in writing when the entire PV system is correctly installed and properly wired.
- B. Commissioning & Testing Process
 1. Post-Installation Inspection & Documentation: Upon completion of general construction, and prior to system operation, the contractor shall perform a “Post-Construction Inspection”, as outlined below. Results of the Post-Installation Inspection, including all factory test reports shall be bundled and submitted to the Commissioning Engineer for approval prior to contractor validation/functional testing.
 2. Validation Testing & Functional Demonstration (Turnover) by Contractor: Pending the approval of Post-Installation inspection results, the Commissioning Engineer shall then provide permission for the Contractor to start-up the system and perform Validation Testing. Once completed, the owner and/or the Commissioning Engineer (as the owner’s representative) shall be present to witness the functional testing and turnover. Pending satisfactory completion Functional Demonstration, the system shall be considered “Commissioned”.
 3. 30 Day Performance Testing by Engineer/Owner: Acceptance testing of the system will take place over a 30 day conditioning and system rating period, led by the Commissioning Engineer, ensuring the system meets contractual system peak power ratings.
 4. Training: Following validation testing, the Solar Contractor shall concurrently perform training requirements, as outlined below.
 5. During any step of the commissioning and testing process the Contractor shall remove and replace malfunctioning equipment and retest as specified.
- C. Post-Installation Inspection: Once general construction is completed, the Solar Contractor shall satisfactorily complete the following inspection. Results of all inspections and tests shall be documented, submitted to the Commissioning Engineer and archived for future reference.
 1. General Inspection: An in-depth inspection shall be conducted to ensure that the system is built in a workmanlike manner and consistent with industry practice and operational requirements.
 - a. Notify Engineer of any damage or repair encountered during inspection.
 - b. Torque verification of bolted connections should be performed randomly
 - c. Inspect that all bolted and similar connections include locking devices and be designed to prevent loosening over the design life of the PV system

- d. ASTM A325 or A490 bolts do not require locking devices but shall be installed in accordance with the applicable standards in the AISC Manual of Steel Construction.
 - e. Inspect all exposed surfaces that they are painted or otherwise suitably protected to survive outdoor environmental conditions for a 25-year design life.
 - f. Inspect that all outdoor enclosures are weatherproof and capable of surviving intact under the site environmental conditions specified.
 - g. Check that all outdoor enclosures are equipped to prevent condensation.
 - h. Check that all doors, covers, panels, and cable exits are gasketed or otherwise designed to limit the entrance of dirt and moisture.
 - i. Inspection that all wiring is new, copper, and continuous for each wiring run; splices are not acceptable.
 - j. Inspect that all exposed wiring shall be suitably sunlight and weather resistant and shall be factory marked (stamped) as such.
 - k. Inspect that wires have identifying labels or markings on both ends. The labels or markings shall be permanent and durable. Labels or markings on exposed wiring shall be of type that is rated for withstanding the outdoor environment.
 - l. Inspect that wiring is bundled, laced and otherwise laid in an orderly manner.
 - m. Verify that all non-current carrying metal parts are solidly grounded and all equipment and system grounding is installed and functional per IEEE Standard 80.
2. Wires, Cables and Buses: Electrical cables and wires operated at or below 1000V (between the array junction boxes on the DC side and the utility interface point on the AC side) shall be tested for continuity and megger tested. All buses and cables operated above 1000V shall be meggered and tested phase-to-phase and phase-to-ground after installation.
 3. Inverter: After the inverter and necessary accessory equipment/devices are installed in their final configuration, but prior to paralleling with the grid, perform a visual inspection of wiring, components, enclosure, etc., verify Start/Stop switch and other controls (as possible). Check for adequacy of grounding.
 4. Array I-V Curve: An I-V curve of each source circuit and entire array shall be performed.
 5. Pre-parallel Inspection: The Acceptance Test reports shall be received by the Utility prior to performing a pre-parallel inspection. Written verification of receipt of the test report shall be returned to the Commissioning Engineer.
 6. Documentation
 - a. The results of any necessary factory acceptance testing and associated factory test reports shall be bundled and submitted to the Commissioning Engineer and Owner for approval.
 - b. Pending approval of such “pre-functional testing” by Commissioning Engineer, the solar contractor can then begin solar contractor start-up and validation testing.
- D. Validation Testing, Functional Demonstration & Turnover (Commissioning)
1. Procedure: Detailed validation and functional testing procedures shall be approved by the Commissioning Engineer prior to initiation.
 2. Manufacturer Procedures: Contractor shall review and incorporate the manufacturer’s recommended commissioning procedures in integrated system validation tests.
 3. Inverter/Power Conditioning Unit (PCU) Operational Tests: The tests shall may be required, as specified by the Commissioning Engineer, to demonstrate proper functional operation of control and protective features under normal and abnormal conditions. In some cases, one or more of these tests may need to be handled by devices external to the inverter/PCU.

4. Functional Testing & Turnover: Upon completion of successful solar contractor startup, the solar contractor can then schedule the functional test procedure that will be witnessed by the owner, commissioning engineer, and construction manager.
5. Final Documentation: Upon commissioning, a final documentation and training bundle (including manuals, operating procedures, electronic information, etc.) shall be assembled and provided to the owner, engineer, and representatives for approval and acceptance.

E. 30 Day Performance Test

1. Monitoring Systems: Appropriate portions of the monitoring system shall be operational prior to initiation of performance testing.
2. Contractor Assist: Solar contractor may be asked to assist in setup and data gathering as part of 30 day performance testing.
3. System Rating: System performance shall be monitored to collect data for the system rating. The AC system shall be rated at modified PVUSA Standard Test Conditions (STC) which are defined as follows: 20°C ambient temperature, 2 m/s wind speed, and 1000 W/m² global plane-to-array irradiance. AC System Power Output (measure at the point of interface)

- F. Training: Upon successful completion of the functional system test and sign-off from all parties involved, the solar contractor can schedule any training sessions with site personnel that may be required. Specific training requirements are further outlined in these specifications.

3.9 TRAINING

- A. Training Parties: Solar Contractor shall be responsible for the training the following personnel on the operation of individual pieces of equipment as well as complete systems.

1. Owner
2. Owner's Representatives
3. Electrical Subcontractor
4. Engineer
5. Facility Personnel
6. Related solar contractors, as specified by Owner's Representative

- B. Special Personnel: If the Contractor is not certified by the associated system manufacturer as witnessed by valid manufacturer training certificate or manufacturer letterhead, in addition to start up services, the Contractor shall provide factory-trained specialists to supervise commissioning and instruct the Owner's operators during initial operating instruction periods.

- C. Training Coordinator: The Contractor's Project Manager shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed to a standard acceptable to the Owner's Representative.

3.10 PERIODIC INSPECTIONS & MAINTENANCE

- A. Warranty: As specified in Sub-Section 1.13, Solar Contractor shall provide a complete warranty of all components, including replacement labor, extending 5 years after date of System Start-up and Acceptance test / Commissioning.

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- B. Service Requirements: The Warranty and the proposal for a Yearly Service Contract shall be based upon the manufacturer's standards and as a minimum and must include the following:
 - 1. PV Module, Racking & Fastening Inspections: Inspect all PV modules annually for safe electrical connections, sound mechanical connection and freedom from corrosion. Conduct a visual inspection of all PV modules for breakage, de-lamination and ensure mechanical connections are torqued and secured as required.
 - 2. Inspection Schedule: Although PV systems utilize solid-state technology and are virtually maintenance free, periodic inspections of the system is a prudent measure. Such inspections should occur on a bi-annually basis.
 - 3. Wiring Inspections: Inspect all wiring connections and terminations for required torque settings at splice boxes, junction boxes, combiner box, switches, inverter/PCU and isolation transformer. Visually inspect conduit runs and connections.

3.11 CLEANING AND RESTORATION

- A. After final acceptance, the Contractor shall clean all dirt, dust, grease and grime from on and within all equipment and components provided.
- B. Contractor shall "touch-up" all scratches, chips and nicks on all equipment provided.
- C. Trenched areas shall be backfilled compacted, topsoil added and properly seeded. If contract work occurs during the "non-growing" months, the Contractor shall seed the affected areas during the spring season "growing" months.

END OF SECTION 263100

SECTION 263213.13 - DIESEL EMERGENCY ENGINE GENERATORS

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. Section includes packaged diesel engine generators for emergency use with the following features:
 - 1. Diesel engine.
 - 2. Diesel fuel-oil system.
 - 3. Control and monitoring.
 - 4. Generator overcurrent and fault protection.
 - 5. Generator, exciter, and voltage regulator.
 - 6. Vibration isolation devices.
 - 7. Finishes.
- B. Related Requirements:
 - 1. Section 263600 "Transfer Switches" for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.3 DEFINITIONS

- A. EPS: Emergency power supply.
- B. EPSS: Emergency power supply system.
- C. Operational Bandwidth: The total variation, from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include thermal damage curve for generator.
 - 3. Include time-current characteristic curves for generator protective device.
 - 4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

MANSFIELD ELEMENTARY SCHOOL

5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

C. Warranty: For special warranty.

MANSFIELD ELEMENTARY SCHOOL

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - b. Operating instructions laminated and mounted adjacent to generator location.
 - c. Training plan.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
 - 4. Tools: Each tool listed by part number in operations and maintenance manual.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components 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 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Onan/Cummins Power Generation; Industrial Business Group, model DQDAB with alternator #HCI434D, and factory aluminum skin-tight Quiet Site II Enclosure or comparable product by one of the following manufacturers in the next paragraph.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is

MANSFIELD ELEMENTARY SCHOOL

acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.

1. Caterpillar, Inc.; Electric Power Division.
2. MTU Onsite Energy Corporation.

- C. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. B11 Compliance: Comply with B11.19.

- B. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 EPSS.

- C. UL Compliance: Comply with UL 2200.

- D. Engine Exhaust Emissions: Comply with EPA Tier 3 requirements and applicable state and local government requirements.

- E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

- F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 41 to 104 deg F.
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 3400 feet.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Service Load: Refer to single line diagram.

- D. Power Factor: 0.8, lagging.

- E. Frequency: 60 Hz

- F. Voltage: 480 V ac.

- G. Phase: Three-phase, four-wire wye.
- H. Governor: Adjustable isochronous, with speed sensing.
- I. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.
- J. Capacities and Characteristics:
 - 1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries, with capacity as required to operate as a unit as evidenced by records of prototype testing.
 - 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- K. Engine Generator Performance:
 - 1. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage, from no load to full load.
 - 2. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 seconds.
 - 3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency, from no load to full load.
 - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
 - 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 - 7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
 - 8. Start Time: Comply with NFPA 110, Type 10 system requirements.

2.4 DIESEL ENGINE

- A. Fuel: ASTM D975 diesel fuel oil, Grade 2-D S15.
- B. Rated Engine Speed: 1800 rpm.

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- C. Lubrication System: Engine or skid mounted.
 - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499. 1500 watts at 120 volts.

- E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.
 - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 - 2. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.
 - 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant-system pressure for engine used. Equip with gage glass and petcock.
 - 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 - 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

- F. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 - 1. Minimum sound attenuation of 25 dB at 500 Hz.
 - 2. Sound level measured at a distance of 23 feet from exhaust discharge after installation is complete shall be 73 dBA or less.

- G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

- H. Starting System: 24Vdc electric, with negative ground.
 - 1. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 - 4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - f. Enclosure and Mounting: NEMA 250, Type 1 wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

- A. Comply with NFPA 30.
- B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.
- C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.
- D. Fuel Filtering: Remove water and contaminants larger than 1 micron.
- E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

- F. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:
 - 1. Tank level indicator.
 - 2. Fuel-Tank Capacity: 600 Gallons.
 - 3. Leak detection in interstitial space.
 - 4. Vandal-resistant fill cap.
 - 5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 CONTROL AND MONITORING

- A. Automatic-Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- B. Provide minimum run time control set for 30 minutes, with override only by operation of a remote emergency-stop switch.
- C. Comply with UL 508A.
- D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.
- E. Control and Monitoring Panel:
 - 1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
 - 2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
 - 3. Instruments: Located on the control and monitoring panel and viewable during operation.
 - a. Engine lubricating-oil pressure gage.
 - b. Engine-coolant temperature gage.
 - c. DC voltmeter (alternator battery charging).
 - d. Running-time meter.
 - e. AC voltmeter, for each phase connected to a phase selector switch.
 - f. AC ammeter, for each phase connected to a phase selector switch.
 - g. AC frequency meter.
 - h. Generator-voltage-adjusting rheostat.
 - 4. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:
 - a. Cranking control equipment.
 - b. Run-Off-Auto switch.
 - c. Control switch not in automatic position alarm.
 - d. Overcrank alarm.
 - e. Overcrank shutdown device.

- f. Low water temperature alarm.
 - g. High engine temperature pre-alarm.
 - h. High engine temperature.
 - i. High engine temperature shutdown device.
 - j. Overspeed alarm.
 - k. Overspeed shutdown device.
 - l. Low-fuel main tank.
 - 1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for the duration required for the indicated EPSS class.
 - m. Coolant low-level alarm.
 - n. Coolant low-level shutdown device.
 - o. Coolant high-temperature prealarm.
 - p. Coolant high-temperature alarm.
 - q. Coolant low-temperature alarm.
 - r. Coolant high-temperature shutdown device.
 - s. EPS load indicator.
 - t. Battery high-voltage alarm.
 - u. Low-cranking voltage alarm.
 - v. Battery-charger malfunction alarm.
 - w. Battery low-voltage alarm.
 - x. Lamp test.
 - y. Contacts for local and remote common alarm.
 - z. Low-starting air pressure alarm.
 - aa. Low-starting hydraulic pressure alarm.
 - bb. Remote manual-stop shutdown device.
 - cc. Air shutdown damper alarm when used.
 - dd. Air shutdown damper shutdown device when used.
 - ee. Generator overcurrent-protective-device not-closed alarm.
 - ff. Hours of operation
 - gg. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.
- F. Connection to Datalink:
- 1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
 - 2. Provide connections for datalink transmission of indications to remote data terminals via Ethernet. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."
- G. Common Remote Panel with Common Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.
- H. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
- 1. Overcrank alarm.

2. Coolant low-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low-fuel main tank alarm.
8. Low coolant level alarm.
9. Low-cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel-supply alarm.
17. Lamp test.
18. Low-cranking voltage alarm.
19. Generator overcurrent protective device not closed.

- I. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.
- J. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
 1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.
- B. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with UL 489.
 1. Tripping Characteristic: Designed specifically for generator protection.
 2. Trip Rating: Matched to generator output rating.
 3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.

- C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:
 - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
 - 2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 - 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
 - 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

- D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.
 - 1. Indicate ground fault with other engine generator alarm indications.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Range: Provide limited range of output voltage by adjusting the excitation level.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Dripproof.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
 - 1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
 - 2. Maintain voltage within 30 percent on one step, full load.
 - 3. Provide anti-hunt provision to stabilize voltage
 - 4. Maintain frequency within 15 percent and stabilize at rated frequency within 2 seconds.

MANSFIELD ELEMENTARY SCHOOL

- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Steady state kVA rating of the alternator shall be 345 kVA with a maximum temperature rise of 105-degree C based on maximum specified site conditions.
- L. Alternator shall be capable of accepting maximum 1028 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
- M. Additionally, the maximum generator voltage dip application on the largest single load step, 553.6 starting kVA, considering both alternator performance and engine speed changes, shall not exceed 16%.
- N. Subtransient Reactance: 12 percent, maximum.

2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE

- A. Description: Vandal-resistant, sound-attenuating, weatherproof aluminum housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
 - 1. Sound Attenuation Level: 72 dBA at 23 feet.
- B. Description: Prefabricated or pre-engineered, aluminum-clad, integral structural-steel-framed, erected on concrete foundation.
- C. Generator enclosure and sub-base tank must include adequate spacing and provisions for bottom entry of all AC and DC conduits into the enclosure for all circuit breaker and control wiring terminations as required.
- D. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads of up to 100 mph.
- E. Hinged Doors: With padlocking provisions.
- F. Space Heater: Thermostatically controlled and sized to prevent condensation.
- G. Lighting: Provide weather-resistant LED lighting with 30-fc average maintained.
- H. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.
- I. Muffler Location: Within enclosure.

- J. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
 - 3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.
- K. Interior Lights with Switch: Factory-wired, vapor-proof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
 - 1. AC lighting system and connection point for operation when remote source is available.
 - 2. DC lighting system for operation when remote source and generator are both unavailable.
- L. Convenience Outlets: Factory-wired GFCI. Arrange for external electrical connection.
- M. 150 amp – 120/208-volt, single phase load center panelboard with circuit breakers for all power requirements including unit lighting, convenience receptacle, alternator heater, battery charger, and engine jacket water heater. Panel shall be factory-installed and pre-wired for genset auxiliary AC loads.

2.10 VIBRATION ISOLATION DEVICES

- A. Generators installed on grade shall be provided with dual vibration isolators integral to the generator set, unless the manufacturer requires the use of spring isolators.

2.11 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Test generator, exciter, and voltage regulator as a unit.
 - 3. Full-load run.
 - 4. Maximum power.
 - 5. Voltage regulation.

MANSFIELD ELEMENTARY SCHOOL

6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify Architect, Construction Manager, Owner no fewer than two working days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Architect's, Construction Manager's, Owner's written permission.

3.3 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.
- C. Equipment Mounting:
 1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

3. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure enclosure to anchor bolts installed in concrete bases.
- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Cooling System: Install Schedule 40 black steel piping with welded joints for cooling water piping between engine generator and heat exchanger. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
 1. Install isolating thimbles where exhaust piping penetrates combustible surfaces. Provide a minimum of 9 inches of clearance from combustibles.
 2. Insulate cooling-system piping and components according to requirements in Section 230700 "HVAC Insulation."
- F. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.
 1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
 2. Install flexible connectors and steel piping materials according to requirements in Section 232113 "Hydronic Piping."
 3. Insulate muffler/silencer and exhaust system components according to requirements in Section 230700 "HVAC Insulation."
 4. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9 inches of clearance from combustibles.
- G. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.
 1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
 2. Drain piping valves, connectors, and installation requirements are specified in Section 232113 "Hydronic Piping."
- H. Fuel Piping:
 1. Copper and galvanized steel shall not be used in the fuel-oil piping system.
- I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- J. Remote alarm annunciator shall be located in the Main Reception area.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.

MANSFIELD ELEMENTARY SCHOOL

- C. Connect cooling-system water piping to engine generator and heat exchanger with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Connect fuel piping to engines with a gate valve and union and flexible connector.
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.
- H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

- A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."
- B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections. Contractor shall provide all fuel for testing and shall fill tank completely prior to turning over to owner. Load testing shall be 100% of the rating of the generator for four continuous hours.
- B. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and in "Visual and Mechanical Inspection" and "Electrical and Mechanical Tests" subparagraphs below, as specified in the NETA ATS. Certify compliance with test parameters.
 - a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with Drawings and the Specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage, alignment, and grounding.
 - 4) Verify that the unit is clean.
 - b. Electrical and Mechanical Tests:
 - 1) Perform insulation-resistance tests according to IEEE 43.
 - a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
 - b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.
 - 2) Test protective relay devices.

- 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
 - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
 - 5) Perform vibration test for each main bearing cap.
 - 6) Conduct performance test according to NFPA 110.
 - 7) Verify correct functioning of the governor and regulator.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
 7. Exhaust Emissions Test: Comply with applicable government test criteria.
 8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 10. Noise-Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet from edge of the generator enclosure, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
- D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

MANSFIELD ELEMENTARY SCHOOL

- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component, indicating satisfactory completion of tests.
- K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels, so terminations and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 263213.13

SECTION 263600 - TRANSFER SWITCHES

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. Section includes automatic transfer switches rated 600 V and less, including the following:
 - 1. Remote annunciator system.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
 - 2. Include material lists for each switch specified.
 - 3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch.
 - 4. Riser Diagram: Show interconnection wiring between transfer switches, annunciators, and control panels.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer-authorized service representative and testing agency.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Features and operating sequences, both automatic and manual.

MANSFIELD ELEMENTARY SCHOOL

- b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications:
 1. Member company of NETA.
 - a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
 1. Notify Architect, Construction Manager, Owner, no fewer than two days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Architect's, Construction Manager's, Owner's, written permission.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components 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 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 110.
- D. Comply with UL 1008 unless requirements of these Specifications are stricter.
- E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.
- F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 1. Short-time withstand capability for three cycles.

- G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.
 - 1. Surge Protective Device: Service rated.
- J. Neutral Switching: Where four-pole switches are indicated, provide overlapping neutral contacts.
- K. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.
- L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- M. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable shrinkable sleeve markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
 - 4. Accessible via front access.
- N. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Schneider Electric, ASCO Power Technologies 7000 Series or comparable product by one of the following in the next paragraph.

- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 - 1. Caterpillar, Inc.; Electric Power Division.
 - 2. Cummins Power Generation.
 - 3. MTU Onsite Energy Corporation.
- C. Comply with Level 1 equipment according to NFPA 110.
- D. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
 - 4. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 5. Material: Hard-drawn copper, 98 percent conductivity.
 - 6. Main and Neutral Lugs: Mechanical type.
 - 7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 - 8. Ground bar.
 - 9. Connectors shall be marked for conductor size and type according to UL 1008.
- E. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.
 - 1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
 - 2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
 - 3. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.
- F. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
 - 1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
- G. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

- H. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- I. Electric Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
- J. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- K. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- L. Automatic Transfer-Switch Controller Features:
 - 1. Controller operates through a period of loss of control power.
 - 2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 - 4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 - 5. Test Switch: Simulate normal-source failure.
 - 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
 - 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
 - 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
 - 9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
 - 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
 - 11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is unavailable.

- M. Large-Motor-Load Power Transfer:
 1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
 2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
 3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 TRANSFER SWITCH ACCESSORIES

- A. Remote Annunciator System:
 1. Source Limitations: Same manufacturer as transfer switch in which installed.
 2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
 3. Annunciation panel display shall include the following indicators:
 - a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 - b. Switch position.
 - c. Switch in test mode.
 - d. Failure of communication link.
 4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
 - a. Indicating Lights: Grouped for each transfer switch monitored.
 - b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
 - c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
 - d. Lamp Test: Push-to-test or lamp-test switch on front panel.

- B. Remote Annunciator and Control System:
1. Source Limitations: Same manufacturer as transfer switch in which installed.
 2. Include the following functions for indicated transfer switches:
 - a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 - b. Indication of switch position.
 - c. Indication of switch in test mode.
 - d. Indication of failure of digital communication link.
 - e. Key-switch or user-code access to control functions of panel.
 - f. Control of switch-test initiation.
 - g. Control of switch operation in either direction.
 - h. Control of time-delay bypass for transfer to normal source.
 3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
 4. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
 - a. Controls and indicating lights grouped together for each transfer switch.
 - b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
 - c. Digital Communication Capability: Matched to that of transfer switches supervised.
 - d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

2.4 POWER METER

- A. The power meter shall conform to the requirements of:
1. UL 3111-1 Electrical Measuring and Testing Equipment
 2. CAN/CSA-C22.2 No. 23-M89-CSA Safety Requirements for Electrical and Electronic Measuring and Test Equipment
 3. The Power Meter shall be capable of operating without modification at a nominal frequency of 45 to 66Hz.
 4. The Power Meter shall be rated for an operating temperature of -4°F to 158°F and a storage temperature of -22°F to 176°F and shall be rated for an 85% non-condensing, relative humidity.
 5. The Power Meter shall accept inputs from industry standard instrument transformers (120 VAC secondary PT's and 5A secondary CT's). Direct phase voltage connections, 0 to 600VAC nominal, shall be possible without the use of PT's.
 6. The Power Meter shall accept single, 3 phase, or three & four wire circuits. A fourth CT input shall be available to measure neutral or ground current.
 7. The Power Meter shall contain a built-in discrete contact to wire an ATS 14A auxiliary contact to indicate switch position.
 8. The Power Meter shall accept AC voltage from the sensing lines for operation. Additional provisions shall be provided for external DC voltage input range 9-36 VDC with a nominal of 24 VDC.
 9. The Power Meter shall be equipped with a continuous duty, long-life, 4 line x 20 character green backlit LCD.

10. All setup parameters required by the Power Meter shall be stored in non-volatile memory and retained in the event of a control power interruption.
11. The Power Meter shall be flush mountable on a surface.
12. The Power Meter enclosure shall be sealed to IP-51 (NEMA 1) and the faceplate shall be sealed to IP-65 (NEMA 4). All push buttons shall be sealed tact switches.
13. The Power Meter shall send, when prompted, information to a central location equipped with a manufacturer supplied critical power management system or 3rd party monitor through manufacturer supplied communication modules. All 3rd party monitor must utilize industry standard open protocols Modbus/RTU, Modbus/TCP or SNMP.
14. An embedded RS-485 port will be provided which shall enable communication at 9600, 19.2K, 38.4K, or 57.6K baud. DIP switches shall be provided on the RS-485 port allowing a user to select 2-wire or 4-wire communication as well as the option to activate a terminating resistor on the port.
15. The Power Meter shall provide Maximum Demand calculations for the past 24 months, as per standards with 15 minute averages.
16. The following data will be available on the display and Modbus registers of the Power Meter:
 - a. Line-to-neutral voltages (V_{AN} , V_{BN} , and V_{CN})
 - b. Line-to-neutral voltage average (V_{AVE})
 - c. Line-to-line voltages (V_{AB} , V_{BC} , and V_{CA})
 - d. Line-Line voltage average (V_{LAVE})
 - e. Current on each phase (I_A , I_B , and I_C)
 - f. Current on the neutral conductor (I_N)
 - g. Average current (I_{AVE})
 - h. Active power, KW per phase and total (W_A , W_B , W_C , and W_T)
 - i. Apparent power, KVA per phase and total (V_{AA} , V_{AB} , V_{AC} , and V_{AT})
 - j. KW Hours importing, exporting and net (KWH_{IMP} , KWH_{EXP} , and KWH_{NET})
 - k. KVAR Hours leading, lagging and net ($KVARH_{LEAD}$, $KVARH_{LAG}$ and $KVARH_{NET}$)
 - l. Power Factor (PF)
 - m. Signal Frequency (Hz)
 - n. Digital Input
17. For ease of operator viewing, the LCD display can be configured to remain on continuously, with no detrimental effect on the life of the Power Meter.
18. The display's contrast shall be configurable in intervals of 10% (ranging 0% - 100%).
19. Setup of a system requirements shall be allowed from the front of the Power Meter.

2.5 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.
- B. Prepare test and inspection reports.
 1. For each of the tests required by UL 1008, performed on representative devices, for emergency required systems. Include results of test for the following conditions:
 - a. Overvoltage.
 - b. Undervoltage.

- c. Loss of supply voltage.
- d. Reduction of supply voltage.
- e. Alternative supply voltage or frequency is at minimum acceptable values.
- f. Temperature rise.
- g. Dielectric voltage-withstand; before and after short-circuit test.
- h. Overload.
- i. Contact opening.
- j. Endurance.
- k. Short circuit.
- l. Short-time current capability.
- m. Receptacle withstand capability.
- n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
 - 3. Provide workspace and clearances required by NFPA 70.
- B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.
- C. Power Meter: Where equipment is not integral to the ATS enclosure, the power meter and display shall be mounted in its own enclosure adjacent to the ATS with center of display 60 inches above finished floor. Coordinate location with other equipment in room and provide all fittings, boxes, and wire. Power metering equipment that is not immediately adjacent to switch being monitored shall be provided a label identifying the load it is monitoring.
- D. Identify components according to Section 260553 "Identification for Electrical Systems."
- E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- F. Comply with NECA 1.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

MANSFIELD ELEMENTARY SCHOOL

- B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
 - 1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- F. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.
- G. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. After installing equipment, test for compliance with requirements according to NETA ATS.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and required clearances.
 - d. Verify that the unit is clean.
 - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - f. Verify that manual transfer warnings are attached and visible.
 - g. Verify tightness of all control connections.
 - h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
 - i. Perform manual transfer operation.
 - j. Verify positive mechanical interlocking between normal and alternate sources.
 - k. Perform visual and mechanical inspection of surge arresters.

1. Inspect control power transformers.
 - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
 - 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
3. Electrical Tests:
 - a. Perform insulation-resistance tests on all control wiring with respect to ground.
 - b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
 - c. Verify settings and operation of control devices.
 - d. Calibrate and set all relays and timers.
 - e. Verify phase rotation, phasing, and synchronized operation.
 - f. Perform automatic transfer tests.
 - g. Verify correct operation and timing of the following functions:
 - 1) Normal source voltage-sensing and frequency-sensing relays.
 - 2) Engine start sequence.
 - 3) Time delay on transfer.
 - 4) Alternative source voltage-sensing and frequency-sensing relays.
 - 5) Automatic transfer operation.
 - 6) Interlocks and limit switch function.
 - 7) Time delay and retransfer on normal power restoration.
 - 8) Engine cool-down and shutdown feature.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 - g. Verify proper readings of installed power meter with portable measurement equipment.

- h. Verify BMS/ATS Monitoring System is reporting information correctly.
- 6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- D. Coordinate tests with tests of generator and run them concurrently.
- E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- F. Transfer switches will be considered defective if they do not pass tests and inspections.
- G. Remove and replace malfunctioning units and retest as specified above.
- H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 - 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 - 3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
- B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.
- C. Coordinate this training with that for generator equipment.

END OF SECTION 263600

MANSFIELD ELEMENTARY SCHOOL

SECTION 265100 - INTERIOR LIGHTING

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:
 - 1. Interior lighting fixtures, lamps, and drivers.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
- B. Related Section include the following:
 - 1. Division 26 Section "Wiring Devices" for automatic control of lighting, including occupancy/vacancy sensors.

1.3 DEFINITIONS

- A. CRI: Color-rendering index.
- B. CU: Coefficient of utilization.
- C. LER: Luminaire efficacy rating.
- D. Luminaire: Complete lighting fixture, including driver housing if provided.
- E. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Driver.
 - 4. Energy-efficiency data.
 - 5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."

6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
 7. Life, output, and energy-efficiency data for lamps.
 8. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, drivers, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
 - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
1. Wiring Diagrams: Power and control wiring.
- C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Lighting fixtures.
 2. Suspended ceiling components.
 3. Structural members to which suspension systems for lighting fixtures will be attached.
 4. Other items in finished ceiling including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Smoke and fire detectors.
 - e. Occupancy sensors.
 - f. Access panels.
 5. Perimeter moldings.
- D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
1. Accessories: Cords and plugs.
- E. Qualification Data: For agencies providing photometric data for lighting fixtures.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- H. Warranties: Special warranties specified in this Section.
- I. Contractor shall perform a coordination review with the wiring device vendor and the lighting fixture submittal to ensure that the wiring devices are compatible with the lighting fixtures they are controlling and shall submit a letter with the shop drawing. If letter is not included, then shop drawing shall be automatically rejected.

MANSFIELD ELEMENTARY SCHOOL

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- B. 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.
- C. Comply with NFPA 70.
- D. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of fixtures for mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- E. LED fixtures, both interior and exterior, shall be DLC listed in order to receive utility company rebates. LED fixtures shall have a minimum efficacy of 90 lumens/watt.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
- B. Special Warranty for LED fixtures and drivers: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Drivers: 1 for every 50 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers indicated in the fixture schedule. If alternate manufacturers are provided, contractor shall provide floor plans with foot candle levels indicated with submittal so engineer can verify foot candle levels match the design as indicated in the foot candle chart on the contract drawings.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.

- F. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

2.4 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
 - 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.5 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

MANSFIELD ELEMENTARY SCHOOL

- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.6 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

- A. Refer to the fixture schedule on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Adjust aimable lighting fixtures to provide required light intensities.
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

MANSFIELD ELEMENTARY SCHOOL

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

SECTION 265600 - EXTERIOR LIGHTING

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:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Poles and accessories.

1.3 DEFINITION

- A. CRI: Color-rendering index.
- B. Luminaire: Complete lighting fixture, including ballast housing if provided.
- C. Pole: Luminaire support structure, including tower used for large area illumination.
- D. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.
- C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
 - 1. Wind speed for calculating wind load for poles exceeding 50 feet in height is 110 mph.
 - 2. Wind speed for calculating wind load for poles 50 feet or less in height is 110 mph.

1.5 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 - 2. Details of attaching luminaires and accessories.
 - 3. Details of installation and construction.
 - 4. Luminaire materials.
 - 5. Photometric data based on laboratory tests of each luminaire type, complete with LED, drivers, and accessories.
 - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - 6. Photoelectric relays.
 - 7. Ballasts, including energy-efficiency data.
 - 8. LEDs, including life, output, and energy-efficiency data.
 - 9. Materials, dimensions, and finishes of poles.
 - 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 - 11. Anchor bolts for poles.
 - 12. Manufactured pole foundations.
- B. Shop Drawings:
 - 1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 - 2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 - 3. Wiring Diagrams: Power and control wiring.
- C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.
- D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.
- E. Qualification Data: For agencies providing photometric data for lighting fixtures.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

MANSFIELD ELEMENTARY SCHOOL

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- B. 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.
- C. Comply with IEEE C2, "National Electrical Safety Code."
- D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
 - 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
 - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

MANSFIELD ELEMENTARY SCHOOL

2. Globes and Guards: 10 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 1. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product indicated on the drawings. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: As indicated by the Architect.

2.3 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 1. Materials: Shall not cause galvanic action at contact points.
 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

MANSFIELD ELEMENTARY SCHOOL

- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.4 POLES AND POLE ACCESSORIES

- A. Site Lighting Poles: One-piece, non-tapered round shaft, low carbon steel material. Refer to the exterior lighting fixture schedule for product selection.
- B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
- C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
- D. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept ballast, indicated accessories.
- E. Grounding lug integrated to inner wall of shaft, drilled and tapped to accommodate ¼ x 20 stainless steel screw.
- F. Provisions for optional GFI receptacle.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- B. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.2 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
 - 3. Trees: 15 feet.

MANSFIELD ELEMENTARY SCHOOL

- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole, unless otherwise indicated.

3.7 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.

- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
 - b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - e. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 265600

SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section includes common work requirements and results for all Communications work performed under Division 27 specifications.
- B. Related Requirements:
 - 1. Section 260533 – “Raceways and Boxes for Electrical Systems” for conduit and fittings, raceways, boxes, enclosures, cabinets, and handholes.

1.3 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. All work of Section 270526 - Grounding and Bonding for Communications Systems
 - 2. All work of Section 270528 - Pathways for Communications Systems
 - 3. All work of Section 270528.26 - Innerduct for Communications Systems
 - 4. All work of Section 270536 – Cable Trays for Communications Systems
 - 5. All work of Section 270537 – Firestopping for Communications Systems
 - 6. All work of Section 270553 - Identification for Communications Systems
 - 7. All work of Section 270800 - Commissioning of Communications
 - 8. All work of Section 271100 – Communications Equipment Room Fittings
 - 9. All work of Section 271116 - Communications Cabinets, Racks Frames and Enclosures
 - 10. All work of Section 271313 - Communications Copper Backbone Cabling
 - 11. All work of Section 271323 - Communications Optical Fiber Backbone Cabling
 - 12. All work of Section 271513 - Communications Copper Horizontal Cabling
 - 13. All work of Section 275313 – Intercommunications, Paging and Clock Systems
- B. Alternates: Not Applicable

MANSFIELD ELEMENTARY SCHOOL

- C. Items To Be Installed Only:
 - 1. Wireless Access Points
- D. Items To Be Furnished Only:
 - 1. Copper and optical fiber patch cords
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Not Applicable

1.4 PROJECT DESCRIPTION

- A. This project consists of the installation of a complete structured cabling and infrastructure pathway system for The Mansfield Elementary School.

1.5 SPECIAL CONDITIONS

- A. The general conditions for contracts of construction, referred to in the contract documents as the General Conditions, together with the following articles of the Communications Structured Cabling Specifications, which amend, modify and supplement various articles and provisions of the General Conditions, are made part of the Contract and shall apply to all work under the Contract.
- B. The Contractor represents that he/she is familiar with, and has expertise in the Work of this nature and scope. The Contractor further agrees that he/she shall provide all Work as may be required to make a complete job of that which may not be fully defined in the Contract documents.
- C. These specifications are material, equipment, and performance specifications. Actual installation requirements shall be as indicated on the drawings. Installation details indicated on the drawings shall govern if they differ from the specifications. Contractor is obligated to identify such differences at the time of bid submission.
- D. Contractor shall comply with all applicable governmental regulations and with all Federal, State, City, and other applicable codes and ordinances. If the contractor performs any work which is contrary to such regulations, codes, and ordinances, contractor shall make all changes to comply therewith and bear all costs arising there from.
- E. It is the intent of this Specification that all items under these Sections be engineered, assembled, installed and maintained by, and under the full responsibility of a single Contractor, whether these processes are actually performed by the Contractor or not. Deviations from this intent are to be fully described in the proposal, with reasons for the same, and the coordination methods required facilitating the least effect of the deviation on the project's implementation.

1.6 WORK INCLUDED

- A. The Owner seeks to identify a qualified low voltage communications cabling contractor capable of performing the scope of work as identified in the Contract Documents.
- B. It is the intent of these Specifications to create an ANSI/TIA-568.1-D compliant cabling system to support high-speed data applications up to 10 Gbps including IEEE standards based on Fast Ethernet, Gigabit Ethernet and 10 Gigabit Ethernet. System acceptance shall be judged on its ability to perform as such, the successful adherence to the installation instructions of this Specification, and compliance with parts and workmanship warranties.
- C. The work covered by this specification includes the installation of a complete cabling system, including all labor necessary to perform and complete such installation, all materials and equipment incorporated or to be incorporated in such installation, and all services, supervision, consumable items, fees, licenses, facilities, tools, and equipment necessary or used to perform and complete such installation.
- D. The Work Included is defined by the following and further defined in the drawings and Sections of Division 270000.
 - 1. Provide project management and oversight for the installation of a complete structured cabling system.
 - 2. Prepare and submit component documentation shop drawings, outlet labeling drawings, cable pull/termination schedules, cable test results and as built drawings as described within this Specification and per the General Conditions.
 - 3. Preparation of shop drawings, record or as-built drawings, manufacturer cut sheets, and other documentation described herein.

1.7 REFERENCES

- A. Abbreviations and Acronyms
 - 1. A/E: Architect / Engineer (designer)
 - 2. ANSI: American National Standards Institute
 - 3. AHJ: Authority Having Jurisdiction
 - 4. APC: Angled Physical Connector
 - 5. BDF: Building Distribution Frame
 - 6. BICSI: Building Industry Consulting Service International
 - 7. CMP: Communications Plenum cable
 - 8. CMR: Communications Riser cable
 - 9. DAS: Distributed Antenna System
 - 10. EIA: Electronics Industry Alliance
 - 11. ELFEXT: Equal Level far End Cross Talk
 - 12. ER: Equipment Room
 - 13. F/UTP: Foil Screened Unshielded Twisted Pair
 - 14. FOTP: Fiber Optic Test Procedure
 - 15. GHz: Gigahertz
 - 16. IDC: Insulation Displacement Conductor
 - 17. IDF: Intermediate Distribution Frame
 - 18. IT: Information Technology
 - 19. ISP: Inside Plant

MANSFIELD ELEMENTARY SCHOOL

- 20. LC: A type of small form factor optical fiber connector
- 21. LOMMF: Laser Optimized Multimode Fiber
- 22. MDF: Main Distribution Frame
- 23. MHz: Megahertz
- 24. MMF: Multimode Fiber
- 25. MPO: Multi-fiber Push On connector
- 26. MPOE: Minimum Point of Entry
- 27. MTER: Main Telecommunications Equipment Room
- 28. NEXT: Near End Cross Talk
- 29. OFNP: Optical Fiber nonconductive plenum cable
- 30. OFNR: Optical Fiber nonconductive riser cable
- 31. OSP: Outside Plant
- 32. OTDR: Optical Time Domain Reflectometer
- 33. PoE: Power-over-Ethernet
- 34. PSELFEXT: Power Sum Equal Level far End Cross Talk
- 35. PSNEXT: Power Sum Near End Cross Talk
- 36. RCDD: Registered Communications Distribution Designer
- 37. RMU: Rack Mount Unit
- 38. RoHS: Restriction of Hazardous Substances
- 39. ScTP: Screened Twisted Pair
- 40. STP: Shielded Twisted Pair
- 41. SMF: Singlemode Fiber
- 42. TCIM: Telecommunication Cabling Installation Manual
- 43. TDMM: Telecommunications Distribution Methods Manual
- 44. TDR: Time Domain Reflectometer
- 45. TGB: Telecommunications Grounding Busbar
- 46. TIA: Telecommunications Industry Association
- 47. PBB: Primary Bonding Busbar
- 48. TR: Telecommunications Room
- 49. TSER: Telecommunications Service Entry Room
- 50. UL: Underwriters Laboratory
- 51. UTP: Unshielded Twisted Pair
- 52. WAP: Wireless Access Point

- B. "PROVIDE" or "FURNISH" means to supply, purchase, transport, place, erect, connect, label, test and turn over to Owner, complete and ready for regular operation, all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for a telecommunications cabling system.
- C. "SUPPLY" means to purchase, procure, acquire, and deliver complete with related accessories.
- D. "INSTALL" means to move from property line, set in place, join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner of equipment and/or components. It means the installation is to be complete and ready for regular operation, except as otherwise noted.
- E. "WIRING" or "CABLING" includes furnishing, unless otherwise noted, of all fittings, hangers, supports, sleeves, etc.

MANSFIELD ELEMENTARY SCHOOL

- F. "CONDUIT" and CABLE TRAY" includes furnishing, unless otherwise noted, of all fittings, hangers, supports, sleeves, etc.
- G. "AS DIRECTED" means as instructed by the Project Manager or his representative.
- H. "CONCEALED" means embedded in masonry or other construction, installed behind wall furring or within double partitions, or installed within hung ceilings.
- I. "EXPOSED" means not installed underground or "CONCEALED" as defined above.
- J. "PERMANENT LINK" means the end-to-end test configuration for a link excluding test cords and patch cords, but including the mated connection with the link.

1.8 CODES, REGULATIONS, AND STANDARDS

- A. All equipment shall be equal to or exceed the minimum requirements of OSHA, NEMA, IEEE, ASME, ANSI, NEC and Underwriters Laboratories.
- B. The installation shall comply fully with all applicable local, county and state laws and ordinances, regulations and codes.
- C. Local electrical and building codes in Connecticut may be more stringent than national codes, recommendations or practice. Follow the most restrictive code or recommendations.
- D. All products, services and materials provided and performed under the scope of this specification shall conform to the following codes and standards. Refer to the most recent version, update or addenda.
 - 1. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual - latest edition
 - 2. Building Industry Consulting Service International (BICSI) Information Transport Systems Installation Manual (ITSIM) – latest edition
 - 3. ANSI/TIA-568.1-D, Commercial Building Telecommunications Cabling Standard
 - 4. ANSI/TIA-568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 - 5. ANSI/TIA-568.3-D, Optical Fiber Cabling Components Standard
 - 6. ANSI/TIA-569-E, Commercial Building Standards for Telecommunications Pathways and Spaces
 - 7. ANSI/TIA-606-C, Administration Standard for Commercial Telecommunications Infrastructure
 - 8. ANSI/TIA-607-D, Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
 - 9. ANSI/TIA-862-B Building Automation Systems Cabling Standard
 - 10. ANSI/TIA-942-B, Telecommunications Infrastructure for Data Centers
 - 11. FCC Part 15
 - 12. FCC Part 68
 - 13. IEEE 802.3ab, 1000Base-T Ethernet Specification
 - 14. IEEE 802.3af Power over Ethernet (PoE) Standard
 - 15. IEEE 802.3at Power over Ethernet+ (Plus) Standard

MANSFIELD ELEMENTARY SCHOOL

16. IEEE 802.3an Physical Layer and Management Parameters for 10 Gbps Operation Type 10GBASE-T.
17. IEEE 802.3ba Media Access Control Parameters, Physical Layers and Management Parameters for 40 Gbps and 100 Gbps Operation.
18. IEEE 802.11, Wireless Ethernet Specifications, including 802.11a, 802.11b, 802.11g, 802.11n and 802.11ac.
19. IEEE 802.12, 100Base-TX Ethernet
20. NEC Article 770, Optical Fiber Cables
21. NEC Article 800, Communications Circuits
22. NFPA 70, National Electrical Code
23. NFPA 75, Protection of Electronic Computer / Data Processing Equipment
24. NFPA 101, Life Safety Code.
25. Underwriters Laboratories Inc. (UL) – Fire Resistance Directory
26. ASTM E 84, Surface Burning Characteristics of Building Materials.
27. ASTM E 119, Fire Tests of Building Construction and Materials.
28. ASTM E 814, Fire Tests of Penetration Firestop Systems.
29. ANSI/UL263, Fire Tests of Building Construction and Materials.
30. ANSI/UL723, Surface Burning Characteristics of Building Materials.
31. ANSI/UL1479, Fire Tests of Through Penetration Firestops.

1.9 QUALITY ASSURANCE

- A. All materials furnished shall be new, unused, clean and free from damage, defects or corrosion.
- B. Equipment and materials of the same type shall be a product of the same manufacturer throughout unless specifically exempted in advance. A specific example is all products comprising the Permanent Link (station cable, patch panels, jacks, faceplates, etc...)
- C. Component manufacturer shall be ISO 9001:2008 and offer products that are RoHS compliant.

1.10 SUBMITTALS

- A. Certificates:
 1. Submit management and installation team reference documentation verifying that:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.
 - b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents.
 - c. The Contractor is a certified Berk-Tek Leviton; a Nexans/Leviton alliance wiring/cable or approved equivalent system contractor/installer.

MANSFIELD ELEMENTARY SCHOOL

- B. Qualification Statements
 - 1. The contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.
- C. Procedure: Prepare and make the submissions listed below and in Division 1.
- D. Shop Drawings: Submit shop drawings of all items proposed to be furnished and installed under this Division.
- E. Manufacturer's Drawings.
 - 1. Equipment listed in each section, include material specifications, operating characteristics and finishes.
- F. Installation Drawings.
 - 1. Coordinated scale drawings of equipment.
 - 2. Coordinate space requirements for equipment and services.
 - 3. Include connections, anchorages and fastenings.
 - 4. Make allowance for clearances for access to and maintenance of equipment.
- G. Provide composite shop drawings showing work of all related construction, when required to ensure full coordination and proper fitting of the work, and when directed by the Architect.
- H. If submissions of catalog cuts of standard manufactured items show different types, options, finishes, performance requirements, or variations, those features proposed shall be clearly identified.
 - 1. If any variations from the catalog description are proposed or required, such variations must be clearly noted on the cut.
 - 2. Shop drawings shall clearly indicate all details, sectional views, arrangements, working and erection dimensions, kinds and quality of materials and their finishes, and information necessary for proper checking and for fabrication and installation of the items, and shall include all information required for making connections to other work.
 - 3. Shop drawings shall be numbered consecutively, and drawings related to various units comprising a proposed assembly shall be submitted simultaneously so that units may be checked individually and as an assembly.
 - 4. Keep on the site, in good order, a complete up-to-date set of approved shop drawings. All shop drawings shall be available for inspection by the Architect.
 - 5. On product data submittals, clearly indicate model numbers, dimensions, weights, electrical requirements, accessories and performance data. Submittals not properly prepared will be rejected without further review.
 - 6. The review of shop drawings will be general, and shall not be construed as permitting any departure from the contract requirements other than those specifically brought to the Architect's attention and so approved.
 - a. If the shop drawings show any variations from contract requirements because of standard shop practices or reasons, such variations shall be clearly identified on the drawings in order that, if acceptable, suitable action may be taken for proper adjustment in other work affected thereby.
 - b. Failure to identify such variations will not relieve the Contractor of responsibility for executing the work in accordance with the Contract even though such shop drawings have been reviewed and the work installed.

- c. Review shall not relieve the Contractor of responsibility for any error in details, dimensions, etc., that may exist on shop drawings nor for the furnishing of materials or work required by the Contract and not indicated on the shop drawings.
- d. Review shall not be construed as acceptable departure from details or instructions previously furnished by the Architect.
- e. Review with a requirement for resubmission is a review contingent upon satisfactory resubmission within 30 days. Failure to comply shall result in a revocation of the contingent review.

I. Shop Drawing Schedule

- 1. The Contractor shall submit, within 30 days of the award of his contract, a schedule of all proposed shop drawing submissions.
- 2. The schedule shall include the following information.
 - a. Item to be submitted
 - b. Date of submission
 - c. Latest date for review
 - d. Manufacturers of the specified item.
- 3. Items not specifically listed as "approved equal" should be listed for consideration at this time.
- 4. Shop drawings require a minimum of 10 business days from the date they have been received by the Consulting Engineer's office to adequately review the submittal. If there is any submittal which requires to be expedited sooner than the 10 business days, the Engineer shall be informed in writing at the beginning of construction with a list of those submittals.

J. Submittals will be reviewed for conformance with the contract drawings and specifications. The engineer's review stamp will be affixed to submittals. One of the following actions will be taken:

- 1. Reviewed:
 - a. No comments, corrections, or marks have been made to the submittal. Re-review by the engineer is not required. The submittal is in general conformance with the design concept. Construction, fabrication and/or manufacture can proceed subject to the provision that the work shall be in accordance with the requirements of the Contract Documents. Final acceptance of the work shall be contingent upon such compliance.
- 2. Furnish As Corrected
 - a. Comments, corrections, or marks made. Re-review is not required. Submission is in general conformance with the design concept subject to notations on the returned Submittal. Construction, fabrication, and/or manufacturer can proceed subject to the provisions that the work shall be carried out in compliance with all annotations and/or corrections indicated on the returned Submittal and in accordance with the Contract Documents. Final acceptance of the work shall be contingent on such compliance.
- 3. Revise and Resubmit
 - a. Significant issues/discrepancies/incomplete information was provided in the Submittal. Revise or prepare a new submittal in accordance with the notations and Contract Documents. Resubmit without delay.

4. Rejected
 - a. Submittal does not meet Contract document intent. Revise or prepare a new submittal in accordance with the notations and Contract Documents. Resubmit without delay.

K. A submittal review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Corrections or comments made on the shop drawings during this review do not relieve the contractor from Compliance with the requirements of the plans and specifications. Approval of a specific item shall not include approval of an assembly of which the item is a component. The contractor is responsible for: dimensions to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of his or her work with that of all other trades; and for performing all work in a safe and satisfactory manner.

1.11 COORDINATION OF WORK

- A. Refer to requirements listed in Division 01.

1.12 PROJECT CLOSEOUT

- A. Subsequent to the installation and prior to acceptance of the work, the contractor shall prepare and issue record (as-built) drawings, in Adobe PDF and BIM format, that reflect the lengths of cables installed, the actual manner and conditions of installation, including all deletions from, additions to or departures from the contract documents. These documents are to include the information outlet station numbers and cable routing where it varies from the original plan.
- B. Provide revised cable termination schedules for all cables installed under the Work. Schedules shall be in printed form and on CD in Microsoft Excel format.
- C. Provide two (2) sets of Operation and Maintenance Manuals including wiring diagrams, parts list, shop drawings and manufacturers' information on all equipment and cables provided under this Work. Provide manuals in a high quality, 3 ring binder, completely indexed. Provide manuals within fifteen days of systems acceptance.

1.13 MANUFACTURER'S EXTENDED WARRANTIES

- A. All manufacturer extended product warranties shall be afforded to The Owner. A copy of certification by the manufacturer for all products listed in this specification is to be provided.
- B. Contractor to provide the Berk-Tek Leviton; a Nexans/Leviton alliance wiring/cable or approved equivalent system Limited Lifetime warranty for the structured cabling system.
- C. Prior to commencement of the work, the successful bidder shall contact an authorized manufacturer's representative to inform them that this job is being registered under the warranty program.

MANSFIELD ELEMENTARY SCHOOL

- D. Upon completion of the work, the contractor shall coordinate with the manufacturer the issuance of a full warranty on the entire copper and fiber optic cable plant including the horizontal cabling for both parts and labor. The cabling contractor at his sole expense will correct any deficiencies determined by the manufacturer

1.14 ALLOWANCES

- A. Not Applicable.

1.15 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at the Project site.
- B. Additional Preinstallation Meetings shall take place at the Project site as follows:
 - 1. Prior to all pathway and cabling rough-ins and installation.
 - 2. Prior to commencement of any IT cabling work within all Telecommunications Rooms.

PART 2 - PRODUCTS

- 2.1 REFER TO THE SPECIFIC SECTIONS OF THE SPECIFICATIONS FOR EQUIPMENT REQUIREMENTS

PART 3 - EXECUTION

3.1 STAFFING

- A. Craft personnel shall be certified personnel qualified to perform the work and be knowledgeable of the following activities.
 - 1. Color coding of standard American telephone/ data telecommunications cables.
 - 2. Bonding and grounding of shields.
 - 3. Testing conductors for transmission impairments.
 - 4. Testing conductor insulation.
 - 5. Installation and termination of optical fiber cabling.
 - 6. Testing and verification of optical fiber transmission characteristics with a power meter.
 - 7. Telephone and Data Industry Cable Installation Standards and Manufacturer's Instructions will be used for in-process quality control and final acceptance of the work installation.
 - 8. Cable tray and ladder rack installation.
- B. Craft personnel will be required to provide and use the proper tools and test equipment in the performance of each activity. The tools must be in good working order, and the test equipment must have current calibration certificates, as applicable. The Owner reserves the right to review the tool and test equipment lists and maintenance procedures of the contractor.
- C. Use of Site – Refer to the Division 01 Requirements.

MANSFIELD ELEMENTARY SCHOOL

- D. Follow manufacturer's instructions for installing, connecting, and adjusting all telecommunications riser and horizontal cabling and associated supporting, termination and splicing equipment, conduits, poke-throughs, and ladder rack. Provide a copy of such instructions at the equipment during any work on the equipment.
- E. Keep all items protected before and after installation. Provide protection for exposed cables roughed onto the floor prior to their installation into the furniture systems. Clean up and remove all debris.
- F. If products and materials are specified herein for a specific item or system, use those products or materials. If products and materials are not listed, use first-class products and materials, subject to acceptance of shop drawings.
- G. Examine and compare the communications cabling drawings and specifications with the drawings and specifications of other trades; report any discrepancies between them to the Construction Manager; and obtain from him written instructions for changes necessary in the work.
- H. The locations of structural and architectural features, existing sleeves, floor slots, termination and cross connect fields, panels, racks and other equipment indicated on the drawings are approximate. The contractor shall verify the existence, locations, and suitability of all such items, and shall present, with bid response, required modifications to contract documents necessary to complete this work.

3.2 SPECIAL CONDITIONS

- A. Furnish, install, terminate and test all horizontal (station) and backbone cabling for all floors shown in the attached and associated drawings and as described below.
 - 1. The contractor shall route all copper and fiber cabling, unless otherwise identified, via hung ceilings, cable tray, ladder rack, conduits, raised floors, poke-throughs, and furniture systems unless otherwise noted. Contractor shall install all overhead station cable in such a manner that the selected route does not in any way compromise ceiling integrity. Cables that are routed in open ceiling areas must be neatly tie wrapped and suspended with the appropriate hangers and shall not be allowed to rest on ducts, pipes and conduits. At no time will cable be supported from hung ceilings or ceiling support wires. All overhead cabling must be neatly bundled and secured as close as possible to the overhead slab to avoid conflict with or EMI from flexible electrical conduits, motors, etc.
 - 2. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - 3. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 4. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
 - 5. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
 - 6. Core drilling and the installation of aftersets, grommeted access slots, sleeves, conduits, fire-rated poke-throughs, and raceways required to route copper and fiber optic cabling will be furnished and installed by parties as indicated by contract documents. Where pathways furnished by others are not sufficient for the routing of cabling, this condition shall be brought to the attention of the Construction Manager, in writing, by this contractor.

7. As indicated, cabling shall run to workstation and other outlets through cavities in the drywall and openings in sheet metal or wooden studs within the drywall construction. The sheet metal studs will not be gasketed for this purpose, it shall be the contractor's responsibility to exercise extreme care in snaking cable through these areas to avoid damage to the cable jacketing.
8. Information Outlet faceplates for all boxes will be furnished and installed by this contractor.
9. All cabling shall be installed at least: 12" from high voltage lighting and fluorescent fixtures unless within a metal enclosure 72" from transformers and motors.

3.3 INSTALLATION

- A. Most optical fiber and copper cables will enter the MDF and Telecom Room(s) through sleeves and conduits based on the cable routing requirements reflected on drawings.
- B. Contractor shall take all necessary precautions to assure that the maximum tensile load and minimum bend radius of all cables (fiber and copper) are not exceeded. When terminating UTP cable, the contractor must maintain pair twists up to the termination point and the cable sheath shall not be removed more than 0.5" from the termination point. Velcro tie wraps are to be hand tightened on cables to prevent crimping cable sheath. Plastic tie wraps are not to be used on lateral cables. The contractor is responsible for protecting all connectorized cables from damage by other contractors at the information outlet before and after installation of the outlet faceplates.
- C. Termination Hardware
 1. All horizontal station cabling will be terminated on 8-pin modular patch panels. The fiber optic riser and tie cabling shall be terminated on fiber distribution coupler panels with LC connectors. All copper riser and tie cables shall be terminated on wall-mounted termination blocks unless otherwise noted.
 2. All termination hardware shall be grounded and bonded according to applicable codes, TIA standards, and Section 270526.
- D. Riser Cabling
 1. As indicated on the drawings, fiber optic and copper riser cables shall be installed from the MDF to each Telecom room. The contractor is responsible for supporting cables installed above hung ceilings separately from the ceiling supports, conduits, etc.
- E. Horizontal (Station) Cabling: All horizontal (station) cables shall be installed as uninterrupted conductor sections between the MDF, Telecom Rooms and station outlets.
 1. Installation of outlet jacks shall be coordinated by the contractor with the work of other trades, all working together with the Construction Manager.
 2. Standard information outlets shall be housed in a single gang box, flush mount poke through, surface mount raceway, or furniture system raceway as indicated on the drawings. All horizontal cables shall be terminated on 8-pin modular jacks.
 3. All installed connectors shall be protected and insulated during and following the installation. Protective caps or dust covers shipped with connectors shall be left in place or replaced by the contractor if found to be dislodged or damaged.
- F. Fire Stop - Penetration Sealant: Refer to section 270537.

MANSFIELD ELEMENTARY SCHOOL

3.4 REPLACEMENT

- A. Any fiber strand, connector, block, or module installed by the contractor, which fails to meet the loss budget, or tests below the manufacturer's standards, shall be replaced at no additional cost to the Owner. The replacement cable, connector, or part shall be tested after repairs have been made to verify compliance. Only equipment that meets the installation requirements stated herein shall meet The Owner's acceptance requirements.

3.5 SOURCE MANUFACTURING AND QUALITY CONTROL

- A. Cables that are supplied by the contractor, and test outside of the factory test data by a margin of 10 percent on loss, may, at The Owner's option, be deemed non-usable and returned to the manufacturer for replacement.

3.6 POST IMPLEMENTATION TESTING

- A. Following the physical installation of the cabling, the contractor will conduct pre-checkout tests as described below, "Physical Inspection", prior to the formal acceptance tests with The Owner.

3.7 PHYSICAL INSPECTION

- A. Prior to conducting any transmission testing, the following visual inspections will be performed:
 1. Verify that all cable has been installed to full compliance with the proposal specifications.
 2. Check for physical damage to the optical fiber distribution panels and termination hardware.
 3. Check that all cabling is properly jacketed, installation properly labeled at both ends of the cable, innerduct and termination hardware is completed in the MDF and all Telecom Rooms.
 4. Verify that all cable bends are within the manufacturer's specified bend radius.
 5. Verify that all cabinets and racks (which require grounding) are properly grounded and comply with the National and Local Electrical Codes for grounding.
 6. Verify that the cables are properly approved and structurally supported for termination.
 7. Verify that the requirements of all authorities having jurisdiction have been satisfied.

END OF SECTION 270500

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding labeling.

1.3 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. EMT: Electrical metallic tubing.
- C. SBB: Secondary Bonding Busbar.
- D. PBB: Primary Bonding Busbar
- E. TBB: Telecommunications Bonding Backbone
- F. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

MANSFIELD ELEMENTARY SCHOOL

1.5 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. BCT, PBB, SBBs, and routing of their bonding conductors.
- B. Qualification Data: For Installer, installation supervisor, and field inspector.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of an ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as a designer RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with ANSI/TIA-607-D - Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises.

2.2 CONDUCTORS

- A. 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:
 - 1. Chatsworth Products Inc.
 - 2. Harger Lightning & Grounding.
 - 3. Panduit Corp.
- B. Comply with UL 486A-486B.
- C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 - 2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

MANSFIELD ELEMENTARY SCHOOL

- D. Cable Tray Grounding Jumper:
 - 1. Not smaller than No. 6 AWG and not longer than 12 inches (300 mm). If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
- E. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

- A. 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:
 - 1. Chatsworth Products, Inc.
 - 2. Harger Lightning & Grounding.
 - 3. Hubbell Incorporated (Burndy).
 - 4. Panduit Corp.
- B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 - 1. Electroplated tinned copper, C and H shaped.
- D. Busbar Connectors: Cast silicon bronze, solderless exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.
- E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

- A. 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:
 - 1. Chatsworth Products, Inc.
 - 2. Harger Lightning & Grounding.
 - 3. Panduit Corp.

MANSFIELD ELEMENTARY SCHOOL

- B. PBB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as PBB and shall comply with ANSI/TIA-607-D.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

- C. SBB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with ANSI/TIA-607-D.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

- D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with ANSI/TIA-607-D. Predrilling shall be with holes for use with lugs specified in this Section.
 - 1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 - 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 - 3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with ANSI/TIA-607-D.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the SBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the PBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Structural Steel: Welded connectors.
- D. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm).
- E. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch intervals.
 - 4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to an SBB.

3.4 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the PBB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pretwist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the PBB with insulated bonding conductor.
- E. Interconnections: Interconnect all SBBs to the PBB with the telecommunications backbone conductor. If more than one PBB is installed, interconnect PBBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the SBB with No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each SBB and PBB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each SBB to the ground bar of the panelboard.

MANSFIELD ELEMENTARY SCHOOL

- I. **Shielded Cable:** Bond the shield of shielded cable to the SBB in communications rooms and spaces. Comply with ANSI/TIA-568.1-E and ANSI/TIA-568.2-D when grounding shielded balanced twisted-pair cables.
- J. **Rack- and Cabinet-Mounted Equipment:** Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. **Outdoor Wireless Access Points and Enclosures:** Bond Wireless Access Points and/or enclosures, equipped with a ground wire or lug, to the nearest interior location of building steel. If steel structure is unavailable, route the bonding conductor to nearest electrical panel ground bar.

3.7 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. **Duct-Bank Grounding Conductor:** Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- B. Comply with IEEE C2 grounding requirements.
- C. **Grounding Manholes and Handholes:** Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- D. **Grounding Connections to Manhole Components:** Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.8 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label PBB(s) with "fs-PBB," where "fs" is the telecommunications space identifier for the space containing the PBB.
 - 2. Label SBB(s) with "fs-SBB," where "fs" is the telecommunications space identifier for the space containing the SBB.
 - 3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a PBB and an SBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
 - 3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB and in each SBB. Maximum acceptable ac current level is 1 A.
- C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- D. Grounding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section Includes:
 - 1. Hooks.
 - 2. Non-continuous cable supports.
- B. Related Requirements:
 - 1. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface pathways, boxes, enclosures, cabinets, and handholes serving both electrical and communications systems.

1.3 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Hooks.
 - 2. Non-continuous cable supports

PART 2 - PRODUCTS

2.1 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. 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:
 - 1. Erico/CADDY.
 - 2. Legrand North America, LLC (Wiremold).
 - 3. MonoSystems, Inc.
 - 4. Panduit Corp.

MANSFIELD ELEMENTARY SCHOOL

- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-E.
- E. Stainless steel.
- F. J shape.
- G. 4-inch diameter.

2.2 NON-CONTINUOUS CABLE SUPPORTS

- A. Description: Adjustable cable support straps for telecommunications cable.
- B. Non-continuous cable supports shall be available in multiple sizes, styles and materials.
- C. Provide drop wire supports and threaded rod assemblies in areas where structural mounting surfaces are non-functional or inaccessible.
- D. Sling assemblies/cable straps shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance UTP and optical fiber cables. Support slings shall have a static load limit of 100 lbs.
- E. Select approved non-continuous cable supports suitable for specific installation environments and/or air handling (plenum) spaces.
- F. Diameter of 4-inches.
- G. Area 20.43 in²
- H. Cable Capacity, Cat 5e cable – 425.
- I. Cable Capacity, Cat 6 cable – 325.
- J. Cable Capacity, Cat 6A cable – 210.
- K. Erico – Caddy CableCat support system
 - 1. CADDY “Cablecat” Part No. CAT425.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.

3. TIA-569-E.
 4. NECA 105.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- E. Complete pathway installation before starting conductor installation.
- F. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- G. Hooks:
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
 2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
 3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
 4. Space hooks no more than 5 feet o.c.
 5. Provide a hook at each change in direction.

3.2 INSTALLATION OF NON-CONTINUOUS CABLE SUPPORTS

- A. Process:
1. Follow manufacturer's instructions and recommended industry standards and guidelines.
 2. The installed non-continuous support system must be an independent support structure for the voice/data communication system.
 3. Draping cables over other structures in the ceiling is unacceptable. Water pipes, ceiling grid, sprinkler system, electrical supports, air ducts or any other in-ceiling structure may not be used for cable support.
 4. Contractor installed supports shall be used to supplement the main cable support system when any cabling leaves the main support system or is unsupported for more than three and one half feet (3'-6").
 5. Supports shall be installed at a maximum distance of 5'-0" apart.
 6. Non-continuous supports shall be installed with ceiling wire or threaded rod secured to the slab above to support the telecommunications cable infrastructure parallel to the slab throughout the cable plant, unless site conditions dictate a non-parallel installation.
 7. Cable must be routed to follow existing corridors and parallel or 90 degree angles from all walls and the cable tray whenever possible.

MANSFIELD ELEMENTARY SCHOOL

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

SECTION 270528.26 - INNERDUCT FOR COMMUNICATIONS SYSTEMS

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section includes:
 - 1. Flexible textile innerduct
- B. Related Requirements:
 - 1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.
 - 2. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
 - 3. Section 270528 "Pathways for Communications Systems" for surface pathways, and non-continuous pathways serving communications systems.

1.3 DEFINITIONS

- A. Not applicable

1.4 ACTION SUBMITTALS

- A. Product Data: for all innerduct provide:
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for all innerduct.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of an ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as a registered communications distribution designer (RCDD) to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Maxcell Textile Innerduct or a comparable product by one of the following:
 - 1. Carlon
 - 2. Endot Industries
 - 3. Dura-Line

2.2 TEXTILE INNERDUCT

- A. Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape.
- B. Indoor Textile Innerduct (Riser-listed): Micro (32mm), 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.
- C. Plenum-Listed Textile Innerduct: Micro (32mm), 2-inch and 3-inch single or multi-cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces.
- D. Each innerduct shall be installed with unique color striping, and multi-colored pull tapes.

2.3 TEXTILE INNERDUCT FITTINGS

- A. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.:
 - 1. 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration
- B. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 3-inch inside diameter conduit, e.g.:
 - 1. 3-inch plug with six holes for cables in a 2 pack (6-cell) configuration
- C. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.

2.4 PULL TAPE

- A. Measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.

2.5 PENETRATION SEALING MATERIALS

- A. Duct Water Seal: products suitable for closing underground and entrance conduit openings where innerduct or cable is installed, to prevent entry of gases, liquids, or rodents into the structure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 INSTALLATION

- A. Protection During Construction
 - 1. Protect products from the effects of moisture, UV exposure, corrosion and physical damage during construction.
- B. Textile Innerduct Type to Be Used
 - 1. Aboveground, Exterior and Interior Conduit Installations: Outdoor textile innerduct (Standard or Detectable as desired)
 - 2. Interior Exposed Locations
 - a. Non-plenum Areas: Indoor textile innerduct
 - b. Plenum Areas: Plenum-listed indoor innerduct
 - 3. When installed in 4" conduit, use two (2) 3" 3-Cell packs with an additional pull tape on the outside for future pulls in each conduit.
 - 4. When installed in 3" conduit, use one (1) 3" 3-Cell packs with an additional pull tape on the outside for future pulls in each conduit.
 - 5. Cable Tray: use standard outdoor or indoor textile innerduct
- C. Textile Innerduct Installation
 - 1. Provide textile innerduct in conduit and wire ways, and place textile innerduct within and under cable trays using continuous unspliced lengths of textile innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.
 - 2. Make a 2" incision, approximately 18" from the end of textile innerduct. Pull out and cut off approximately 2 feet of pull-tape. Thus allowing the pull tape ends to retract back into the cells.
 - 3. Using approximately 6 feet of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of textile innerduct. Apply black vinyl tape over all knots and the end of textile innerduct. Using a Bow Line knot tie a swivel to the end of 3 feet pull tape. For multi-pack installations one swivel is sufficient, but stagger each textile innerduct.
 - 4. Using a Bow Line knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install textile innerduct – ensuring that no twist is introduced to the innerduct.
 - 5. Provide suitable textile innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.

6. Textile Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.
 - a. Design & install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.
 - b. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires
 - c. When appropriate, use the following cable ties to secure textile innerduct through previously created incisions:
 - 1) Plenum areas: plenum-rated plastic or stainless steel
 - 2) Non plenum areas: Conventional flame-retardant nylon ties
 - 3) Underground locations: Conventional plastic cable ties
7. Maintenance Hole and Hand Hole Installation:
 - a. At locations where textile innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.
 - b. At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.
8. Cable Tray and Runway Installation: Cut incisions every 24 inches into the edge of the textile innerduct and cable wrap to one side of vertical ladder rack or horizontal ladder-type cable tray at each incision.

D. Penetrations

1. Seal all conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids or rodents.
2. Inspect fire stopping installation by others between building structure and conduit, wire way, and cable tray to verify integrity of installation.
3. Exposed Textile Innerduct Penetrations: Install conduit sleeves or fire barrier sealing systems in all openings where open and exposed textile innerduct passes through fire-rated walls and floors. After installation, install intumescent fire barrier penetration sealing material between textile innerduct and sleeves or fire barrier system.
4. Raceway Penetrations: After textile innerduct installation, install intumescent fire barrier penetration sealing material between textile innerduct and conduit or wire way at all exposed penetration locations.
5. Protect adjacent surfaces from damage during water seal or fire stop installation. Repair any damage.
6. Document entire installation process for future referral.

3.3 RE-INSTALLATION

- A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

END OF SECTION 270528.26

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. EDUCATIONAL SPECIFICATIONS for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section Includes:
 - 1. Ladder cable tray.
 - 2. Cable tray accessories.
 - 3. Warning signs.
- B. Related Requirements:
 - 1. Not Applicable.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 2. Vertical and horizontal offsets and transitions.
 - 3. Clearances for access above and to side of cable trays.
 - 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 LADDER CABLE TRAY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Chatsworth Products Inc. Universal Cable Runway or comparable product by one of the following:
 - 1. Eaton (B-line).
 - 2. Hubbell Premise Wiring
 - 3. Panduit
- B. Description:
 - 1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
 - 2. Width: 18 inches unless otherwise indicated on Drawings.
 - 3. Minimum Usable Load Depth: 3 inches.
 - 4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
 - 5. Rung Spacing: 12 inches o.c.
 - 6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
 - 7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
 - 8. No portion of the rungs shall protrude below the bottom plane of side rails.

9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 12 inches.
11. Class Designation: Comply with NEMA VE 1, Class 12B.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:
 - a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
 - b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - d. Finish: Black Powder-coat enamel paint.
 - 1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
 - 2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
 - 3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
 - 4) Hardware: Chromium-zinc plated, ASTM F 1136.

2.3 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.
- C. Ladder Cable Tray - Specific Accessory Products:
 1. Radius drop-cross member - Chatsworth Products Inc. (CPI) Part No. 12100-718 or approved equivalent.
 2. Radius drop-stringer - Chatsworth Products Inc. (CPI) Part No. 12101-711 or approved equivalent.
 3. Junction splice kit - Chatsworth Products Inc. (CPI) Part No. 11302-701 or approved equivalent.
 4. Butt splice kit - Chatsworth Products Inc. (CPI) Part No. 11301-701 or approved equivalent.
 5. Wall angle support kit - Chatsworth Products Inc. (CPI) Part No. 11421-718 or approved equivalent.
 6. End closing kit - Chatsworth Products Inc. (CPI) Part No. 11700-718 or approved equivalent.
 7. Protective end caps - Chatsworth Products Inc. (CPI) Part No. 10642-001 or approved equivalent.
 8. "L" bracket for ground wire support - Chatsworth Products Inc. (CPI) Part No. 11268-001 or approved equivalent.

MANSFIELD ELEMENTARY SCHOOL

9. 6" cable runway elevation kit- Chatsworth Products Inc. (CPI) Part No. 10506-706 or approved equivalent.
10. 12" cable runway elevation kit- Chatsworth Products Inc. (CPI) Part No. 10506-708 or approved equivalent.

2.4 WARNING SIGNS

- A. Comply with requirements for identification in Section 270553 "Identification for Communications Systems."
- B. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.5 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Fasten cable tray supports to building structure.
- F. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- G. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- H. Support bus assembly to prevent twisting from eccentric loading.
- I. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

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- J. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- K. Make changes in direction and elevation using manufacturer's recommended fittings.
- L. Make cable tray connections using manufacturer's recommended fittings.
- M. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- N. Install cable trays with enough workspace to permit access for installing cables.
- O. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 LADDER CABLE TRAY INSTALLATION

- A. Install all ladder rack per the manufacturer's recommended installation instructions, as indicated in the project drawings. Follow all mounting and support guidelines.
- B. Provide all components of the ladder rack system (ladder rack, turns, splices, supports, and accessories) from a single manufacturer.
- C. Ladder rack shall be installed with side stringers facing down so that the ladder forms an inverted U-shape and so that welds between the stringers (sides) and cross members (middle) face away from cables.
- D. Ladder rack shall be secured to the structural ceiling, building truss system, wall, floor or the tops of equipment racks and/or cabinets using the manufacturer's recommended supports and appropriate installation hardware and methods as defined by local code or the authority having jurisdiction (AHJ).

- E. Ladder rack splices will be made in mid-span, not over a support, with the manufacturer's recommended splice hardware.
- F. Ladder rack shall be supported every 5' (1.5 m) or less in accordance with TIA-569-E. Ladder rack shall be supported within 2' (0.6 m) of every splice and within 2' (0.6 m) on both/all sides of every intersection. Support ladder rack within 2' (0.6 m) on both sides of every change in elevation. Support ladder rack every 2' (0.6 m) when attached vertically to a wall.
- G. Heavy-duty splices are recommended for 18" (460 mm) wide or wider ladder rack. Heavy-duty splices are required for any splice formed in the vertical orientation including changes in elevation formed using vertical-to-horizontal 90° turns or horizontal-to-vertical 90° turns. Use heavy-duty splices to secure all overhead turns to the overhead horizontal pathway(s).
- H. When the pathway is overhead, ladder rack shall be installed with a minimum clearance of 12" (300 mm) above the ladder rack. Leave a minimum of 12" (300 mm) in between ladder rack and ceiling/building truss structure. Leave a minimum of 3" (75 mm) in between ladder rack and the tops of equipment racks and/or cabinets. Multiple tiers of ladder rack shall be installed with a minimum clearance of 12" (300 mm) in between each tier of ladder rack. When located above an acoustical drop ceiling, leave a minimum of 3" (75 mm) clearance between the top of the drop ceiling tiles and the bottom of the ladder rack.
- I. When installed under a raised floor, ladder rack shall be installed with a minimum 3" (75 mm) clearance between the top of the ladder rack and the bottom of the floor tiles or floor system stringers, whichever is lower in elevation. Maintain a 3" (75 mm) clearance between ladder racks wherever ladder racks cross.
- J. Within each telecommunications room, ladder rack should be bonded together, electrically continuous, and bonded to the SBB, unless otherwise noted in the specifications and contract documents. Ladder rack and turns shall be bonded across each splice with a bonding kit or with splices per the manufacturer's installation instructions. Ladder rack shall be bonded to the Secondary Bonding Busbar (SBB) using an approved ground lug on the ladder rack and a minimum #6 grounding wire or as recommended by the AHJ. Remove paint from the ladder rack where bonding/ground lugs or splices contact the ladder rack so that the lug or splice will contact bare metal. Use antioxidant joint compound in between the bare metal on the ladder rack and ground lug or splice. Use antioxidant joint compound in between the bus bar and the ground lug. Verify continuity through the bonds at splices and intersections between individual ladder rack sections and turns and through the bond to the SBB.
- K. The quantity of cables within the ladder rack will not exceed a whole number value equal to 50% of the interior area of the ladder rack divided by the cross-sectional area of the cable. The interior area of ladder rack will be considered to be the width of the ladder rack multiplied by a height of 2" (50 mm), unless cable retaining posts are added to the ladder rack. The interior area of ladder rack equipped with cable retaining posts will be considered to be the width of the ladder rack multiplied by a height of 6" (150 mm). Actual cable fill for ladder rack that is not equipped with cable retaining posts will not exceed 2" (50 mm) in height. Actual cable fill for ladder rack equipped with cable retaining posts will not exceed 6" (150 mm) in height.
- L. The combined weight of cables within the ladder rack will not exceed the stated load capacity of the ladder rack as stated in the manufacturer's product specifications or load/design tables.

- M. Cables (cable bundles) will be secured to the cross members of ladder rack with 3/4" (19 mm) wide reusable straps. Straps are not required when ladder rack is equipped with cable retaining posts.
- N. Add 8" (200 mm) high cable retaining posts to the open sides of ladder rack when cable fill exceeds 2" (50 mm) in height or when cable bundles cannot be secured directly to the ladder rack cross members with a strap. Cable fill within any ladder rack should not exceed 6" (150 mm) in height.
- O. When a single ladder rack supports different types of cable media, the cable media will be separated within the pathway by cable spools that attach to the cross members on the ladder rack. Treat each type of cable media and divided area of the ladder rack separately when determining cable fill limits.
- P. Use a radius drop to guide cables wherever cable exits overhead ladder rack to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field. If necessary, provide a moveable cross member also to attach and align the radius drop in between the welded cross members of a ladder rack.
- Q. Cover the exposed ends of cable runway that do not terminate against a wall, the floor or the ceiling with end caps or an end closing kit.
- R. Use auxiliary support brackets that attach to the side stringer of the ladder rack to support interconnect cabling (patch cords, equipment cords, jumper cords) that is routed between racks using the ladder rack. Auxiliary support brackets can be used to support other conductors that should be physically separated from cables within the ladder rack as defined by local code or the authority having jurisdiction (AHJ).
- S. Whenever possible, maintain a 2' (0.6 m) separation between ladder rack used for communications cables and pathways for other utilities or building services.
- T. The installer will provide touch-up paint color-matched to the finish on the ladder rack and will correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery to the owner. If a component is cosmetically damaged to the extent that correction in the field is obvious against the factory finish, the component will be replaced with a new component finished from the factory. If a component is physically damaged due to mishandling or modification during the installation process, it shall not be used as part of the ladder rack system.

3.4 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with hook-and-loop cable ties or Velcro fasteners according to NEMA VE 2. Tighten fasteners only enough to secure the cable, without indenting the cable jacket. Install fasteners with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches.

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- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

3.5 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorqued in suspect areas.
 - 7. Check for improperly sized or installed bonding jumpers.
 - 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 - 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.
- B. Prepare test and inspection reports.

3.7 PROTECTION

- A. Protect installed cable trays and cables.
 - 1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

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2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 270537 - FIRESTOPPING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section includes:
 - 1. Firestopping of Through Penetrations in Fire Rated Assemblies.
 - 2. Smoke Seals.
 - 3. Construction enclosing compartmentalized areas.
- B. Related Requirements:
 - 1. Section 078413 “Penetration Firestopping” for penetration firestopping systems installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.

1.3 DEFINITIONS

- A. Not applicable

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of an ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as a registered communications distribution designer (RCDD) to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Specified Technologies Inc or comparable product by one of the following: but are not limited to, the following
1. 3M
 2. Hilti
 3. Specified Technologies Inc.

2.2 FIRESTOPPING DESCRIPTION

- A. General
1. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
 2. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
 3. Provide an enclosed fire rated cable management device whenever cable bundles penetrate fire rated walls. The cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type.
 4. Provide non-curing, re-penetrable, intumescent firestop materials around communications cable trays or ladder racks penetrating through a fire rated wall. The firestop system assembly shall be able accessible and re-installed from one side of the wall. The firestop material shall allow up to 12” of unreinforced annular space.

2.3 PERFORMANCE REQUIREMENTS

- A. Penetrations in Fire Resistance Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.
- B. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
 2. T-Rating: when penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
 3. W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.

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- C. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.
- D. Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of 0 as determined by ASTM G21.

2.4 COMPONENTS

- A. Firestop Sealants: STI SpecSeal® Brand single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) SpecSeal® Series SSS Sealant or approved equivalent.
 - 2. Specified Technologies Inc. (STI) SpecSeal® Series LCI Sealant or approved equivalent.
- B. Firestop Putty: STI SpecSeal® Brand intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) SpecSeal® Series SSP Putty or approved equivalent.
- C. Firestop Pillows: STI SpecSeal® Brand re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows or approved equivalent.
- D. Fire Rated Cable Pathways: STI EZ-PATH™ Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway – no approved equivalent.
- E. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material for use in blank openings and cable sleeves, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) SpecSeal Series FP Firestop Plug or approved equivalent.
- F. Fire-Rated Cable Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing individual cable penetrations up to 0.27 in. (7 mm) diameter, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) Ready Firestop Grommet or approved equivalent.

2.5 SOURCE QUALITY CONTROL

- A. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirements.

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- B. Use only firestopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
- B. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.
- C. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.
- D. Provide masking and temporary covering to protect adjacent surfaces.
- E. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Process:
 - 1. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
 - 2. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

3.3 RE-INSTALLATION

- A. No additional burden to the owner regarding costs, network down-time, and end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning any re-installation work.

3.4 FIELD QUALITY CONTROL

- A. Inspections: Owner shall engage qualified independent inspection agency to inspect through-penetration firestop systems.
- B. Keep areas of work accessible until inspection by authorities having jurisdiction.
- C. Where deficiencies are found, repair firestopping products so they comply with requirements.

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3.5 ADJUSTING AND CLEANING

- A. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- B. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

3.6 SCHEDULES

A.

	Concrete Floor	Concrete Wall	Gypsum Board Wall
Penetrant Type			
Blank Opening	C-AJ-0100, C-AJ-0101	C-AJ-0100, C-AJ-101	
Metal Conduits	C-AJ-1080, C-AJ-1240, C-AJ-1353	C-AJ-1080, W-J-1098, W-J-1100	W-L-1049, W-L-1222, W-L-1168
Plastic Conduits/ Raceways	C-AJ-2140, C-AJ-2292	W-J-2018, W-J-2076	W-L-2093, W-L-2241
Cables	F-A-3021, F-A-3037	W-J-3098, W-J-3130, W-J-3158, W-J-3180	W-L-3218, W-L-3255, W-L-3306, W-L-3377
Cable Trays	C-AJ-4029	W-J-4021, W-J-4022, W-J-4033	W-L-4008, W-L-4029, W-L-4043

3.7 CLOSEOUT ACTIVITIES

- A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
- B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the Owner.

END OF SECTION 270537

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for labels and signs.
 - 2. Labels.
 - 3. Bands and tubes.
 - 4. Signs.
 - 5. Cable ties.
 - 6. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.
- B. Identification Schedule:
 - 1. Outlets: Scaled drawings indicating location and proposed designation.
 - 2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
 - 3. Racks: Scaled drawings indicating location and proposed designation.
 - 4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-C.

- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:
 - 1. Black letters on a white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
 - 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. Brady Corporation.
 - b. HellermannTyton.
 - c. Panduit Corp.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.
 - 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. Brady Corporation.
 - b. HellermannTyton.
 - c. Panduit Corp.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, polyester flexible labels with acrylic pressure-sensitive adhesive.
 - 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. Brady Corporation.
 - b. Brother International Corporation.
 - c. Panduit Corp.
 - 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.

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3. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 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. Brady Corporation.
 - b. Brother International Corporation.
 - c. HellermannTyton.
 - d. Panduit Corp.
 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.
 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. Brady Corporation.
 - b. HellermannTyton.
 - c. Panduit Corp.

2.5 SIGNS

- A. Baked-Enamel Signs:
 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. Carlton Industries, LP.
 - b. Champion America.
 - c. emedco.
 - d. Marking Services, Inc.
 2. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 3. 1/4-inch grommets in corners for mounting.
 4. Nominal Size: 7 by 10 inches.

MANSFIELD ELEMENTARY SCHOOL

B. Metal-Backed Butyrate Signs:

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. Brady Corporation.
 - b. Champion America.
 - c. emedco.
 - d. Marking Services, Inc.
2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch (1-mm) galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 10 by 14 inches.

C. Laminated-Acrylic or Melamine-Plastic Signs:

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. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. emedco.
 - d. Marking Services, Inc.
2. Engraved legend.
3. Thickness:
 - a. For signs up to 20 sq. in. (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 CABLE TIES

A. 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:

1. HellermannTyton.
2. Ideal Industries, Inc.
3. Panduit Corp.

B. Plenum-Rated Hook and Loop Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and constructed of soft, premium material to use on high performance network cables, protecting against over-tensioning.

1. Minimum Width: 1/2 inch (12.7 mm).
2. Tensile Strength at 73 deg F according to ASTM D 638: 40 lbs.
3. UL 94 Flame Rating: 94V-2.
4. Temperature Range: Zero to plus 122 deg F.
5. Color: Black.

MANSFIELD ELEMENTARY SCHOOL

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. The Owner-approved labeling scheme is intended to comply with the ANSI/TIA-606-C standard for labeling and administration of a cable plant. It is the responsibility of the contractor to acquire, understand, and utilize the owner's labeling scheme for all components of the voice data communications system.

3.2 PREPARATION

- A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.3 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

- H. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 - 3. Provide label 6 inches from cable end.
- I. Snap-Around Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label 6 inches from cable end.
- J. Self-Adhesive Wraparound Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label 6 inches from cable end.
- K. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
- L. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- M. Cable Ties: General purpose, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.4 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
 - 1. System legends shall be as follows:
 - a. Telecommunications.
- D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, composed of the following, in the order listed:
 - 1. Wiring closet designation.
 - 2. Colon.
 - 3. Faceplate number.

MANSFIELD ELEMENTARY SCHOOL

- E. Equipment Room Labeling:
 - 1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels.
 - 2. Patch Panels: Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.

- F. Backbone Cables: Label each cable with a vinyl-wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

- G. Horizontal Cables: Label each cable with a vinyl-wraparound label indicating the following, in the order listed:
 - 1. Cable ID number.

- H. Equipment Identification Labels:
 - 1. Indoor Equipment: Laminated-acrylic or melamine-plastic sign.
 - 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.
 - 3. Equipment to Be Labeled:
 - a. Communications cabinets.
 - b. Uninterruptible power supplies.
 - c. Computer room air conditioners.
 - d. Fire-alarm and suppression equipment.
 - e. Egress points.
 - f. Power distribution components.

END OF SECTION 270553

SECTION 270800 - COMMISSIONING OF COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. EDUCATIONAL SPECIFICATIONS for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section includes:
 - 1. Copper cable test device
 - 2. Optical fiber cable test device
 - 3. Cable Test Results and testing procedures
 - 4. As-built drawings
- B. Related Requirements:
 - 1. Not applicable.
- C. Alternates: Not Applicable.
- D. Items To Be Installed Only: Not Applicable.
- E. Items To Be Furnished Only: Not Applicable.

1.3 SCOPE

- A. Testing shall be carried out in accordance with this document. This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR). The condition of the fiber end faces shall also be verified.
- B. Testing shall be performed on each cabling link (connector to connector - 100% testing).
 - 1. Testing shall be performed on each cabling channel (equipment to equipment) that is identified by the owner.

MANSFIELD ELEMENTARY SCHOOL

- C. Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- D. All tests shall be documented including OLTS dual wavelength attenuation measurements and OTDR traces with event tables as well as OTDR maps.
- E. Optionally, documentation shall also include optical length measurements and pictures of the connector end face.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of an ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as a registered communications distribution designer (RCDD) to perform the on-site inspection.
- B. All testing procedures and field-test instruments shall comply with applicable requirements of:
 - 1. ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
 - 2. ANSI/EIA/TIA 455 50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
 - 3. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR
 - 4. ANSI/TIA/EIA 455 60A, Measurement of Fiber or Cable Length Using an OTDR
 - 5. ANSI/TIA/EIA 455 61A, Measurement of Fiber or Cable Attenuation Using an OTDR
 - 6. ANSI/TIA/EIA 526 7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant
 - 7. ANSI/TIA 526 14 B, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 edition 2, Fibre-Optic Communications Subsystem Test Procedure- Part 4-1: Installed cable plant- Multimode attenuation measurement
 - 8. TIA-TSB-4979 Practical Considerations for Implementation of Multimode Launch Conditions in the Field
 - 9. ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - 10. ANSI/TIA-568.0-E, Generic Telecommunications Cabling for Customer Premises.
 - 11. ANSI/TIA-568.1-E, Commercial Building Telecommunications Cabling Standard
 - 12. ANSI/TIA 568.2-D, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
 - 13. ANSI/TIA-606-C, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.
- C. Trained technicians who have successfully attended an appropriate training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
 - 1. Manufacturer of the copper and fiber optic cable and connectors.

2. Manufacturer of the test equipment used for the field certification.
 3. Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas)
- D. The Owner or the Owner's representative shall be invited to witness and/or review field-testing.
1. The Owner or the Owner's representative shall be notified of the start date of the testing phase five (5) business days before testing commences.
 2. The Owner or the Owner's representative will select a random sample of five percent of the installed links. The Owner or the Owner's representative shall test these randomly selected links and the results are to be stored in accordance with Part 3 of this document. The results obtained shall be compared to the data provided by the installation contractor. If more than two percent of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat one hundred percent testing at no cost to the Owner.

1.5 SUBMITTALS

- A. Manufacturers catalog sheets and specifications for the copper cable test equipment and fiber optic field instruments including optical loss test sets (OLTS; power meter and source), optical time domain reflectometer (OTDR) and video microscope.
- B. A schedule (list) of all balanced twisted-pair copper and optical fibers links to be tested.
- C. Sample test reports.

1.6 ACCEPTANCE OF TEST RESULTS

- A. Unless otherwise specified by the Owner or the Owners representative, each Category 6 cabling link shall be tested for:
 1. Wire Map
 2. Length
 3. Propagation Delay
 4. Delay Skew
 5. DC Loop Resistance – recorded for information only
 6. DC Resistance Unbalance – recorded for information only
 7. Insertion Loss
 8. NEXT (Near-End Crosstalk)
 9. PS NEXT (Power Sum Near-End Crosstalk)
 10. ACR-N (Attenuation to Crosstalk Ratio Near-End) – recorded for information only
 11. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) – recorded for information only
 12. ACR-F (Attenuation to Crosstalk Ratio Far-End)
 13. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 14. Return Loss
 15. TCL (Transverse Conversion Loss) – recorded for information only
 16. ELTCTL (Equal Level Transverse Conversion Transfer Loss) – recorded for information only

- B. Unless otherwise specified by the Owner or the Owners representative, each Category 6A cabling link shall be tested for:
1. Wire Map
 2. Propagation Delay
 3. Delay Skew
 4. DC Loop Resistance
 5. DC Resistance Unbalance within a pair
 6. DC Resistance Unbalance between pairs
 7. Insertion Loss
 8. NEXT (Near-End Crosstalk)
 9. PS NEXT (Power Sum Near-End Crosstalk)
 10. ACR-N (Attenuation to Crosstalk Ratio Near-End)
 11. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
 12. ACR-F (Attenuation to Crosstalk Ratio Far-End)
 13. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 14. Return Loss
 15. TCL (Transverse Conversion Loss)
 16. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 17. PS ANEXT (Power Sum Alien Near-End Crosstalk) – sampled per section 3.2.
 18. Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk) – sampled per section 3.2.
 19. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2.
 20. Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2.
- C. Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in compliance with the following test limits:
1. Optical loss testing
 - a. Multimode and Singlemode links
 - 1) The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA-568.0-E.
 - a) $\text{Link Attenuation (dB)} = \text{Cable_Attn (dB)} + \text{Connector_Attn (dB)} + \text{Splice_Attn (dB)}$
 - b) $\text{Cable_Attn (dB)} = \text{Attenuation_Coefficient (dB/km)} * \text{Length (Km)}$
 - c) $\text{Connector_Attn (dB)} = \text{number_of_connector_pairs} * \text{connector_loss (dB)}$
 - d) Maximum allowable connector_loss = 0.75 dB
Check your application limits, you may need to reduce the allowable connector loss here
 - e) $\text{Splice_Attn (dB)} = \text{number_of_splices} * \text{splice_loss (dB)}$
 - f) Maximum allowable splice_loss = 0.3 dB
Check your application limits, you may need to reduce the allowable connector loss here

- g) The values for the Attenuation_Coefficient (dB/km) are listed in the table below: Your cable may perform better than this, check the datasheet from the vendor and insert values here if desired

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Multimode 62.5/125 μm	850	3.5	1300	1.5
Multimode 50/125 μm	850	3.5	1300	1.5
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

2. OTDR testing

- a. Reflective events (connections) shall not exceed:
 - 1) 0.75 dB in optical loss when bi-directionally averaged
 - 2) -35 dB Reflectance for multimode connections
 - 3) -40 dB reflectance for UPC singlemode connections
 - 4) -55 dB reflectance for APC singlemode connections
- b. Non-reflective events (splices) shall not exceed 0.3 dB.

3. Magnified end face inspection

- a. Fiber connections shall be visually inspected to IEC 61300-3-35 Edition 1.0 for end face quality.
- b. Scratched, pitted or dirty connectors shall be diagnosed and corrected.

D. All installed cabling permanent links and channels shall be field-tested and pass the test requirements and analysis as described in Part 3. Any permanent link or channel that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected permanent link or channel meets performance requirements. The final and passing result of the tests for all permanent links and channels shall be provided in the test results documentation in accordance with Part 3.

E. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

Note: High Bandwidth applications such as 1000BASE-SX, 10GBASE-SR, and FC1200 impose stringent channel loss limits. Where practical, certification should consider loss length limits that meet maximum channel (transmitter to receiver) loss. 0.75 dB per connector pair loss may not support the intended application.

F. Performance specification for multimode fiber links at 850 nm.

Fiber Type	Bandwidth	1000BASE-SX		10GBASE-SR		FibreChannel 1200-MX-SN-I		
		Length (m)	Loss (dB)	Length (m)	Loss (dB)	Length (m)	Loss (dB)	
OM1	62.5 μm	200	275	2.38	33	2.5	33	2.4
OM2	50	500	550	3.56	82	2.3	82	2.2
OM3	50	2000	N/A	N/A	300	2.6	300	2.6

Fiber Type		Bandwidth	1000BASE-SX		10GBASE-SR		FibreChannel 1200-MX-SN-I	
	μm	(MHz•Km)	Length (m)	Loss (dB)	Length (m)	Loss (dB)	Length (m)	Loss (dB)
OM4	50	47000	N/A	N/A	400	2.9	N/A	N/A

PART 2 - PRODUCTS

2.1 CABLE TEST DEVICE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Fluke DTX Cable Analyzer, Model No. DSX-5000 or comparable product by one of the following:
 1. Ideal Networks
 2. EXFO
 3. Greenlee Communications

2.2 BALANCED TWISTED-PAIR CABLE TESTER

- A. Must meet or exceed TIA Level IV compliant network cable-testing device certification by an independent laboratory, such as Intertek, for verification of high speed, TIA T568 compliant cables.
- B. Copper test equipment must be capable of certifying Category-3, Category-5e, Category 6 and Category 6A UTP/ScTP links or channels independent of termination hardware configuration (RJ45 port or 110-style) for each level of performance.
- C. Provide full 2-way Autotest of Category-3, 5e, 6, and 6A twisted pair links.
- D. All test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
- E. The field-test instrument shall be within a 12 month calibration period.
- F. Results Storage
 1. Must be capable of storing > 10,000 results for all measurements found in 2.2G below
- G. Measurement capabilities
 1. Wire Map
 2. Length
 3. Propagation Delay
 4. Delay Skew
 5. DC Loop Resistance
 6. DC Resistance Unbalance within a pair
 7. DC Resistance Unbalance between pairs
 8. Insertion Loss
 9. NEXT (Near-End Crosstalk)
 10. PS NEXT (Power Sum Near-End Crosstalk)

11. ACR-N (Attenuation to Crosstalk Ratio Near-End)
12. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
13. ACR-F (Attenuation to Crosstalk Ratio Far-End)
14. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
15. Return Loss
16. TCL (Transverse Conversion Loss)
17. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
18. Time Domain Reflectometer
19. Time Domain Xtalk Analyzer
20. PS ANEXT (Power Sum Alien Near-End Crosstalk)
21. Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk)
22. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
23. Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

H. Accessory Products:

1. Interface Adapters
 - a. TIA Category-3, 5e, 6 and 6A: 100 ohm
 - b. Category/Class E permanent link adapters for TIA Cat 3, 5e 6, and 6A unshielded and shielded cables.
 - 1) RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568.2-D Annex C
 - 2) Twisted pair Category 5e, 6, 6A, 7 or 7A cords are not permitted as their performance degrades with use and can cause false Return Loss failures

2.3 OPTICAL FIBER CABLE TESTER

A. The field-test instrument shall be within the calibration period recommended by the manufacturer and a copy of the calibration certificate made available.

B. Optical loss test set (OLTS)

1. Multimode optical fiber light source
 - a. Provide dual LED light sources with central wavelengths of 850 nm (± 30 nm) and 1300 nm (± 20 nm). VCSEL sources are not permitted per ANSI/TIA-526-14-B.
 - b. Output power of -20 dBm minimum.
 - c. The launch shall meet the Encircled Flux launch requirements of ANSI/TIA-526-14-B.
 - d. The test reference cords must demonstrate an insertion loss ≤ 0.15 dB when mated against each other.
2. Singlemode optical fiber light source
 - a. Provide dual laser light sources with central wavelengths of 1310 nm (± 20 nm) and 1550 nm (± 20 nm).
 - b. Output power of -10 dBm minimum.
 - c. The test reference cords must demonstrate an insertion loss ≤ 0.25 dB when mated against each other.
3. Power Meter
 - a. Provide 850 nm, 1300 nm, 1310 nm, and 1550 nm wavelength test capability.
 - b. Power measurement uncertainty of ± 0.25 dB.
 - c. Store reference power measurements.
 - d. Save at least 10,000 results to internal memory.

- e. PC interface (USB).
- 4. Optional length measurement
 - a. It is preferable to use an OLTS that is capable of measuring the optical length of the fiber using time-of-flight techniques. In the case of MPO/MTP trunk cables, this is not possible.
- C. Optical Time Domain Reflectometer (OTDR)
 - 1. Shall have a bright, color LCD display with backlight.
 - 2. Shall have rechargeable Li-Ion battery for 8 hours of normal operation.
 - 3. Weight with battery and module of not more than 4.5 lb and volume of not more 200 in³.
 - 4. Internal non-volatile memory with capacity for storing at least 2,000 OTDR bi-directionally tested fiber links.
 - 5. USB port to transfer data to a PC or thumb drive/memory stick.
 - 6. Multimode OTDR
 - a. Wavelengths of 850 nm (± 10 nm) and 1300 nm (+ 35 nm / - 15 nm).
 - b. Event dead zones not to exceed 0.7 m at 850 nm and 1300 nm.
 - c. Attenuation dead zones not to exceed 2.5 m at 850 nm and 4.5 m at 1300 nm.
 - d. Distance range not less than 9,000 m.
 - e. Dynamic range at least 28 dB for 850 nm and 30 dB at 1300 nm.
 - f. Allow bi-directional testing without moving the OTDR to the far end.
 - 7. Singlemode OTDR
 - a. Wavelengths of 1310 nm (± 25 nm) and 1550 nm (± 30 nm).
 - b. Event dead zones not to exceed 0.6 m at 1310 nm and 1550 nm.
 - c. Attenuation dead zones not to exceed 3.7 m at 1310 nm and 1550 nm.
 - d. Distance range not less than 80 km at 1310 nm and 130 km at 1550 nm.
 - e. Dynamic range at least 32 dB for 1310 nm and 30 dB at 1550 nm.
 - f. Allow bi-directional testing without moving the OTDR to the far end.
- D. Fiber Microscope
 - 1. Field of view 420 μ m x 320 μ m
 - a. Video camera systems are preferred.
 - b. Camera probe tips that permit inspection through adapters are required.
 - c. Test equipment shall be capable of saving and reporting the end face image to IEC 613003-3-35.
 - d. FiberInspector Mini Video Microscope – Fluke Model No. FT500; the DSX-5000Qi is preferred since it allows the images to be saved.
- E. Integrated OLTS, OTDR and fiber microscope
 - 1. Test equipment that combines into one instrument an OLTS, an OTDR and a fiber microscope may be used.
- F. Accessory Products:
 - 1. Interface Adapters
 - a. DTX Fiber Module for Multimode cable @ 850 and 1300 nm – Fluke Model No. DTX-EFM2 or DSX-5000Qi/CertiFiber Pro for EF (encircled flux) Compliance.
 - b. DTX Fiber Module for Singlemode cable @ 1310 and 1500 nm – Fluke Model No. DTX-SFM2
 - c. EF Test reference cords.

2.4 ADMINISTRATION

- A. Administration of the documentation shall include test results of each copper and optical fiber Permanent Link and channel.
- B. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
- C. The test result records saved within the field-test instrument shall be transferred into a Windows®-based database utility that allows for the maintenance, inspection and archiving of these test records.
- D. Alien Crosstalk measurements shall be stored to a PC upon completion of the test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
- B. Verify telecommunications cabling is installed and supported, terminated, mounted in an appropriate housing or terminated on the applicable component and labeled prior to certification testing and documentation.
- C. Verify certification tester universal interface adapters and manufacturer patch cords that enable permanent link verification are in new condition not indicating any twisting or kinking resulting from incorrect storage of the tester interface adapters.
- D. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.
- E. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
- F. Optical fiber patch cords shall be inspected to ensure connector surfaces are clean and free of defects that may affect testing results.

3.2 BALANCED TWISTED PAIR CABLE TESTING

- A. Field-test instruments shall have the latest firmware installed.
- B. Permanent Link test results, including the individual frequency measurements from the tester, shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.

- C. Permanent Link testing shall be performed on each cabling segment (connector to connector). Sampling is not acceptable.
- D. Alien Crosstalk testing shall be performed using a sampling plan. An acceptance quality level (AQL) of 0,4 %, normal inspection, general inspection level I as defined in ISO 2859-1 for populations of up to 500,000 links shall be used. The following table represents this sampling level.

Total number of links (N)	Sample size (No. of links to test)
3 – 33	3 or 0.1 x N (whichever is greatest)
34 – 3,200	33
3,201 – 35,000	126
35,001 – 150,000	201
150,001 – 500,000	315

- E. Disturbed (Victim) links chosen for Alien Crosstalk testing shall be an equal combination of short, medium and long links.
- F. Permanent Link adapters made from twisted pair Category 5e, 6, 6A, 7 or 7_A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
- G. The installer shall build a reference link. All components shall be anchored so it is not possible to disturb them. The technician is to conduct a Category 6 and 6A Permanent Link test each day to ensure no degradation of the tester or its Permanent Link adapters.
- H. Wire Map Measurement
 - 1. The wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors.
 - 2. For each of the eight conductors in the cabling, the wire map indicates:
 - a. Continuity to the remote end
 - b. Shorts between any two or more conductors
 - c. Reversed pairs
 - d. Split pairs
 - e. Transposed pairs
 - f. Distance to open on shield
 - g. Any other miss-wiring

3. The correct connectivity of telecommunications outlets/connectors is defined in ANSI/TIA-568.2-D. Two color schemes are permitted. The user shall define which scheme is to be used. The field tester shall document which color scheme was used. Examples are given below:



- I. Length Measurement
 1. The length of each balanced twisted pair shall be recorded.
 2. Since physical length is determined from electrical length, the physical length of the link calculated using the pair with the shortest electrical delay shall be reported and used for making the pass or fail determination.
 3. The pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in ANSI/TIA-568.2-D plus the nominal velocity of propagation (NVP) uncertainty of 10%. For a Permanent Link, the length measurement can be 325 ft. (99 m) before a fail is reported.

- J. Propagation Delay measurement
 1. Is the time it takes for a signal to reach the end of the link.
 2. The measurement shall be made at 10 MHz per ANSI/TIA-1152.
 3. The propagation delay of each balanced twisted pair shall be recorded.
 4. Is not to exceed 498 ns per ANSI/TIA-568.2-D Section 6.3.18.

- K. Delay Skew measurement
 1. Is the difference in propagation delay @ 10 MHz between the shortest delay and the delays of the other wire pairs.
 2. The delay skew of each balanced twisted pair shall be recorded.
 3. Is not to exceed 44 ns per ANSI/TIA-568.2-D Section 6.3.19.

- L. DC Loop Resistance
 1. Often reported as Resistance, is the DC loop resistance of both conductors in the pair.
 2. The DC Resistance shall be reported for all four pairs.
 3. Is not to exceed 21 Ω for all four pairs per ANSI/TIA-568.2-D Section 6.3.1.

- M. DC Resistance Unbalance
 1. Often reported as Resistance Unbalance, is the difference in resistance of the two wires within the pair.
 2. Is not specified in ANSI/TIA-1152 for a Permanent Link, but shall be reported for all four pairs.

- N. DC Resistance Unbalance within a pair
1. Is the difference in DC resistance of the two wires within the same pair.
 2. The DC Resistance Unbalance within a pair shall be reported for all four pairs.
 3. Is not to exceed 200 mΩ or 3%, whichever is the greatest per ANSI/TIA-568.2-D Section 6.2.2.

- O. DC Resistance Unbalance between pairs
1. Is the difference in DC parallel resistance of the conductors of a pair compared to the DC parallel resistance of another pair, given in the formula below:

$$Resistance_Unbalance_{Between_pairs} = \left(\frac{|R_{p1} - R_{p2}|}{R_{p1} + R_{p2}} \right) 100\%$$

Where:

R_{p1} is the DC parallel resistance of the conductors of a pair.

R_{p2} is the DC parallel resistance of the conductors of another pair.

2. The DC Resistance Unbalance shall be reported for the following pairs
 - a. 1,2-3,6
 - b. 1,2-4,5
 - c. 1,2-7,8
 - d. 3,6-4,5
 - e. 3,6-7,8
 - f. 4,5-7,8
3. is not to exceed 200 mΩ or 7.5%, whichever is the greatest.

- P. Insertion Loss

1. Is the loss of signal strength over the cabling (in dB).
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
3. Both worst case and worst margins shall be reported in one direction for all four pairs.
4. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
5. Is not to exceed the Category **[6]** **[and]** **[6A]** Permanent Link limits found in ANSI/TIA-568.2-D Section 6.3.7.

- Q. NEXT (Near-End Crosstalk)

1. Is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling.
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
3. Both worst case and worst margins shall be reported in both directions for the following pair combinations
 - a. 1,2-3,6
 - b. 1,2-4,5
 - c. 1,2-7,8
 - d. 3,6-4,5

- e. 3,6-7,8
 - f. 4,5-7,8
 - 4. Is not to exceed the Category 6 and 6A Permanent Link limits found in ANSI/TIA-568.2-D Section 6.3.8.
 - 5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
 - 6. The Time Domain Xtalk data shall be stored for any marginal or failing NEXT results.
- R. PS NEXT (Power Sum Near-End Crosstalk)
- 1. Is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling.
 - 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
 - 3. Both worst case and worst margins shall be reported in both directions for all four pairs.
 - 4. Is not to exceed the Category 6 and 6A Permanent Link limits found in ANSI/TIA-568.2-D Section 6.3.9.
 - 5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
 - 6. The Time Domain Xtalk data shall be stored for any marginal or failing PS NEXT results.
- S. ACR-N (Attenuation Crosstalk Ratio Near-End)
- 1. Is a calculation of NEXT minus Insertion Loss of the disturbed pair in dB.
 - 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
 - 3. Both worst case and worst margins shall be reported in both directions for the following pairs
 - a. 1,2-3,6
 - b. 1,2-4,5
 - c. 1,2-7,8
 - d. 3,6-4,5
 - e. 3,6-7,8
 - f. 4,5-7,8
 - 4. Although not specified in ANSI/TIA-568.2-D, it shall be recorded for all twelve possible combinations.
- T. PS ACR-N (Power Sum Attenuation Crosstalk Ratio Near-End)
- 1. Is a calculation of PS NEXT minus Insertion Loss of the disturbed pair in dB.
 - 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
 - 3. Both worst case and worst margins shall be reported in both directions for all four pairs.

4. Although not specified in ANSI/TIA-568.2-D, it shall be recorded for all eight possible combinations.
- U. ACR-F (Attenuation Crosstalk Ratio Far-End)
1. Is a calculation of FEXT minus Insertion Loss of the disturbed pair in dB.
 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
 3. Both worst case and worst margins shall be reported in both directions for the following pairs
 - a. 1,2-3,6
 - b. 1,2-4,5
 - c. 1,2-7,8
 - d. 3,6-1,2
 - e. 3,6-4,5
 - f. 3,6-7,8
 - g. 4,5-1,2
 - h. 4,5-3,6
 - i. 4,5-7,8
 - j. 7,8-1,2
 - k. 7,8-3,6
 - l. 7,8-4,5
 4. Is not to exceed the Category 6 and 6A Permanent Link limits found in ANSI/TIA-568.2-D Section 6.3.11.
 5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
- V. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
1. Is a calculation of PS FEXT minus Insertion Loss of the disturbed pair in dB.
 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
 3. Both worst case and worst margins shall be reported in both directions for all four pairs.
 4. Is not to exceed the Category 6 and 6A Permanent Link limits found in ANSI/TIA-568.2-D Section 6.3.13.
 5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
- W. Return Loss
1. Is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz

3. Both worst case and worst margins shall be reported in both directions for all four pairs.
 4. Shall be ignored at all frequencies where the Insertion Loss is less than 3 dB for that pair.
 5. Is not to exceed the Category 6 and 6A Permanent Link limits found in ANSI/TIA-568.2-D Section 6.3.6.
 6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
 7. The Time Domain Reflectometer data shall be stored for any marginal or failing Return Loss results.
- X. TCL (Transverse Conversion Loss)
1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.
 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
 3. Both worst case and worst margins shall be reported in both directions for all four pairs.
 4. Is not to exceed the Category 6 and 6A limits found ANSI/TIA-568.2-D Section 6.2.14.
- Y. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the Insertion Loss of that pair.
 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
 3. Both worst case and worst margins shall be reported in both directions for all four pairs.
 4. Is not to exceed the Category 6 and 6A limits found in ANSI/TIA-568.2-D section 6.2.16.
- Z. PS ANEXT (Power Sum Alien Near-End Crosstalk)
1. Takes into account the combined alien crosstalk (statistical) on a receive pair from all external near-end disturbers operating simultaneously.
 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
 3. The disturbed (victim) link shall have disturber links to the left and right of it and if present, links above and below it.
 4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
 5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
 6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568.2-D Section 6.3.21.

AA. Average PS ANEXT (Power Sum Alien Near-End Crosstalk)

1. Is calculated by averaging the individual PSANEXT loss values, in dB, for all four pairs in the disturbed (victim) link.
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
3. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568.2-D Section 6.3.22.

BB. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

1. AFEXT loss is the coupling of crosstalk at the far-end from external link pairs into a disturbed (victim) pair of the 4-pair link under test. PS AACR-F is the calculated power sum from all external pairs into the disturbed (victim) pair.
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
3. The disturbed (victim) link shall have disturber links to the left and right of it and if present, links above and below it.
4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568.2-D Section 6.3.25.

CC. Average PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

1. Is calculated by averaging the individual PS AACR-F values, in dB, for all four pairs in the disturbed (victim) link.
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 - d. 250 – 500 MHz: 1000 kHz
3. The disturbed (victim) link shall have disturber links to the left and right of it and if present, links above and below it.
4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568.2-D Section 6.3.26.

3.3 ADMINISTRATION - COPPER CABLING

A. Test results documentation

1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”. The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
2. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period and shall be passed to the Owner’s representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.
3. The database for the complete project, including twisted-pair copper cabling and fiber links, if applicable, shall be stored and delivered on CD or DVD prior to Owner acceptance of the building. This CD or DVD shall include the software tools required to view, inspect, and print any selection of the test reports.
4. Circuit IDs reported by the test instrument should match the specified label ID.
5. For Permanent Link testing, the detailed test results documentation data is to be provided in an electronic database for each tested balance twisted-pair and shall contain the following information
 - a. The overall Pass/Fail evaluation of the link-under-test
 - b. The date and time the test results were saved in the memory of the tester
 - c. The identification of the customer site as specified by the end-user
 - d. The name of the test limit selected to execute the stored test results
 - e. The name of the personnel performing the test
 - f. The version of the test firmware and the version of the test limit database held within the test instrument
 - g. The manufacturer, model and serial number of the field-test instrument
 - h. The adapters used
 - i. The factory calibration date
 - j. Wire Map
 - k. Propagation Delay values, for all four pairs
 - l. Delay Skew values, for all four pairs
 - m. DC Resistance values, for all four pairs
 - n. DC Resistance Unbalance within a pair, values for all four pairs
 - o. DC Resistance Unbalance between pairs, values for all four pairs
 - p. Insertion Loss, worst case values for all four pairs
 - q. NEXT, worst case margin and worst case values, both directions
 - r. PS NEXT, worst case margin and worst case values, both directions
 - s. ACR-N, worst case margin and worst case values, both directions
 - t. PS ACR-N, worst case margin and worst case values, both directions
 - u. ACR-F, worst case margin and worst case values, both directions
 - v. PS ACR-F, worst case margin and worst case values, both directions
 - w. Return Loss, worst case margin and worst case values, both directions
 - x. TCL, worst case margin and worst case values, both directions
 - y. ELTCTL, worst case margin and worst case values, both directions.
 - z. Time Domain Crosstalk data if the link is marginal or fails
 - aa. Time Domain Reflectometer data if the link is marginal or fails

6. For Alien Crosstalk testing, the detailed test results documentation data is to be provided in AxTalk Analyzer for each tested balance twisted-pair and shall contain the following information
 - a. The overall Pass/Fail evaluation of the link-under-test
 - b. The date and time the measurements were made
 - c. The identification of the customer site as specified by the end-user
 - d. The name of the test limit selected to execute the stored test results
 - e. The name of the personnel performing the test
 - f. The version of the test software
 - g. PS ANEXT, worst case margin for all four pairs
 - h. Average PS ANEXT, worst case margin
 - i. PS AACR-F, worst case margin for all four pairs
 - j. Average PS AACR-F, worst case margin

B. Record copy and as-built drawings - Copper Cabling

1. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on a CD or DVD. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion:
 - a. Field directed changes to pull schedule.
 - b. Horizontal cable routing changes.
 - c. Associated detail drawings.

3.4 OPTICAL FIBER CABLE TESTING

- A. Field-test instruments shall have the latest software and firmware installed.
- B. Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- C. Fiber end faces shall be inspected using a video scope with a field of view not less than 425 μm x 320 μm .
 1. It is preferable that the end face images be recorded in the memory of the test instrument for subsequent uploading to a PC and reporting.
- D. Testing shall be performed on each cabling segment (connector to connector).
- E. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.
- F. Testing of the cabling shall be performed using high-quality test reference cords of the same core size as the cabling under test, terminated with reference grade connectors. Reference grade connectors are defined as having a loss not exceeding 0.1 dB for multimode and 0.2 dB for singlemode. The test reference cords for OLTS testing shall be between 2 m and 5 m in length.

The length of the launch and tail fibers for multimode OTDR testing shall be at least 100 m (328 ft.). For singlemode, the length of the launch and tail fibers will depend on the link under test. As a guide, the following table can be used for determining the length of the launch and tail fibers.

Maximum Length of Link (km)		Typical Pulse Width (ns)	Minimum Launch and Tail Cord Length (m)
1310 nm	1550 nm only		
0 to 35	0 to 50	≤ 1,000	130
35 to 45	50 to 65	3,000	400
45 to 50	65 to 75	10,000	1,000
≥ 50	≥ 75	20,000	2400

G. Optical loss testing

1. Horizontal/Backbone link
 - a. Multimode links shall be tested in one direction at 850 nm and 1300 nm in accordance with ANSI/TIA-526-14-B, one-cord reference method, with an Encircled Flux compliant launch.
 - b. Singlemode backbone links shall be tested in one direction at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1 (One-cord reference method).
 - c. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

H. OTDR Testing

1. Fiber links shall be tested at these wavelengths for anomalies and to ensure uniformity of cable attenuation, connector insertion loss and reflectance.
 - a. Multimode: 850 nm and 1300 nm.
 - b. Singlemode: 1310 nm and 1550 nm.
2. Each fiber link and channel shall be tested in both directions.
 - a. The launch and tail fibers shall remain in place for the measurement in the opposite direction – failing to do so will result in an increase in measurement uncertainty.
 - b. The use of a loop back fiber at the far end with a tail fiber at the near end on the adjacent fiber is permitted for bi-directional testing, so long as the OTDR is able to split the trace automatically into two traces for the two fibers under test.
3. A launch cable shall be installed between the OTDR and the first link connection.
4. A tail cable shall be installed after the last link connection.

I. Magnified End face Inspection

1. Fibers shall be inspected using a video scope with a minimum field of view 425 μm x 320 μm to IEC 61300-3-35 Edition 1.0. The following test limits shall be used:
 - a. Multimode connectors; Table 6 of IEC 61300-3-35 Edition 1.0
 - b. Singlemode field polished connectors; Table 5 of IEC 61300-3-35 Edition 1.0
 - c. Singlemode factory polished connectors; Table 3 of IEC 61300-3-35 Edition 1.0
 - d. Angled Physical Contact (APC) connectors; Table 4 of IEC 61300-3-35 Edition 1.0

J. Length Measurement

1. The length of each fiber shall be recorded.
2. It is preferable that the optical length be measured using an OLTS or OTDR.

K. Polarity Testing

1. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA-568.0-E. The polarity of the paired duplex fibers shall be verified using an OLTS.

3.5 ADMINISTRATION – OPTICAL FIBER

A. Test results documentation

1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”. The following formats do not provide adequate protection of these records and shall not be used.
 - a. Portable document format (PDF)
 - b. Word (.doc & .docx)
 - c. Comma separated values (.csv)
 - d. Excel separated values (.xls & .xlsx)
 - e. Text (.txt)
2. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.
3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD/DVD prior to Owner acceptance of the building in the original format used by the cabling vendors’ software.
4. Circuit IDs reported by the test instrument should match the specified label ID (see 3.6 of this Section).
5. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information
 - a. The identification of the customer site as specified by the end-user.
 - b. The name of the test limit selected to execute the stored test results.
 - c. The name of the personnel performing the test.
 - d. The date and time the test results were saved in the memory of the tester.
 - e. The manufacturer, model and serial number of the field-test instrument.
 - f. The version of the test software and the version of the test limit database held within the test instrument.
 - g. The fiber identification number.
 - h. The length for each optical fiber.
 - i. The index of refraction used for length calculation when using length capable OLTS.
 - j. The backscatter coefficient of the fiber under test when using an OTDR.
 - k. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).

MANSFIELD ELEMENTARY SCHOOL

- l. Test results to include OTDR link and channel traces, event tables at the appropriate wavelength(s) and a map of the link tested.
 - m. The length for each optical fiber as calculated by the OTDR.
 - n. The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements
 - o. Optional
 - 1) A picture or image of each fiber end-face
 - 2) A pass/fail status of the end-face using IEC 61300-3-35 Edition 1.0
- B. Record Copy and As-built drawings – Optical Fiber
1. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on CD/DVD. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. CAD drawings are to incorporate test data imported from the test instruments.
 2. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-built shall include all field changes made up to construction completion:
 - a. Field directed changes to pull schedule.
 - b. Field directed changes to cross connect and patching schedule.
 - c. Horizontal cable routing changes.
 - d. Backbone cable routing or location changes.
 - e. Associated detail drawings.

3.6 IDENTIFICATION

- A. Labeling
1. Labeling shall conform to the requirements specified within ANSI/TIA-606-C or to the requirements specified by the Owner or the Owner's representative.

3.7 REPAIR

- A. Any connections failing to meet referenced standards or more stringent performance requirements stated above, must be removed and replaced with connections that prove, in additional testing, to meet or exceed the performance standards set forth.

3.8 RE-INSTALLATION

- A. No additional burden to the owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning the work.

3.9 CLOSEOUT ACTIVITIES

- A. Contractor to submit all test results and any test documentation required prior to acceptance by the Owner.
- B. Record copy and as-built drawings
- C. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on CD-ROM. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. CAD drawings are to incorporate test data imported from the test instruments.
- D. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion:
 - 1. Field directed changes to pull schedule.
 - 2. Field directed changes to cross connect and patching schedule.
 - 3. Horizontal cable routing changes.
 - 4. Backbone cable routing or location changes.
 - 5. Associated detail drawings.

END OF SECTION 270800

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section Includes:
 - 1. Backboards.
 - 2. Entrance Protection
- B. Related Requirements:
 - 1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
 - 2. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
 - 3. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
 - 4. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. RCDD: Registered communications distribution designer.
- D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- E. SBB: Secondary bonding bus bar.
- F. PBB: Primary bonding bus bar.

MANSFIELD ELEMENTARY SCHOOL

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 - 2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.
- B. Backboard Paint: Light-colored fire-retardant paint.
- C. Plywood to be installed such that the fire-rated stamp along the edge or center of the plywood is visible and can be easily inspected. If plywood is painted, the stamp must remain visible. If the stamp is painted-over, the contractor shall be required to replace and properly repaint the plywood.

MANSFIELD ELEMENTARY SCHOOL

2.2 ENTRANCE PROTECTION

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Circa Telecom Part No. 1880ECA1-100 or comparable product by one of the following:
 - 1. ITW Linx
 - 2. TII Technologies
 - 3. CircaMax
- B. Building Entrance Terminals (BETs):
 - 1. 16 AWG powder coated steel building entrance terminals.
 - 2. Industry standard 110-Style Connector for both input and output terminals.
 - 3. Connectors shall accept up to 22 AWG wire terminations.
 - 4. Multiple external and internal ground lugs.
 - 5. Stackable to allow for future expansion
 - 6. Equipped with internal fuse link
 - 7. UL497 approved.
 - 8. Accommodates industry standard 5 Pin Protection Modules.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in racks and in room. Coordinate service entrance configuration with Owner.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- G. Backboards:
 - 1. Install from 6 inches (150 mm) to 8 feet, 6 inches (2588 mm) above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
 - 2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
 - 3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-E.

MANSFIELD ELEMENTARY SCHOOL

3.2 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-E, Annex A, "Firestopping."
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 271100

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section Includes:
 - 1. 19-inch equipment racks.
 - 2. 19-inch freestanding equipment cabinets.
 - 3. 19-inch wall-mounted equipment cabinets.
 - 4. Open Rack equipment racks.
 - 5. Power strips.
 - 6. Grounding.
 - 7. Labeling.
- B. Related Requirements:
 - 1. Section 271110 "Communications Equipment Room Fittings" for backboards and accessories.
 - 2. Section 270526 "Grounding and Bonding for Telecommunications Equipment" for PBBs and SBBs.
 - 3. Section 270536 "Cable Trays for Communications Systems" for cable trays and cable tray accessories.
 - 4. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
 - 5. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
 - 6. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

MANSFIELD ELEMENTARY SCHOOL

- B. BICSI: Building Industry Consulting Service International.
- C. LAN: Local area network.
- D. RCDD: Registered communications distribution designer.
- E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- F. SBB: Secondary bonding bus bar.
- G. PBB: Primary bonding bus bar.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.
- B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 - 2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. UL listed.
- B. RoHS compliant.

2.2 19-INCH EQUIPMENT RACKS

- A. Description: Four- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Chatsworth Products Inc.; Universal Rack or a comparable product by one of the following:
 - 1. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
 - 2. Ortronics, Inc.
 - 3. Panduit Corp.
- C. General Requirements:
 - 1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Material: Extruded steel.
 - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 - 4. Color: Black.
- D. Floor-Mounted Racks:
 - 1. Overall Height: As indicated on Drawings.
 - 2. Overall Depth: As indicated on Drawings.
 - 3. Upright Depth: As indicated on Drawings.
 - 4. Four-Post Load Rating: 1000 lb.
 - 5. Number of Rack Units per Rack: As indicated on Drawings.
 - a. Numbering: Every rack units, on interior of rack.
 - 6. Threads: Universal square.
 - 7. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
 - 8. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
 - a. Chatsworth Products Inc. Vertical Mount PDU, Part No. 35643-2A1.
 - 9. Base shall have a minimum of four mounting holes for permanent attachment to floor.
 - 10. Top shall have provisions for attaching to cable tray or ceiling.
 - 11. Self-leveling.

- E. Cable Management:
 - 1. Vertical cable management panels shall have front and rear channels, with covers. Panels shall be 6-inch and 10-inch wide minimum unless otherwise noted on drawings.
 - a. Chatsworth Products Inc. Evolution g3 Combination Vertical Cable Manager 10-inch wide Part No. 35573-703 or approved equivalent.
 - b. Chatsworth Products Inc. Evolution g3 Combination Vertical Cable Manager 6-inch wide Part No. 35571-703 or approved equivalent.
 - 2. Horizontal wire management panels
 - a. 2 RMU - Chatsworth Products Inc. Evolution Horizontal Cable Manager Part No. 35441-702 or approved equivalent.
 - b. 1 RMU - Chatsworth Products Inc. Evolution Horizontal Cable Manager Part No. 35441-701 or approved equivalent.

2.3 19-INCH FREESTANDING EQUIPMENT CABINETS (GYM ST 040A IT CABINET)

- A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Chatsworth Products, Inc. GF-Series GlobalFrame Gen 2 Cabinet System: Part No. GF-1A120-CA or comparable product by one of the following:
 - 1. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
 - 2. Ortronics, Inc.
 - 3. Panduit Corp.
- C. General Cabinet Requirements:
 - 1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Material: Sheet steel.
 - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 - 4. Color: Black.
- D. Modular Freestanding Cabinets:
 - 1. Overall Height: 79.4 inches.
 - 2. Overall Depth: 31.5 inches.
 - 3. Load Rating: 3000 lb.
 - 4. Number of Rack Units: 42.
 - a. Numbering: Every five rack units, on interior of rack.
 - 5. Threads: Universal Square.
 - 6. Removable and lockable side and top panels.
 - 7. Hinged and lockable front and rear doors.
 - 8. Includes leveling feet and casters.
 - 9. Screened ventilation openings in roof and rear door.
 - 10. Cable access provisions in roof and base.
 - 11. TGB.
 - 12. Power strip.
 - a. APC Part No AP8959.

13. All cabinets keyed alike
- E. Cable Management – Horizontal Cable Manager
 1. Metal, with integral wire retaining fingers.
 2. Baked-polyester powder coat finish.
 3. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each
 4. Horizontal wire management panels
 - a. 2 RMU - Chatsworth Products Inc. Evolution Horizontal Cable Manager Part No. 35441-702 or approved equivalent.
 - b. 1 RMU - Chatsworth Products Inc. Evolution Horizontal Cable Manager Part No. 35441-701 or approved equivalent.
- 2.4 19-INCH WALL-MOUNTED EQUIPMENT CABINET (LOWER LEVEL PUMP HOUSE IT CABINET)
 - A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.
 - B. Basis-of-Design Product: Subject to compliance with requirements, provide Chatsworth Products Inc.; CUBE-iT Wall-Mount Cabinet, Part No. 12419-736 or comparable product by one of the following:
 1. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
 2. Ortronics, Inc.
 3. Panduit Corp.
 - C. General Cabinet Requirements:
 1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 2. Material: Extruded steel.
 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 4. Color: Black.
 - D. Modular Wall Cabinets:
 1. Height: As indicated on Drawings.
 2. Depth: 30 inches.
 3. Load Rating: 200 lb.
 4. Number of Rack Units: 19.
 5. Threads: 12-24.
 6. Lockable front door.
 7. Louvered side panels.
 8. Cable access provisions top and bottom.
 9. Grounding lug.
 10. Roof-mounted, 250-cfm fan.
 11. Power strip.
 - a. Chatsworth Part No. 12820-706.
 12. All cabinets keyed alike.

- E. Cable Management:
 - 1. Metal, with integral wire retaining fingers.
 - 2. Baked-polyester powder coat finish.
 - 3. Horizontal wire management panels
 - a. 1 RMU - Chatsworth Products Inc. Evolution Horizontal Cable Manager Part No. 35441-701 or approved equivalent.

2.5 OPEN RACK EQUIPMENT RACKS

- A. Description: Two- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Chatsworth Products Inc.; Heavy-Duty Wall-Mount IT Equipment Rack, Part No. 15321-724 or comparable product by one of the following:
 - 1. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
 - 2. Ortronics, Inc.
 - 3. Panduit Corp.
- C. General Requirements:
 - 1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Material: Extruded steel.
 - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 - 4. Color: Black.
- D. Wall-Mounted Racks:
 - 1. Height: As indicated on Drawings.
 - 2. Depth: As indicated on Drawings.
 - 3. Load Rating: 350 lb.
 - 4. Number of Rack Units per Rack: 40.
 - 5. Threads: 12-24.
 - 6. Wall Attachment: Four mounting holes.
- E. Cable Management:
 - 1. Vertical cable management for wall racks.
 - a. Chatsworth Products Inc. Cable Management Rings Part No. 11799-001 or approved equivalent.
 - 2. Horizontal wire management panels
 - a. 2 RMU - Chatsworth Products Inc. Evolution Horizontal Cable Manager Part No. 35441-702 or approved equivalent.
 - b. 1 RMU - Chatsworth Products Inc. Evolution Horizontal Cable Manager Part No. 35441-701 or approved equivalent.

MANSFIELD ELEMENTARY SCHOOL

2.6 UPS

1. Rack Mounted
 - a. To be installed in all 19-inch equipment racks, 19-inch freestanding equipment cabinets, 19-inch wall-mounted equipment cabinets and open rack equipment racks as noted on drawings.
 - 1) APC Part No. SMX2000RMLV2U

2.7 POWER STRIPS

- A. Power Strips: Comply with UL 1363.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Vertical rack mounting.
 3. Twenty-four 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
 4. LED indicator lights for power and protection status.
 5. LED indicator lights for reverse polarity and open outlet ground.
 6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
 7. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
 8. Cord connected with 15-foot line cord.
 9. Rocker-type on-off switch, illuminated when in on position.
 10. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.
 11. Voltage and Current Metering:
 - a. Digital voltage and ammeter included
 - b. Each voltage and ammeter has a 3-digit LED display
 - c. Voltage meter has 1VA resolution, $\pm 1\%$ accuracy
 - d. Ammeter has 0.1A resolution, $\pm 1\%$ accuracy
 - e. Overload alarm/flashing LED at 16A
 - f. The button near the display toggles voltage and current display and can activate/deactivate the alarm function
 12. Coordinate exact power strip requirements and installation locations with Owner-furnished UPSs and data switch equipment.
 13. Chatsworth Products Inc. Part No. 12848-755 or approved equivalent.

2.8 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

2.9 LABELING

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

- A. Comply with NECA/BICSI 607.
- B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Chapter 4.
- C. Locate SBB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind SBB. Connect SBB with a minimum No. 4 AWG grounding electrode conductor from SBB to suitable electrical building ground. Connect rack SBB to near SBB or the PBB.
 - 1. Bond the shield of shielded cable to patch panel, and bond patch panel to SBB or PBB.

3.3 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-C. Comply with requirements in Section 270553 " Identification for Communications Systems."

MANSFIELD ELEMENTARY SCHOOL

- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA-606-C for Class 2 level of administration.
- D. Labels shall be machine printed. Type shall be 1/4 inch in height.

END OF SECTION 271116

SECTION 271313 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section Includes:
 - 1. High-count Category 5e twisted pair cable.
 - 2. Twisted pair cable hardware, including plugs, jacks, patch panels, and cross-connects.
 - 3. Grounding provisions for twisted pair cable.
 - 4. Cabling identification.
 - 5. Source quality control requirements for twisted pair cable.
- B. Related Requirements:
 - 1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. F/FTP: Overall foil screened cable with foil screened twisted pair.
- D. FTP: Shielded twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- H. LAN: Local area network.

MANSFIELD ELEMENTARY SCHOOL

- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. S/FTP: Overall braid screened cable with foil screened twisted pair.
- M. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER BACKBONE CABLING DESCRIPTION

- A. Copper backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 2. Cabling administration Drawings and printouts.
 - 3. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system
 - e. Cross-connects.
 - f. Patch panels.
 - g. Patch cords.
 - 4. Cross-Connects and Patch Panels: Detail mounting assemblies, and show elevations and physical relationship between the installed components.
- C. Twisted pair cable testing plan.

MANSFIELD ELEMENTARY SCHOOL

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Product Certificates: For each type of product.
- D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568.1-E, when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Telecommunications Pathways and Spaces: Comply with TIA-569-E.
- D. Grounding: Comply with ANSI/TIA-607-D.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway or Type CMP in listed cable routing assembly.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.3 HIGH-COUNT CATEGORY 5e TWISTED PAIR CABLE

- A. Description: 25-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; Power Sum Category 5e cable or comparable product by one of the following:
 - 1. Belden Inc.
 - 2. Superior Essex.
 - 3. General Cable; General Cable Corporation.
 - 4. Hitachi Cable America Inc.
 - 5. SYSTIMAX Solutions; a CommScope Inc. brand.
- C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568.2-D for Category 5e cables.

MANSFIELD ELEMENTARY SCHOOL

- D. Conductors: 100-ohm, 24 AWG solid copper.
- E. Shielding/Screening: Unshielded balanced twisted pairs (UTP).
- F. Cable Rating: Plenum.
- G. Jacket: Gray thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; Extreme UTP hardware or a comparable product by one of the following:
 - 1. Belden Inc.
 - 2. Superior Essex.
 - 3. General Cable; General Cable Corporation.
 - 4. Hitachi Cable America Inc.
 - 5. SYSTIMAX Solutions; a CommScope Inc. brand.
- C. General Requirements for Cable Connecting Hardware:
 - 1. Twisted pair cable hardware shall meet the performance requirements of Category 5e.
 - 2. Comply with TIA-568.2-D, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
 - 4. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- D. Connecting Blocks: 110-style IDC for Category 5e. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- E. Legend:
 - 1. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 CABLING IDENTIFICATION

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

MANSFIELD ELEMENTARY SCHOOL

- B. Comply with TIA-607-D.

2.7 SOURCE QUALITY CONTROL

- A. Factory test cables on reels according to TIA-568.1-E.
- B. Factory test cables according to TIA-568.2-D.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Comply with Section 270536 "Cable Trays for Communications Systems."
- D. Drawings indicate general arrangement of pathways and fittings.

3.4 INSTALLATION OF COPPER BACKBONE CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568.0-E, TIA-568.1-E, and TIA-568.2-D.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM)," Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section Use lacing bars and distribution spools.
 - 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
 - 10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 11. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
 - 12. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- C. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Group connecting hardware for cables into separate logical fields.
- E. Separation from EMI Sources:
 - 1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-E for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
 - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).

- b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-E, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.6 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-D and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-C. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Administration Class: 2.
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-C for Class 2 level of administration.
- C. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling" for cable and asset management software.
- D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- F. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- G. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-C requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1-E.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568.2-D. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 271313

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section Includes:
 - 1. 9/125 micrometer single-mode, inside plant optical fiber cable (OS2).
 - 2. 9/125 micrometer single-mode, outside plant optical fiber cable (OS2).
 - 3. Optical fiber cable connecting hardware, patch panels, and cross-connects.
 - 4. Cabling identification products.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. RCDD: Registered Communications Distribution Designer.

1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

- A. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. Cabling administration drawings and printouts.
 - 3. Wiring diagrams to show typical wiring schematics including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Cross-connects.
 - f. Patch panels.
 - g. Patch cords.
 - 4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
- C. Optical fiber cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Product Certificates: For each type of product.
- D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.

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1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight.
 - 2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568.1-E, when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Telecommunications Pathways and Spaces: Comply with TIA-569-E.
- D. Grounding: Comply with ANSI/TIA-607-D.

2.2 9/125 MICROMETER SINGLE-MODE, INSIDE PLANT OPTICAL FIBER CABLE (OS2)

- A. Description: Single mode, 9/125-micrometer, 12 fibers, tight buffered, armored optical fiber cable.

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- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; Indoor Plenum Premises Distribution w/ Armor-Tek (PDPK), interlocking Armor OS2 single mode fiber optic cable or a comparable product by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. Corning Cable Systems.
 - 3. General Cable; General Cable Corporation.
 - 4. SYSTIMAX Solutions; a CommScope Inc. brand.
 - 5. Hitachi Cable America Inc.
- C. Standards:
 - 1. Comply with TIA-492CAAB for detailed specifications.
 - 2. Comply with TIA-568.3-D for performance specifications.
 - 3. Comply with ICEA S-83-596 for mechanical properties.
- D. Armored cable shall be aluminum armored type.
- E. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.
- F. Jacket:
 - 1. Jacket Color: Yellow.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
- G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 1. Plenum Rated, Armored (Conductive): Type OFCP, complying with NFPA 262.

2.3 9/125 MICROMETER SINGLE-MODE, OUTSIDE PLANT OPTICAL FIBER CABLE (OS2)

- A. Description: Single mode, 9/125-micrometer, 12 fibers, loose tube, optical fiber cable.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; Indoor/Outdoor Plenum Adventum (LTP), OS2 single mode fiber optic cable or a comparable product by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. Corning Cable Systems.
 - 3. General Cable; General Cable Corporation.
 - 4. SYSTIMAX Solutions; a CommScope Inc. brand.
 - 5. Hitachi Cable America Inc.
- C. Standards:
 - 1. Comply with TIA-492CAAB for detailed specifications.
 - 2. Comply with TIA-568.3-D for performance specifications.
 - 3. Comply with ICEA S-87-640 for mechanical properties.
- D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

- E. Jacket:
 - 1. Jacket Color: Black.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.4 OPTICAL FIBER CABLE HARDWARE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; Singlemode Enterprise Fiber (OPT-X 1000I fiber optic enclosures and OPT-X adapter plates) or comparable products by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. Corning Cable Systems.
 - 3. General Cable; General Cable Corporation.
 - 4. Panduit.
 - 5. SYSTIMAX Solutions; a CommScope Inc. brand
 - 6. Hitachi Cable America Inc.
- B. Standards:
 - 1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
 - 2. Comply with TIA-568.3-D.
- C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
 - 1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria
- D. Patch Cords: Factory-made, dual-fiber cables in 36 inch lengths.
- E. Connector Type: Type LC complying with TIA-604-10-B.
 - 1. Berk-Tek Leviton FastCAM fiber connectors Part No. 49991-SLC or approved equivalent.
- F. Plugs and Plug Assemblies:
 - 1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
 - 2. Insertion loss not more than 0.25 dB.
 - 3. Fusion splice-on connectors.
 - 4. Marked to indicate transmission performance.
- G. Jacks and Jack Assemblies:
 - 1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
 - 2. Insertion loss not more than 0.25 dB.
 - 3. Marked to indicate transmission performance.
 - 4. Designed to snap-in to a patch panel or faceplate.

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2.5 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-D.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

- A. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568.3-D.
- B. Cable will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
- B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.
- B. General Requirements for Optical Fiber Cabling Installation:
 - 1. Comply with TIA-568.1-E and TIA-568.3-D.
 - 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, provide a 10-foot- long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
12. Install backbone cables with attention paid to aesthetic means and methods when routing cabling within IT spaces. No backbone cable shall be left unsupported for more than three (3) feet vertically or horizontally at any time.
13. A minimum of three feet (3'-0") of each optical fiber strand shall be left protected within the termination shelf for any future re-termination of a particular optical fiber strand.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-E, Annex A, "Firestopping."
- C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

- A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-D and NECA/BICSI-607.

- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-C. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Administration Class: Class 2.
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-C for Class 2 level of administration.
- C. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.
- D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- F. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

- G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-C, for the following:
 - 1. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1-E.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568.1-E. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568.1-E.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- D. Remove and replace cabling where test results indicate that it does not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 271323

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section Includes:
 - 1. Category 6 twisted pair cable.
 - 2. Category 6A twisted pair cable.
 - 3. Twisted pair cable hardware, including plugs and jacks.
 - 4. Cabling identification products.
 - 5. Grounding provisions for twisted pair cable.
 - 6. Source quality control requirements for twisted pair cable.

1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. LAN: Local area network.
- H. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

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- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- M. S/FTP: Overall braid screened cable with foil screened twisted pair.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. TIA-568.1-E requires that a minimum of two equipment outlets be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. Cabling administration Drawings and printouts.
 - 3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Telecommunications conductor drop locations.
 - f. Typical telecommunications details.

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g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568.1-E, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-E.
- C. Grounding: Comply with TIA-607-D.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE - UTP

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; Cat 6 Enhanced Plus UTP (LANmark-1000) or a comparable product by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. General Cable; General Cable Corporation.
 - 3. SYSTIMAX Solutions; a CommScope Inc. brand.
 - 4. Hitachi Cable America Inc.
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568.2-D for Category 6 cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).
- F. Cable Rating: Plenum.
- G. Jacket: Blue thermoplastic

2.4 CATEGORY 6 TWISTED PAIR CABLE – UTP (INDOOR-OUTDOOR)

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Shall be used for all outside plant and below slab pathway applications.
- C. Basis-of-Design Product: Subject to compliance with requirements, provide Hitachi Cable America Inc.; Drybit Category 6 UTP Indoor-Outdoor cable or a comparable product by one of the following:
 - 1. Mohawk.
 - 2. SYSTIMAX Solutions; a CommScope Inc. brand.
- D. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568.2-D for Category 6 cables.
- E. Conductors: 100-ohm, 23 AWG solid copper.
- F. Shielding/Screening: Unshielded twisted pairs (UTP).
- G. Cable Rating: Plenum.
- H. Jacket: Black thermoplastic.

2.5 CATEGORY 6 TWISTED PAIR CABLE – UTP (OUTSIDE PLANT)

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Shall be used for all outside plant and below slab pathway applications.
- C. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; LANmark-6 OSP UTP or a comparable product by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. General Cable; General Cable Corporation.
 - 3. SYSTIMAX Solutions; a CommScope Inc. brand.
 - 4. Hitachi Cable America Inc.
- D. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568.2-D for Category 6 cables.
- E. Conductors: 100-ohm, 23 AWG solid copper.
- F. Shielding/Screening: Unshielded twisted pairs (UTP).
- G. Cable Rating: Plenum.
- H. Jacket: Black thermoplastic.

MANSFIELD ELEMENTARY SCHOOL

2.6 CATEGORY 6A TWISTED PAIR CABLE – UTP (OUTSIDE PLANT)

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6A cable at frequencies up to 500MHz.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; LANmark-10G Cat 6A OSP or a comparable product by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. General Cable; General Cable Corporation.
 - 3. SYSTIMAX Solutions; a CommScope Inc. brand.
 - 4. Hitachi Cable America Inc.
- C. Standard: Comply with TIA-568.2-D for Category 6A cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).
- F. Cable Rating: Plenum.
- G. Jacket: Black thermoplastic.

2.7 CATEGORY 6A TWISTED PAIR CABLE – F/UTP

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6A cable at frequencies up to 500MHz.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; LANmark-10G FTP or a comparable product by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. General Cable; General Cable Corporation.
 - 3. SYSTIMAX Solutions; a CommScope Inc. brand.
 - 4. Hitachi Cable America Inc.
- C. Standard: Comply with TIA-568.2-D for Category 6A cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Screened twisted pairs (F/UTP).
- F. Cable Rating: Plenum.
- G. Jacket: Yellow thermoplastic.

2.8 TWISTED PAIR CABLE HARDWARE – CATEGORY 6 UTP

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; Cat 6 Premium Plus UTP System (CX6300) or a comparable system by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. General Cable; General Cable Corporation.
 - 3. SYSTIMAX Solutions; a CommScope Inc. brand.
 - 4. Hitachi Cable America Inc.
- C. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6.
 - 2. Comply with TIA-568.2-D, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- E. Connecting Blocks:
 - 1. 110-style IDC for Category 6.
 - 2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - 2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
 - 3. Number of Jacks per Field: One for each four-pair cable indicated.
- G. Patch Cords: Factory-made, four-pair cables in 5-foot and 15-foot lengths; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.
- H. Plugs and Plug Assemblies:
 - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Standard: Comply with TIA-568.2-D.
 - 3. Marked to indicate transmission performance.

MANSFIELD ELEMENTARY SCHOOL

- I. Jacks and Jack Assemblies:
 - 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Designed to snap-in to a patch panel or faceplate.
 - 3. Standard: Comply with TIA-568.2-D.
 - 4. Marked to indicate transmission performance.
 - 5. Color:
 - a. Data Jack – Blue
 - b. Colors to be coordinated with Owner and Architect during submittal phase.
 - 6. Berk-Tek Leviton Atlas-X1 Cat 6 Jacks or approved equivalent.

- J. Faceplate:
 - 1. Two, Four, or Six port, vertical single gang faceplates designed to mount to single gang wall boxes.
 - 2. Eight, Ten, or Twelve port, vertical double gang faceplates designed to mount to double gang wall boxes.
 - 3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 4. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
 - 5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.

- K. Legend:
 - 1. Machine printed, in the field, using adhesive-tape label.
 - 2. Snap-in, clear-label covers and machine-printed paper inserts.

2.9 TWISTED PAIR CABLE HARDWARE – CATEGORY 6A UTP (OUTSIDE PLANT)

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; Cat 6A Premium Plus X/UTP Industrial System (IX6850) or a comparable system by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. General Cable; General Cable Corporation.
 - 3. SYSTIMAX Solutions; a CommScope Inc. brand.
 - 4. Hitachi Cable America Inc.

- C. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6A.
 - 2. Comply with TIA-568.2-D, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.

- D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - 2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
 - 3. Number of Jacks per Field: One for each four-pair cable indicated.
- F. Patch Cords: Factory-made, four-pair cables in various lengths and colors; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.
 - 3. Berk-Tek Leviton DuraPort Industrial Patch Cords or approved equivalent.
- G. Plugs and Plug Assemblies:
 - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Standard: Comply with TIA-568.2-D.
 - 3. Marked to indicate transmission performance.
- H. Jacks and Jack Assemblies:
 - 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Designed to snap-in to a patch panel or faceplate.
 - 3. Standard: Comply with TIA-568.2-D.
 - 4. Marked to indicate transmission performance.
 - 5. Color: Black
 - 6. Berk-Tek Leviton Atlas-X1 Cat 6A Component-Rated UTP QuickPort Jacks or approved equivalent.
- I. Connector Housings:
 - 1. Berk-Tek Leviton DuraPort Industrial Connector/Jack Housing or approved equivalent.
- J. Faceplate:
 - 1. Berk-Tek Leviton DuraPort Industrial Stainless-Steel Wallplates or approved equivalent.
- K. Legend:
 - 1. Snap-in, clear-label covers and machine-printed paper inserts.

2.10 TWISTED PAIR CABLE HARDWARE – CATEGORY 6A F/UTP

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek Leviton; a Nexans/Leviton alliance; Cat 6A Shielded System (CS6700) or a comparable system by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. General Cable; General Cable Corporation.
 - 3. SYSTIMAX Solutions; a CommScope Inc. brand.
 - 4. Hitachi Cable America Inc.

- C. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6A.
 - 2. Comply with TIA-568.2-D, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.

- D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.

- E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - 2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
 - 3. Number of Jacks per Field: One for each four-pair cable indicated.

- F. Patch Cords: Factory-made, four-pair cables in various lengths and colors; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.

- G. Plugs and Plug Assemblies:
 - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Standard: Comply with TIA-568.2-D.
 - 3. Marked to indicate transmission performance.

- H. Jacks and Jack Assemblies:
 - 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Designed to snap-in to a patch panel or faceplate.
 - 3. Standard: Comply with TIA-568.2-D.
 - 4. Marked to indicate transmission performance.
 - 5. Color: Yellow
 - 6. Berk-Tek Leviton Atlas-X1 Cat 6A Shielded Jacks or approved equivalent.

MANSFIELD ELEMENTARY SCHOOL

- I. Faceplate:
 - 1. Two, Four, or Six port, vertical single gang faceplates designed to mount to single gang wall boxes.
 - 2. Eight, Ten, or Twelve port, vertical double gang faceplates designed to mount to double gang wall boxes.
 - 3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 4. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
 - 5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
- J. Legend:
 - 1. Snap-in, clear-label covers and machine-printed paper inserts.

2.11 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.12 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-D.

2.13 SOURCE QUALITY CONTROL

- A. Factory test cables on reels according to TIA-568.1-E.
- B. Factory test twisted pair cables according to TIA-568.2-D.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Comply with Section 270536 "Cable Trays for Communications Systems."
- D. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 1. Comply with TIA-568.0-E, TIA-568.1-E, and TIA-568.2-D.
 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 3. Install 110-style IDC termination hardware unless otherwise indicated.
 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.

10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
11. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
12. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-E for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-E, Annex A, "Firestopping."

- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-D and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-C. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Administration Class: Class 2.
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-C for Class 2 level of administration.
- C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- E. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.

4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-C requirements for the following:
1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1-E.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568.2-D. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 271513

SECTION 272133 – ACCESS POINT MOUNTING SOLUTIONS AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.

1.2 SUMMARY

- A. Section includes:
 - 1. Suspended and Hard Ceiling Locking Enclosures
 - 2. Panel, Suspended, and Hard Ceiling Recess Mounts
 - 3. Open Ceiling and Right-Angle Wall Mounts
 - 4. Outdoor Wall Mounts and Pole Mounts.
- B. Related Requirements:
 - 1. Section 260500 - Common Work Results for Electrical

1.3 REFERENCES

- A. Underwriters Laboratories (UL)
- B. National Electrical Manufacturer's Association (NEMA)

1.4 ACTION SUBMITTALS

- A. Submit under provisions of Section 013000 - Administrative Requirements
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Installation Instructions
 - 2. Customer Print
 - 3. Storage and handling requirements and recommendations

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation

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1.6 WARRANTY

- A. Warranty: Provide manufacturer's standard one-year warranty against defects in materials or workmanship

1.7 COORDINATION

- A. Coordinate exact enclosure requirements and Part Numbers with Owner at time of Bid Submission. Owner to furnish all Wireless Access Points for installation by Contractor within Access Point Enclosures.

PART 2 - PRODUCTS

2.1 SUSPENDED AND HARD CEILING LOCKING ENCLOSURES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Oberon Inc.; Model 1064-00 or a comparable product by one of the following:
 - 1. Chatsworth
 - 2. Panduit Corp
 - 3. Tripp Lite
 - 4. Ventev
- B. Design: Economical ceiling mount designed specifically for aesthetic, secure mounting of Cisco APs
- C. Performance: UL Listed and designed to meet NEC300-22 and 300-23 for plenum installations. OSHPD approved OPM-0110-13
- D. Construction: 18 ga. textured white powder-coated steel flange, 16 ga. aluminum back-box. Patent pending locking mechanism, keyed alike, secures AP into the ceiling mount. Solid back-box fills opening behind AP, creating an effective fire, smoke and dust barrier to simplify ICRA compliance
- E. Constructed to be compliant with City of Chicago Environmental Air (CCEA) plenum requirements
- F. Product must be supported by the building structure independent of the suspended ceiling
- G. Size: 23.75 x 23.75 x 2.5 in. (603 x 603 x 64 mm)

2.2 PANEL, SUSPENDED, AND HARD CEILING RECESS MOUNTS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Oberon Inc.; Model 1043-FL or a comparable product by one of the following:
 - 1. Chatsworth
 - 2. Panduit Corp
 - 3. Tripp Lite
 - 4. Ventev

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- B. Design: Economical, recessed hard ceiling or wall installation kit designed for APs and antennas. For new drywall, sheetrock, gypsum board hard ceilings and walls (new construction). AP or antenna mounts in interchangeable bracket and trim, providing a professional finish. Designed for all leading vendors' APs and antennas, as identified in Oberon's model 1043 configuration guide
- C. Performance: UL listed for low voltage applications, and designed to meet NEC300-22 and 300-23 for plenum installations. De-rate AP operating temperature range by 10°C when mounted in enclosure
- D. AP/antenna bracket and trim are interchangeable for other APs or antennas, without removing back-box
- E. Firestop grommet for insertion into back-box, large enough for 2 Cat 6A cables
- F. 1 in. trade size knockouts in two walls
- G. Ceiling/wall bridges secure enclosure into ceiling joists
- H. Construction: 20 ga. galvanized steel back-box, and white, powder-coated 20 ga. steel trim. Solid back-box fills opening behind AP, creating an effective fire, smoke and dust barrier to simplify ICRA compliance. (Model 1042-FL only: Paintable, UL 94-5VA ABS Plastic cover)
- I. Constructed to be compliant with City of Chicago Environmental Air (CCEA) plenum requirements
- J. Maximum weight inside enclosure is 25 lbs.
- K. 10. Size: Trim is 14.67 x 14.67 x 0.3 in. (373 x 373 x 8 mm). Back-box is 11 x 11 x 3 in. (280 x 280 x 76 mm)

2.3 OPEN CEILING AND RIGHT-ANGLE WALL MOUNTS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Oberon Inc.; Model 1011-00-WH or a comparable product by one of the following:
 - 1. Chatsworth
 - 2. Panduit Corp
 - 3. Tripp Lite
 - 4. Ventev
- B. Design: Wedge shaped right-angle mounting bracket with cover for securing APs on walls. Designed to mount the AP in the preferred horizontal
- C. orientation. Accommodates most vendors' APs
- D. Knockouts on two sidewalls for 1 in. trades size conduit connectors
- E. Hinged cover to conceal cabling
- F. Mounting features to directly attach Cisco, Meraki, and Aruba APs. Also Includes adjustable T-bar bracket for attaching most vendors' APs

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- G. Customers engaging hyperlocation capabilities with Cisco 4802 and 3802 with HLA antenna: Requires Oberon's 39-HLA-PLATE to properly position AP away from wall
- H. Construction: 20 ga. powder-coated steel Size: 9 x 7 x 5 in. (229 x 178 x 127 mm)

2.4 OUTDOOR WALL MOUNTS AND POLE MOUNTS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Oberon Inc.; Model 1021-00 or a comparable product by one of the following:
 - 1. Chatsworth
 - 2. Panduit Corp
 - 3. Tripp Lite
 - 4. Ventev
- B. Design: Rugged polycarbonate AP enclosure designed for surface mounting AP indoors or outdoors, including wall mounting, or light pole mounting. Conceal and protect AP, antennas, and cabling
- C. Includes internal universal T-bar bracket and universal mounting panel
- D. Construction: White UL 94 V-0 Polycarbonate Enclosure, Gray UL 94-HB ABS Plastic Universal Mounting Panel, Gray UL 94-HB ABS Plastic Wall Mount Brackets, 18 Ga. White Powder Coated Steel T-bar Bracket
- E. Exterior Size: 13.5 x 21.0 x 5.5 in. (343 x 533 x 140 mm). Interior dimensions: 19.4 x 12.0 x 4.9 in. (493 x 305 x 124 mm)
- F. Pole Mount Bracket with white ABS vanity cover
 - 1. Oberon 33-1021-PMB-CVR or approved equivalent.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Inspect and prepare substrates using the methods recommended by the manufacturer for achieving best result for the substrates under project conditions. Clean surfaces thoroughly prior to installation.
- B. Do not proceed with installation until substrates have been prepared using the methods recommended by the manufacturer and deviations from manufacturer's recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.
- C. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

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3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and in proper relationship with adjacent materials. Test units for proper operation.

END OF SECTION 272133

SECTION 274116 - INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT

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. Section includes functional description and requirements for integrated audiovisual systems.
- B. Related Requirements:
 - 1. Section 115213 – Projection Screens
 - 2. Section 271513 – Communications Copper Horizontal Cabling
 - 3. Section 275126 - Assistive Listening Systems

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Provide complete and operable systems as described herein.
- C. Work Includes:
 - 1. The Contractor shall generate all shop drawings and information for the complete installation and wiring of the system. The Contractor shall provide (or sub-contract for) the on-site installation and wiring, and shall provide on-going supervision and coordination during the implementation phase.
 - 2. The Contractor shall be responsible for the initial and final adjustment of the systems as herein prescribed and shall provide all test equipment for the system checkout and acceptance tests. Contractor shall provide on-the-job training in the operation and maintenance of the systems for personnel designated by the Owner.
 - 3. Preparation of a project management schedule, including a time line for equipment procurement and installation of all AV systems.

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1.4 CONTRACT DRAWINGS

- A. The drawings do not show all requirements of the specifications. The drawings and specifications are complementary and what is called for (or shown) in either is required to be provided as if called for in both.
- B. Equipment racks, connection panels, and all other associated devices are shown diagrammatically only and indicate the general character and approximate location. Furnish, install and place in satisfactory condition, all AV equipment, cabling and all other materials required for the systems shown or noted in the contract documents, so that it is a complete system which is fully operational and fully tested.
- C. Design Intent
 - 1. The design intent of the system may require equipment not listed in the attached spreadsheet, but are indicated elsewhere in the contract documents, in either the drawings or the written specification or is required for normal or intended operation of the system. It is the sole responsibility of the Bidder to reconcile the contract documents with the equipment and labor required for this project. In all cases, the most stringent requirements of the contract documents shall be followed.
 - 2. The AV Contractor is to research, design and engineer a complete working and turnkey solution. That solution is to be provided as a part of this bid return with all components of that solution identified inclusive of Manufacturer, Model Number, Quantities (either provided in these documents herein or required for the AVC proposed solution), itemized costs, associated cut sheets as well as a system diagram equal to the level of detail of other fully designed systems within this specification.
 - a. In this situation, the bidder is required to submit 3 references of similar size and complexity within the last 3 years in support of the components identified to include Contact Name, Address, Phone Number and detailed description of the system and application.
 - 3. It is the sole responsibility of the Bidder to verify the completeness of the proposed solution included in the AVC's bid.

1.5 DEFINITIONS

- A. The following shall serve as general identifiers as specified herein.
 - 1. Architect – TSKP Studio
 - 2. Consultant – Kohler Ronan LLC (KR).
 - 3. AV Contractor – The AV Contractor is the firm submitting a proposal to furnish and install the Work as defined within this Specification.
 - 4. Project – The Project is the AV System installation for the Mansfield Elementary School.
 - 5. Work – The term “Work” means all construction and services specified within this document. The Work includes all related labor, materials, equipment, and services provided, or to be provided, by the AV Contractor to fulfill the proposal's obligations.
 - 6. Drawings – The term “Drawings” means all Audio Visual Systems, Architectural, Electrical Drawings and associated sketches, details, riser diagrams, relative to this project.

- B. As used in the Drawings and Specifications for the Work, certain non-technical words and phrases shall be understood to have specific meanings as follows, regardless of indications to the contrary in the General Conditions or other documents governing the Work.
1. “Furnish” – Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the Audio Visual Systems Work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims, or encumbrances.
 2. “Install” – Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the Work.
 3. “New” – Manufactured within the past year and never before used.
 4. “Provide” – Furnish and Install.
- C. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
1. “Circuit” – Any specific run of circuitry
 2. “Circuitry” – Any Work which consists of wires, cables, raceways, and/or specialty wiring method assemblies complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices, and connections except where limited to a lesser meaning by specific description.
 3. “Concealed” (as applied to circuitry) – Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.
 4. “Exposed” (as applied to circuitry) – Not covered in any way by building materials.
 5. “Normal Work Conditions” – Locations within building confines that are not damp, wet, or hazardous and that are not used for air handling.
 6. “Patch Panel” – A System of terminal blocks, patch cords, and backboards that facilitate administration of cross-connecting cables.
 7. “Raceway” – Any pipe, duct, extended enclosure, or conduit (as specified for a particular System) which is used to contain wires and which is of such nature as to require that the wires be installed by a “pulling in” procedure.
 8. “Riser” – Shall refer to the portion of the installation that transmits between building floors (or between Audio Visual Systems rooms), also referred to as “Backbone Cabling”.
 9. “Audio Visual Closet” – The enclosed area or room specifically designated for the routing, termination, and/or cross connecting of Audio Visual Systems cable (i.e. riser cable) to other Audio Visual Systems cable and/or equipment.
 10. “AV Systems Control Room” and/or “AV Systems Headend” – The enclosed area or room specifically designated for the routing, termination, and/or cross connecting of Audio Visual System cable (i.e. riser cable) to other Audio Visual System cable, and/or equipment and racks.
 11. “AV System(s)” – Audio Visual System(s), includes all components contained herein that work in conjunction to create and completely integrated and fully functioning system as described within the Drawings and Specifications
 12. “Audio Visual Systems Wiring” – see “Circuitry”
 13. “Audio Visual Systems Work” – See “Scope of Work”
 14. “Standard” (as applied to wiring devices) – Not of a separately designated individual type.
 15. “Subject to Mechanical Damage” – Exposed within 2,200 mm of the floor in mechanical rooms, manufacturing spaces, vehicular spaces, or other spaces where heavy items are moved around or rigged as a common practice or as required for replacement purposes.

16. "System" – See "AV Systems"
17. "Wiring" – see "Circuitry"
18. "AVC" – Audio Visual Systems Contractor

- D. Where the word "conduit" is used without specific reference to type, it shall be understood to mean "raceway".
- E. Reference to "U.L. (Materials Construction) Standards" shall mean the "Standards for Safety" published by Underwriters Laboratories, Inc.

1.6 CONTRACTOR QUALIFICATIONS

- A. Work in this section shall be performed by a Contractor who:
 1. Complies with the requirements of Division 1, and
 - a. Is licensed to perform work of this type in the project jurisdiction, and
 - b. Has at least five (5) years of verifiable direct experience with the devices, equipment and systems of the type and scope specified herein, and
 - c. Has a minimum of one full-time staff member who has attended technical system engineering courses in the past ten (10) years, and
 - d. Has a fully staffed and equipped maintenance and repair facility.
- B. The Contractor shall use sufficient numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work in this specification. These personnel shall have at least three (3) years direct experience in similar work, evidence of which shall be verified in writing with appropriate references.
- C. The Contractor shall appoint a designated supervisor who shall have at least five (5) years direct experience in similar work. The supervisor shall be present and in responsible charge of all work in the fabrication shop and on the project site during all phases of the installation and testing of the system(s). To ensure continuity, this supervisor shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
- D. The Contractor shall be a factory-authorized dealer for the major components specified, including items such as loudspeakers, video projectors, control systems, power amplifiers, video switcher, integrated processing system, and mixing console. Specific exceptions may be granted by the Owner for limited items of equipment, provided that a request is submitted with the bid and is approved by the Owner prior to equipment procurement or installation. Such approval shall not be unreasonably withheld.
- E. The Owner may request a prospective Contractor to provide additional information as desired for review by the Owner, Architect, and Consultant to make a determination of the Contractor's acceptability.
- F. Other Contractors bidding this work who cannot meet the above qualifications must employ the services of a qualified Contractor who meets the above qualifications. This Contractor shall supervise the installation, perform all wiring connections, and complete the testing and final adjustment of the system.

- G. Quality of Materials And Equipment
 - 1. All materials and equipment supplied by the Contractor shall be new and shall meet or exceed the latest published specification of the manufacturer in all respects.
 - 2. At the time of submittal the Contractor shall supply the latest model for each piece of equipment.
 - 3. All equipment shall be UL listed, or equivalent.

1.7 CODES, PERMITS, INSPECTION FEES

- A. Conform to all State and Local ordinances. If any conflict occurs between government adopted code rules and this specification, the codes shall govern. Perform all work and provide materials and equipment in accordance with the latest referenced codes and standards of the following organizations:
 - 1. American National Standards Institute (ANSI).
 - 2. National Electrical Code (NEC).
 - 3. National Fire Protection Association (NFPA).
 - 4. Underwriter's Laboratories (UL).
- B. Install the AV systems based on the following:
 - 1. NFPA 70: National Building Code as adopted and amended by the Local Jurisdiction.
 - 2. IBC: International Building Code as adopted and amended by the Local Jurisdiction.
- C. The referenced codes establish a minimum level of requirements. Compliance with code requirements shall not be construed as relieving the Contractor from complying with any requirements of the drawings or specifications which may be in excess of requirements of the governing codes and rules and not contrary to same rules governing work specified herein. Arrange for inspection of work by the inspectors and give the inspectors all necessary assistance in their work of inspection.
- D. The Audio Visual Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
 - 1. Local Governing Authorities Having Jurisdiction
 - 2. Any portion of the audiovisual work not subject to the requirements of an electrical code published by a specific authority having jurisdiction over such work shall be governed by the National Electrical Code and any and all applicable sections of the National Fire code, as published by the National Fire Protection Association.
 - 3. Installation procedures, methods and conditions shall be in compliance with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA), the Americans with Disabilities Act (ADA) and the Architectural Barriers Act (ABA).
 - 4. The AV Contractor is responsible for all costs incurred to meet these codes and conditions.
 - 5. Additional codes and requirements pertaining to the work:
 - a. NFPA-72 National Fire Alarm and Signaling Code
 - b. International and National Electric Codes (IEC/ NEC)
 - c. IEC 60268-16 Third Edition 2003-05 Objective rating of speech intelligibility
 - d. ANSI/Infocomm
 - 1) A102.01:2017 Audio Coverage Uniformity in Listener Areas
 - 2) 2M-2010 Standard Guide for Audiovisual Systems Design and Coordination Processes

- 3) 3M:2011 Projected Image System Contrast Ratio
- 4) 4:2012 Audiovisual Systems Energy Management
- 5) 10:2013 Audiovisual Systems Performance Verification
- 6) F501.01:2015 Cable Labeling for Audiovisual Systems
- 7) V202.01:2016 Display Image Size for 2D Content in Audiovisual Systems
- 8) RP-38-17 Recommended Practice for Lighting Performance for Small to Medium Sized Videoconferencing Rooms
- 9) F502.01:2018 Rack Building for Audiovisual Systems
- e. Sustainable Technology Environments Program
- f. Underwriters Laboratories, Inc. (UL)
- g. Society of Motion Picture and Television Engineers (SMPTE)
- h. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual - latest edition.
- i. ANSI X3T9.5 FDDI
- j. ANSI X3T9.5 CDDI
- k. ANSI/TIA/EIA-568-B - Commercial Building Telecommunications Cabling Standard
- l. ANSI/TIA/EIA-569 - Commercial Building Standards for Telecommunications Pathways and Spaces
- m. ANSI/TIA/EIA-606-A. Administration Standard for Commercial Telecommunications Infrastructure
- n. TIA-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- o. EIA RS-232 Serial Communications Electrical Interface
- p. EIA RS-310-C Racks, Panels and Associated Equipment
- q. FCC Part 15
- r. FCC Part 68
- s. IEEE 802.3
- t. IEEE 802.5
- u. Article 770 Optical Fiber Cables
- v. Article 800 Communications Circuits
- w. NFPA 70 National Electrical Code
- x. NFPA 75 Protection of Electronic Computer / Data Processing Equipment
- y. United States Green Building Council (USGBC): Leadership in Energy & Environmental Design(LEED®): Green Building Rating System for New Construction & Major Renovations (NC) Version 3.0 (2009) www.usgbc.org.

1.8 COORDINATION

- A. The Contractor shall continually interface and coordinate the work with the work of other Contractors and/or other trades and shall examine all drawings and specifications of other trades including the mechanical, electrical, and structural for construction details and coordination.
- B. Obtain submittals, shop drawings, and other information for all equipment to be furnished by the Owner or under other divisions of the specifications.
- C. Special attention is called to the following items for coordination.
 1. Conduit, cable tray, boxes, and other raceway components.

2. Location of casework, cabinets, counters, doors, and equipment racks so that all equipment is clear of and in proper relation to these items.
 3. Mounting, recessing and concealing video projectors, visual displays, speakers and other associated equipment in specially constructed casework and niches.
- D. At the beginning of the project, meet with Owner and AV Consultant to review specified AV systems and develop a full understanding of each system to be installed as part of this project.
- E. Provide coordination to the Owner in relation to special installation details associated with any and all AV hardware. This will include but is not limited to mounting details of screen assemblies, speakers, equipment, projectors, equipment racks, interactive whiteboards, visual displays, and any other project-related coordination between the AV integration and building construction.
- F. Prior to roughing-in, verify the exact location of all devices with Architect.
- G. The Contractor shall schedule its work to prevent conflicts with other activities in the building, and shall execute without claim for extra payment moderate moves or changes as are necessary to accommodate other equipment, or preserve symmetry and pleasing appearance.
- H. The Contractor will not be paid for work associated with the relocation of equipment, conduits, cabling, or any other materials requiring removal or reinstallation as a result of a lack of sufficient coordination prior to installation.

1.9 SUBMITTALS AND SHOP DRAWINGS

- A. Submittals: Comply with Division 1, Construction Progress Documentation, and submit:
1. Equipment list, based on the specified equipment and other additional equipment or materials needed for complete systems.
 2. Product data with index and divider tabs by specification section, with brochures and/or catalog cuts for all items of equipment and hardware, in a Adobe .pdf format. Clearly identify each component.
 3. For each item, indicate listing by UL or other approved testing agency. For audio power amplifiers, indicate the NEC Class of output wiring.
 4. List each item of equipment with:
 - a. Item number
 - b. Name of manufacturer
 - c. Model number
 - d. Description or nomenclature
 - e. Quantity to be furnished
 5. Descriptions of specially fabricated items.
 6. Equipment submittals and shop drawings will be submitted simultaneously.
 7. In the event that the initial submittal is not complete, or is not accepted due to failure to comply with this specification, including content and format of the submittal, the Contractor shall assume the cost for evaluation of all resubmittals.
- B. Shop Drawings: Submit shop drawings showing the ratings of items and systems and how the components of an item or system are to be assembled, interconnected, function together and how they will be installed on the project. System layout drawings shall show floor plans with

complete device layout and point-to-point wiring and connection diagrams between all components of the system.

- C. The Contractor agrees that submittals and shop drawings processed by the Consultant are not change orders; that the purpose of submittals and shop drawings by the Contractor is to demonstrate to the Consultant that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. The Contractor alone accepts all responsibility for assuring that all materials furnished under this Division of the specifications meet in full all requirements of the contract documents. The Consultant's review is for general conformance with the design concept and contract documents. Markings or comments shall not be construed as relieving the Contractor from compliance with the project plans and specifications, nor departures therefrom. The Contractor remains responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes and for techniques of assembly.
- D. Submittals and shop drawings which are incomplete or which contain insufficient information will be returned without review, for resubmittal.
- E. Shop drawings: submit shop drawings of all items proposed to be furnished and installed under this Division.
- F. Manufacturer's Drawings.
 - 1. Equipment listed in each section, include material specifications, operating characteristics and finishes.
- G. Installation Drawings.
 - 1. Coordinated scale drawings of equipment.
 - 2. Coordinate space requirements for equipment and services.
 - 3. Include connections, anchorages and fastenings.
 - 4. Make allowance for clearances for access to and maintenance of equipment.
- H. Provide composite shop drawings showing work of all related construction, when required to ensure full coordination and proper fitting of the work, and when directed by the Architect.
- I. If submissions of catalog cuts of standard manufactured items show different types, options, finishes, performance requirements, or variations, those features proposed shall be clearly identified.
 - 1. If any variations from the catalog description are proposed or required, such variations must be clearly noted on the cut.
 - 2. Shop drawings shall clearly indicate all details, sectional views, arrangements, working and erection dimensions, kinds and quality of materials and their finishes, and information necessary for proper checking and for fabrication and installation of the items, and shall include all information required for making connections to other work.
 - 3. Shop drawings shall be numbered consecutively, and drawings related to various units comprising a proposed assembly shall be submitted simultaneously so that units may be checked individually and as an assembly.
 - 4. Keep on the site, in good order, a complete up-to-date set of approved shop drawings. All shop drawings shall be available for inspection by the Architect.

5. On product data submittals, clearly indicate model numbers, dimensions, weights, electrical requirements, accessories and performance data. Submittals not properly prepared will be rejected without further review.
6. The review of shop drawings will be general, and shall not be construed as permitting any departure from the contract requirements other than those specifically brought to the Architect's attention and so approved.
 - a. If the shop drawings show any variations from contract requirements because of standard shop practices or reasons, such variations shall be clearly identified on the drawings in order that, if acceptable, suitable action may be taken for proper adjustment in other work affected thereby.
 - b. Failure to identify such variations will not relieve the Contractor of responsibility for executing the work in accordance with the Contract even though such shop drawings have been reviewed and the work installed.
 - c. Review shall not relieve the Contractor of responsibility for any error in details, dimensions, etc., that may exist on shop drawings nor for the furnishing of materials or work required by the Contract and not indicated on the shop drawings.
 - d. Review shall not be construed as acceptable departure from details or instructions previously furnished by the Architect.
 - e. Review with a requirement for resubmission is a review contingent upon satisfactory resubmission within 30 days. Failure to comply shall result in a revocation of the contingent review.

J. Shop Drawing Schedule

1. The Contractor shall submit, within 30 days of the award of his contract, a schedule of all proposed shop drawing submissions.
2. The schedule shall include the following information.
 - a. Item to be submitted
 - b. Date of submission
 - c. Latest date for review
 - d. Manufacturers of the specified item.
3. Items not specifically listed as "approved equal" should be listed for consideration at this time.
4. Shop drawings require a minimum of 10 business days from the date they have been received by the Consulting Engineer's office to adequately review the submittal. If there is any submittal which requires to be expedited sooner than the 10 business days, the Engineer shall be informed in writing at the beginning of construction with a list of those submittals.

K. Submittals will be reviewed for conformance with the contract drawings and specifications. The engineer's review stamp will be affixed to submittals. One of the following actions will be taken:

1. Reviewed:
 - a. No comments, corrections, or marks have been made to the submittal. Re-review by the engineer is not required. The submittal is in general conformance with the design concept. Construction, fabrication and/or manufacture can proceed subject to the provision that the work shall be in accordance with the requirements of the Contract Documents. Final acceptance of the work shall be contingent upon such compliance.

2. Furnish As Corrected
 - a. Comments, corrections, or marks made. Re-review is not required. Submission is in general conformance with the design concept subject to notations on the returned Submittal. Construction, fabrication, and/or manufacturer can proceed subject to the provisions that the work shall be carried out in compliance with all annotations and/or corrections indicated on the returned Submittal and in accordance with the Contract Documents. Final acceptance of the work shall be contingent on such compliance.
3. Revise and Resubmit
 - a. Significant issues/discrepancies/incomplete information was provided in the Submittal. Revise or prepare a new submittal in accordance with the notations and Contract Documents. Resubmit without delay.
4. Rejected
 - a. Submittal does not meet Contract document intent. Revise or prepare a new submittal in accordance with the notations and Contract Documents. Resubmit without delay.

L. A submittal review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Corrections or comments made on the shop drawings during this review do not relieve the contractor from Compliance with the requirements of the plans and specifications. Approval of a specific item shall not include approval of an assembly of which the item is a component. The contractor is responsible for: dimensions to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of his or her work with that of all other trades; and for performing all work in a safe and satisfactory manner.

1.10 STATUS REPORTS

- A. Comply with Division 1, Project Management and Coordination. Contractor is responsible for providing status reports outlining his progress on the project. These reports will include information on the work completed during the week, the work to be completed during the upcoming week and any potential scheduling issues. The following should be included in this Status Report:
1. Expected date of project submittals, including equipment cut sheets, shop drawings, control system interface designs, etc.
 2. Anticipated completion date and percentage complete of in-house rack fabrication and testing, prior to shipping to the job-site.
 3. Anticipated completion date and percentage complete of control system programming, prior to shipping to the job-site.
 4. Schedule and percentage complete of on-site wiring and supervision.
 5. Schedule and percentage complete of on-site installation.
 6. Schedule for Owner training.
 7. Schedule for systems checkout and turnover to the Owner.

MANSFIELD ELEMENTARY SCHOOL

1.11 PUBLICATION

- A. No information relative to the project or work, whether covered in this specification or otherwise may be released for publication without prior written consent and approval from the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All systems mentioned shall be complete in every detail and fully operational upon completion of the project unless specifically noted otherwise. Mention of certain materials in these specifications shall not be construed as releasing the Contractor from furnishing such additional materials and performing all labor required to provide a complete and fully operational system.
- B. The AV systems Contractor will be responsible for determining the proper equipment complement to provide complete and working systems, based on the operational requirements set forth in the specification.
- C. All materials shall be new, free from defects and not less than the quality herein specified. Materials shall be designed to ensure satisfactory operation and operational life in the environmental conditions which will prevail where they are being installed.
- D. Where these specifications include model or series numbers, the provided equipment (including substitutions) shall meet or exceed the manufacturer's published specifications for the specified model or series the same as if the manufacturer's published specifications were enumerated within these project specifications. This requirement is in addition to the other requirements given in the project specifications. This requirement is not intended to apply to characteristics (such as color or appearance) which do not affect performance, function, or reliability.
- E. Prior to ordering equipment, the Contractor shall coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms. This includes, but is not limited to, wireless microphones, assisted listening system devices, wireless control panels, etc.
- F. All accessories, including rack mounting hardware, power supplies, etc., shall be obtained from the original equipment manufacturer. Unless otherwise noted or specified, third party accessories shall not be used.
- G. Equality
 - 1. Other products of equal quality and function may be furnished, subject to approval by the Owner, Architect, and Consultant.
 - 2. Proof of equality rests with the submitter. The Owner shall be the final judge of equality.
- H. Substitutions:
 - 1. Substitutions: In accordance with Division 1, Substitutions.

MANSFIELD ELEMENTARY SCHOOL

- I. Manufacturer:
 1. Do not provide an assortment. For each category, provide products of the same manufacturer; for each item, provide the same model for all pieces.

2.2 EQUIPMENT RACKS

- A. Provide hardware as required to provide finished install of specified racks, doors, rack rails, side panels, top and bottom sections, fans, etc.
- B. Where racks are shown together, gang together using factory-provided hardware.
- C. Provide hardware as required for standard 19" rack mounting of equipment.
 1. Items that do not include manufacturer-provided rack hardware shall utilize a factory-made rack-mount kit such as manufactured by Middle Atlantic Products.
 2. There shall not be any shelf-mounted components in the audiovisual racks.

2.3 POWER STRIP

- A. Provide plug strips or plug mold as required to connect AC power to all associated equipment in racks, equipment consoles and custom mounting enclosures. Provide a minimum of one plug strip or plug mold per rack.
- B. Where applicable use rack manufacturer part or plug strip kit.

2.4 CABLE

- A. Provide wire and cables which are UL-listed and marked for their Class of wiring, per NEC.
- B. Trade numbers shown below are for general-purpose cables for use in raceway and where otherwise allowed by NEC and other codes. Prior to installation, the Contractor shall verify, for each installation situation, with the local authority having jurisdiction that non-plenum and non-riser rated cables are acceptable. In the event that plenum or riser-rated cables are required, provide cables so rate with equivalent electrical characteristics to those specified below.
 1. Crestron DigitalMedia 8G+
 - a. Crestron DM-CBL-8G-P
 2. HDMI
 - a. HDMI v2.1 to carry 4K signals a minimum 10'.
 - b. Provide cable lashing as required to prevent unplugging within conduit.
 - c. Provide HDMI equalizers as required.
 3. Speaker Cable
 - a. 16 AWG
 - b. Extron #SPK16
 4. Line Level Audio / Control
 - a. 20 AWG shielded twisted pair
 - b. Extron #STP20
 5. RS-232
 - a. DB9 Female-to-DB9 Male

MANSFIELD ELEMENTARY SCHOOL

- b. Extron #232 Series
 - 6. IR Emitters
 - a. Sonance #E1
- C. Color-coding shall conform to the NEC color coding standard for all multi-pin connector wiring.
- D. Unless otherwise called for in these specifications and drawings, the following cables, or their approved equivalent, shall be used in these systems:

Type	Manufacturer	Non-Plenum	Plenum
RF-CATV (Horizontal-RG6)	Belden	1189A	1189P
RF-DBS/DSS (Horizontal-RG6)	Belden	1829A	1829P
RF-CATV (Vertical-RG11)	Belden	1617A/7731	1153A
RF-50 Ohm (Horizontal RG-8)	Times Microwave	Microwave	LMR400
Video (Baseband & SDI)	Belden	1505A	1506A
S-Video	Belden	1807A	7700A
Control (4 conductor shielded)	Belden	1502R	1502P
Control (12 conductor shielded)	Belden	9556	6309FE
Audio	Belden	9451/1266A	9451P
Audio (8 Ohm program speakers)	Belden	8473	1861A
Audio (70 Volt Speaker)	Belden	8461	1863A
Video, RGB (RG6)	Belden	7721A	None
Video, RGB (RG59)	Belden	7796A	1826A
Multi-Channel Audio	Belden	8774	88778
Digital Audio (110 Ohm)	Belden	1800B	1801B
4-Fiber Riser Cable Tight-Buffered 50 μm multimode (OM3)	Corning Cable Systems		004T88-31180-29
Category 6 – Unshielded Twisted Pair	Berk-Tek		LANmark-1000 Enhanced Category 6 UTP
Category 6 – Shielded Twisted Pair	Berk-Tek		LANmark-HD High-Definition AV Plenum Cable
Category 5e	Berk-Tek		LANmark-350 Prem. Cat 5e

2.5 CONNECTION PLATE RECEPTACLES

- A. Balanced audio connectors shall be 3-conductor gold plated XLR type, Neutrik NC-MX-B for male or NC-FX-B for female, or approved equivalents.

MANSFIELD ELEMENTARY SCHOOL

- B. Unbalanced audio connectors for both RCA and 1/4" phone and balanced 1/4" phone shall have metal case and solder connections for connecting wire to plug contact, Switchcraft P/N 280 for 1/4" two-conductor, Switchcraft P/N 282 for 1/4", 3-conductor, and P/N 3502 for RCA.
- C. Note: All connectors on wall plates, or in other exposed locations, are to be recessed.

2.6 FLAT PANEL DISPLAY (AV DISPLAYS)

- A. Description: 4K Ultra High Definition Commercial Grade Video Display with RS-232 external control.
- B. Manufacturers: Subject to compliance with requirements, provide the following:
 - 1. LG
 - 2. NEC
 - 3. Samsung
 - 4. Sharp

2.7 MOBILE INTERACTIVE DISPLAY STANDS (GYMNASIUM SMART BOARD)

- A. Description: For creative, presentation and collaboration workspaces. Heavy Duty mobile stand integrates seamlessly with most large displays including 98" Screens, see VESA pattern and weight limits. Effortless precision ergonomics allow to focus on productivity then raise the interactive display to collaborate in presentation mode. The extended range of motion from highest to lowest position useful to achieve ADA compliance and the best possible user experience for collaborators.
- B. Products: Subject to compliance with requirements, provide the following:
 - 1. Salamander FPS Series Mobile Stand – XL, Electric Lift – Graphite/Gray; Part no: FPS1XL/EL/GG
 - 2. Salamander FPS Series Cable Reel – Cat 6, 20' Payout, 36" Pigtail; Part no: FPSA/CR/CAT6
 - 3. Salamander FPS Series Cable Reel – 30' Payout, 24" Tri-Tap Female End; Part no: FPSA/CR

2.8 DIGITAL SIGNAGE SYSTEM

- A. Description:
 - 1. A building wide digital signage system for the display of custom and injected content for information sharing with employees and guests. Authoring and server or cloud software to be included for the creation and streaming of custom channels on the LAN.
- B. Signage Monitor
 - 1. Furnished and installed by AVC
 - 2. Diagonal Size: 75"
 - 3. Resolution: UHD
 - 4. Aspect Ratio: 16 x 9
 - 5. Professional grade 24x7 rated

MANSFIELD ELEMENTARY SCHOOL

6. Shall include cable management accessories
7. Shall include all necessary mounting brackets or accessories
8. Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. LG
 - b. NEC
 - c. Samsung
 - d. Sharp

2.9 LOWER LEVEL AND MAIN LEVEL CLASSROOMS / TEACHING SPACES

- A. Functional Operation
 1. An integrated presentation system with an input location for a laptop/PC and an interactive writable surface with a control system.
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Crestron DigitalMedia.
- C. Rooms
 1. Pre-K and K classrooms, Music Room, Art Room, Art Display, Maker's Room, Learning Room, Self Cont. Room, Spec Ed Room, Speech, World L, Reading Room, Admin Offices, Reception and Teach Room.
- D. Document Camera
 1. Products: Subject to compliance with requirements, provide the following:
 - a. IPEVO 4K 5-880-4-01.
- E. Transmitter Wall Plate
 1. Description: Pairs with a DM Lite® or DMPS Lite™ receiver to provide a signal extender for HDMI® signals up to UHD and 4K. Advanced 4-port USB 3.1, 2.0, 1.1, 100 meters Cat6 Point-to-Point Extender System.
 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron HD-TX-101-C-1G-E-B-T
 - b. Icron Raven 3104 PRO – REX box
- F. Receiver Surface Mount
 1. Description: Pairs with a DM Lite transmitter to provide a simple point-to-point signal extender for HDMI® signals up to UHD and 4K.
 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron HD-RX-101-C-E
 - b. Icron Raven 3104 PRO – LEX box
- G. Audio Systems
 1. Assistive Listening System
 - a. See Section 275126 Assistive Listening Systems

MANSFIELD ELEMENTARY SCHOOL

H. Amplifier (Music Room Only)

1. Description: Configurable for 4 X 75 W output, 2 X 150 W output, 1 x 300 W (bridged) output and 2 x 75 W + 1 x 150 W (bridged) output.
2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron AMP-X300

I. Speakers (Music Room Only)

1. Description: 8” 2-Way Surface Mount Indoor/Outdoor Speaker, Black Textured
2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron SAROS SR8T-B-T-EACH

J. AV Switcher (Art Display Room in Cafeteria Only)

1. Description: A high-performance 4K60 4:4:4 AV switcher. Provides four HDMI® inputs and two HDMI outputs. Includes support of HDR (High Dynamic Range) and Dolby Vision® video formats, automatic switching of HDMI inputs, advanced EDID management, native Crestron® control via Ethernet, XiO Cloud® connectivity, and enterprise-grade security.
2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron HD-MD4X2-4KZ-E
3. Only ONE teacher station (A or B) can be used at any given time. See Integrator programming instructions below.
 - a. When video signal is detected on either input from teacher station A, the switcher will route both teacher station A inputs to the smart board HDMI 1 and HDMI 2.
 - b. When video signal is detected on either input from teacher station B, the switcher will route both teacher station B inputs to the smart board HDMI 1 and HDMI 2.
 - c. The end user will use the smart board remote or on display buttons to switch between either HDMI or HDMI 2 (similar to typical classrooms).

K. POE Switch (5-Port) - Art Display Room in Cafeteria Only

1. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron CEN-SW-POE-5

L. Room Controller - Art Display Room in Cafeteria Only

1. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron RMC4

2.10 CONFERENCE ROOMS

A. Functional Operation:

1. Audio Visual presentation and videoconferencing systems.

B. Advanced Tabletop Video Conference Systems

1. Description: Provides a complete conferencing and collaboration solution for open-platform UC applications. It supports a single video display, and features the Crestron Flex tabletop conference device, a collaboration camera, and HDMI® over CATx Receiver, cables, and power supply.
2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron UC-MX50-U

C. AV Switcher

1. Description: A high-performance 4K60 4:4:4 AV switcher. Provides four HDMI® inputs and one HDMI output. Includes support of HDR (High Dynamic Range) and Dolby Vision® video formats, automatic switching of HDMI inputs, advanced EDID management, native Crestron® control via Ethernet, XiO Cloud® connectivity, and enterprise-grade security.
2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron HD-MD4X1-4KZ-E

2.11 GYMNASIUM

A. Functional Operation:

1. An integrated presentation system with multiple input locations for laptops, and output connections for projection screen use with a control system.
2. Split the gymnasium into two divisible spaces to be used as classrooms. Audio system to be split into two separate systems to support each classroom. When classrooms are not in use, the audio system will be used as a unified system.
3. Distance presentation mode - Media booth with remote control of video cameras in logical locations in the space and video broadcasting and recording equipment including video and audio integration.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Crestron DigitalMedia.

C. Rooms

1. Gymnasium 040

D. Equipment Rack

1. Installed in Gymnasium Storage Room (GYM ST 040A). See AV drawings.
2. Dimension: 82.88-inches H x 32-inches D x 19-inches W, 45 rack-mount units.
3. Products: Subject to compliance with requirements, provide the following:
 - 1) Middle Atlantic BGR-45SA-32

E. Transmitter Wall Plate

1. Description: Provides a 1-gang mountable interface for an HD or 4K source as part of a complete DigitalMedia™ system. Supports 4K60 4:4:4 and HDR video signals. Connects to the DM 8G+® input of a DM® switcher or receiver via a single CATx cable. Includes IR and RS-232 control ports. Black finish.
2. Products: Subject to compliance with requirements, provide the following:
 - 1) Crestron DM-TX-4KZ-100-C-1G-B-T

F. Wall Mount Touch Screen

1. Description: A stylish and versatile wall mount touch screen featuring web browsing, Crestron HTML5 and Smart Graphics® software technology, custom-programmable icons, H.265/H.264 streaming video, a Rava® SIP intercom, Wi-Fi network® connectivity, and PoE+ (Power over Ethernet Plus) network power. Built-in applications are provided for room scheduling, conferencing, and home control. Touch screen needs to be password protected.

2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron TSW-1070-B-S

- G. USB Extender Kit
 1. Description: Extends any USB 1.1 or 2.0 device up to 100 meters (330 feet) point-to-point over one CAT5e (or better) unshielded twisted pair cable.
 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron USB-EXT-2 KIT

- H. USB Extender Remote
 1. Description: Extends any USB 1.1 or 2.0 device up to 330 ft (100 m) point-to-point over one CAT5e (or better) unshielded twisted pair cable.
 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron USB-EXT-2-REMOTE

- I. Universal Mounting Bracket
 1. Description: Provides an in-wall mounting solution for TSW-570, TSW-570P, TSW-770, Manufacturer TSW-1070, TSS-770, and TSS-1070 series touch screens.
 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron TSW-UMB-70

- J. AV Switcher
 1. Description: Fully modular and expandable 8x8 DigitalMedia matrix switcher offering ultra-fast digital video and audio switching and lossless HD multiroom signal distribution for all types of AV sources. Based on the 3-Series® platform. Provides complete management of SD, HD, UHD, 2K, 4K60 4:4:4 HDR, and computer signals with advanced HDCP support, EDID resolution management, CEC signal management, USB signal routing, integrated Ethernet switch, simultaneous 7.1 and stereo audio, H.264 streaming, and a full range of selectable input and output types.
 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron DM-MD8X8-CPU3

- K. Dante Network Switch
 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. Cisco Systems
 - b. Netgear
 - c. Hewlett Packard Enterprise
 - d. Or approved equivalent

- L. Streaming and Lecture Capture Appliance
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Epiphan Pearl Mini

- M. DM Input Card
 1. Description: Provides a single DM 8G+® or HDBaseT® input for any DigitalMedia™ Switcher with modular input card slots. Handles 4K60 4:4:4 and HDR video signals.
 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron DMC-4KZ-C

- N. Receiver Wall Plate
 - 1. Description: Provides a cost-effective, 1-gang mountable interface for an HD or 4K display device as part of a complete DigitalMedia™ System. Connects to the DM 8G+® output of a DM® Switcher or Transmitter via a single CATx cable. Includes IR and RS-232 control ports. Available in white or black.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron DM-RMC-4K-100-C-1G-B-T
- O. DM Input Card – HD
 - 1. Description: Provides a single HDMI® input for any DigitalMedia™ Switcher with modular input card slots. Supports 4K60 4:4:4 and HDR video sources.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron DMC-4KZ-HD
- P. DM Output Card – HD
 - 1. Description: A modular output card for DM-MD8X8, DM-MD16X16, or DM-MD32X32 switchers. Provides two independent 4K DM 8G+® outputs, plus one HDMI® output in parallel with the first DM 8G+ output. Supports 4K60 4:4:4 and HDR video signals.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron DMC-4KZ-CO-HD
- Q. DM Output Card – Scaling
 - 1. Description: A modular output card for card-based Crestron® DigitalMedia™ switchers. Provides two independent 4K HDMI® outputs with complementary analog audio outputs. Supports 4K60 4:4:4 and HDR video signals and provides built-in scaling.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron DMC-4KZ-HDO
- R. Camera
 - 1. Description: Production-quality RoboSHOT 40 UHD provides brilliant 4K video footage for broadcasting or live streaming applications.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Vaddio RoboShot 40 UHD
- S. Assistive Listening System
 - 1. See Section 275126 Assistive Listening Systems
- T. DM Receiver with Scaler
 - 1. Description: Provides a controller and interface for an HD or 4K display device as part of a complete DigitalMedia™ system. Supports 4K60 4:4:4 and HDR video signals. Includes a built-in 4K60 4:4:4 scaler. Provides a DM 8G+® input that connects to the DM 8G+ output of a DM® switcher or transmitter via CAT5e (or higher) cable. Compatible with the HDBaseT® standard. Also provides an HDMI® input and analog audio output as well as IR, RS-232, Ethernet, and relay control ports.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron DM-RMC-4KZ-SCALER-C

MANSFIELD ELEMENTARY SCHOOL

- U. 4-Series Control System
 - 1. Description: A rack-mountable control system with a powerful 4-Series control engine and numerous integrated control ports. Features an isolated control subnet that provides a Gigabit Ethernet LAN dedicated to Crestron devices.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron CP4N
- V. 16-Port POE Switch
 - 1. Description: A 16 port Gigabit Ethernet switch with PoE+ in an AV-friendly rack-mount form factor.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron CEN-SWPOE-16
- W. DSP with Dante
 - 1. Description: A powerful digital audio signal processor featuring best-in-class audio performance, Dante™ audio networking, extensive yet simple configurability, and native Crestron system integration.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron DSP-1281
- X. Amplifier
 - 1. Description: Configurable for 4 X 75 W output, 2 X 150 W output, 1 x 300 W (bridged) output and 2 x 75 W + 1 x 150 W (bridged) output.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron AMP-X300
- Y. Ceiling Speaker - Pendant
 - 1. Description: Saros® pendant speakers are designed to deliver excellent speech intelligibility and full, rich music reproduction for use in open-ceiling spaces such as restaurants, night clubs, retail spaces, houses of worship, and convention facilities.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Crestron SAROS PD8T-B-T-EACH
- Z. Wireless Microphone System
 - 1. Furnished and installed by AV Contractor.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Shure BLX 1288/CVL
- AA. Universal Media Player
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Denon DN-500BD MKII
- BB. Projector
 - 1. Description: The E-Vision 11000 4K-UHD delivers a stunning 10,500 lumens from a stable, solid-state light source capable of producing over 20,000 hours of illumination. Revealing the extraordinary detail that can only be conveyed by 4K-UHD DLP, this single-chip projector was developed with 'Fit and Forget' directive, ensuring it needs only minimal maintenance throughout the lifetime of the display.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Digital Projection (DPI) E-Vision 11000 4k-UHD, Part No 120-602

- b. Digital Projection (DPI) .38:1 ultra short throw Lens, Part No. 117-341
- 3. Projection Screen
 - a. See Section 115213 Projection Screen.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install and test all equipment in operating order under the terms of this specification.
- B. Install all equipment in accordance with all appropriate local electrical codes for public buildings.
- C. Equipment and installation shall be of a design to eliminate electrical shock to operators.
- D. Component grounds, interconnections, and cable shield ground to be rendered such that system shall be free from ground loops, hum, noise, instability, and crosstalk.

3.2 PHYSICAL INSTALLATION

- A. The equipment shall be as detailed on the drawings.
- B. Verify all rough-in requirements.
- C. Boxes, equipment, etc. shall be plumb and square.
- D. Equipment (except portable equipment) shall be firmly held in place. Fastenings and supports shall be adequate to support their loads with a safety factor of at least ten, or as required by code, whichever is greater. Equipment shall be braced for seismic conditions according to applicable codes and regulations.
- E. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.
- F. Installation shall include the delivery to the installation site, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of the system components, equipment alignment and adjustment, programming and configuration and all other work whether or not expressly required herein which is necessary to result in complete and fully operational systems.
- G. Prior to ordering equipment, the contractor shall coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms. This includes, but is not limited to, wireless microphones, assisted listening system devices, wireless control panels, etc.
- H. All accessories, including rack mounting hardware, power supplies, etc., shall be obtained from the original equipment manufacturer. Unless otherwise noted or specified, third party accessories shall not be used.

MANSFIELD ELEMENTARY SCHOOL

- I. If, in the opinion of the Contractor, an installation practice is desired or required, which is contrary to these specifications or drawings, a written request for modification shall be made to the Design Team. Modifications shall not commence without written approval from the Design Team
- J. During the installation, and up to the date of final acceptance, the Contractor shall be under obligation to protect his finished and unfinished work against damage and loss. In the event of such damage or loss, the damage shall be replaced or repaired at no cost to the Owner.
- K. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise.
- L. All equipment shall have an engraved plaque permanently affixed, denoting its function.
- M. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three. All boxes, equipment, etc., shall be secured plumb and square.
- N. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.
- O. Trim and Escutcheon Components
 - 1. To insure a proper finished appearance, the AV Contractor shall furnish and install trim/escutcheon components at all conditions where A/V components pass through the finished ceilings. This would include but not be limited to video projector supports, television monitor/receiver supports and any other component which is not specifically supplied with integral flanges/trim components; i.e. speaker mounts, assistance listening devices, etc.
 - 2. The visible component of any trim should be minimal in size, preferably no wider than 1/2". All trim components at the ceiling plane shall be finished to match the approved ceiling finish. The audiovisual contractor should obtain a sample from the General Contractor, including any custom color information, or standard color numbers.
 - 3. All visible components and finish options shall be submitted to the Design Team for review and approval prior to fabrication.
- P. Cable Installation
 - 1. All wire bundles are to be neat and combed free of cable crossovers.
 - 2. All cables, regardless of length, shall be marked with a permanent, self-laminating wrap-around number or letter cable marker at both ends, similar to the Panduit "Pan-Code" system. Labels must be computer-generated for legibility. Wire labels done by hand in the field must be replaced with computer generated labels. There shall be no unmarked cables at any place in the system. Marking codes used on cables shall correspond to codes shown on drawings and or run sheets. All labeling must be reviewed and approved by Owner prior to installation as part of the shop drawing process.
 - 3. All cables shall be grouped according to the signals being carried. In order to reduce signal contamination, separate groups shall be formed for the following cable families:
 - a. Power cables
 - b. Control cables
 - c. Video cables
 - d. Audio cables carrying signals less than - 20 dBm
 - e. Audio cables carrying signals between - 20 dBm and +20 dBm
 - f. Audio cables carrying signals above +20 dBm

4. As a general practice, all power cables, control cables, and high level cables shall be run on the left side of an equipment rack as viewed from the rear. All other cables shall be run on the right side of an equipment rack, as viewed from the rear.
5. Velcro cable ties shall be placed at appropriate intervals of no greater than six inches for vertical bundles, two inches for horizontal bundles.
6. All vertical cable bundles shall be attached to the rack frame.
7. All cables shall be continuous lengths without splices. All system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. Except where noted otherwise in the specifications, **NO BARE WIRE TERMINATIONS WILL BE ACCEPTED**. Heat-shrink tubing shall be used to insulate the ground or drain wire. Unused wires at the end of a cable shall remain unstripped and shall be laid back and held in place with wire ties.
8. All solder connections shall be made with rosin-core solder using temperature-controlled solder stations. Care shall be taken to avoid cold or cracked solder joints. Any connections that do not appear to be clean and shiny, or which show signs of cracking, shall be resoldered by the contractor before final acceptance of the system.
9. Mechanical connections using insulated, crimp-type connectors shall be bonded to the connector by soldering the wire to the metal part of the connector.
10. Connections made with screw actuated pressure type terminal strips shall be made by stripping approximately 1/4 inch of insulation from the stranded conductor. Then the un-tinned wire shall be inserted into the terminal and the screw tightened using a secure fitting precision screwdriver.
11. Terminal blocks, boards, strips or connectors shall be furnished for all cables which interface with racks, cabinets, consoles, or equipment modules. No audio cables shall run directly to the audio patch panel jacks. Each audio patch panel shall be furnished with an audio terminal block, and all audio cables to and from the audio patch panel shall terminate on this block.
12. All wire markers shall face a common direction.
13. All cables shall have proper connector housing.
14. Cables shall not protrude from the back of racks.
15. All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear or side panel openings.
16. It is the responsibility of the Audiovisual Contractor to verify, furnish and install the correct CATV cable type and connectors, as per the local CATV provider.
17. Unless otherwise noted, all video and computer video cables are to be terminated using seventy-five ohm (75 Ohm) connectors, with a captive center pin.
18. Cables running in plenum areas without conduit shall be plenum rated cable, and match the specified cable above. It is the responsibility of the Bidder to inspect the electrical drawings, and verify in what spaces plenum cable shall be used. No claims for additional monies, based on the use of plenum cable, will be allowed.
19. All cables that can be terminated in the field (except video and pulse cables, which must be cut to an electrical length) shall be cut to the length dictated by the run. No splices shall be permitted in any pull boxes without prior permission of the Consultant. For equipment mounted on casters, in drawers or on slides, the interconnecting cables shall be provided with a service loop of appropriate length.
20. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer.
21. Where cables are installed in architectural niches, ensure that the cables are black, unless otherwise directed, to reduce visibility from the audience.

22. Where cables are visible, the cables will be sheathed in a color wrap that has been submitted for approval by the Design Team.

Q. Cable Separation

1. Cable separation of cables for runs greater than 24'.
 - a. Microphone Level – 12” from all other circuits.
 - b. Line Level and Control – 12” from any circuit with signal of 20dB or greater than Line Level and Control cables.
 - c. Speaker level circuits – 12” from other circuits.
 - d. Video and Data – 12” from any circuit with signal of 20dB or greater than Video and Data.
 - e. AC Power Circuits – 12” from all other circuits.
 - f. Required conduit separation are given for all audiovisual pathways on plans

R. Cable Support

1. Supporting method in accordance with Section 260500
2. Individual runs throughout building – Support cable at 600mm on center and 100mm at any change in direction. Support from building structure. Cables on top of ceiling tiles will be rejected. Cable supported by ceiling grid support wires will be rejected.
3. Cable Bundles – Where multiple cable combine support at 300mm on center and 100mm at any change in direction. Support from building structure. Cables on top of ceiling tiles will be rejected. Cable supported by ceiling grid support wires will be rejected.

S. Rack Cabling

1. Neatly train and lace cables.
2. Route Cables from components to lacing bars installed on rear rack rail.
3. Provide services loops for each cable.
4. Cable separation of cables for runs within Equipment rack.
 - a. Microphone Level – 50mm from all other circuits.
 - b. Line Level and Control – 50 mm from any circuit with signal of 20dB or greater than Line Level and Control cables.
 - c. Speaker level circuits – 50mm from other circuits.
 - d. Video and Data – 50 mm from any circuit with signal of 20dB or greater than Video and Data.
 - e. AC Power Circuits – 50mm from all other circuits.

T. Approved Wire Termination Means

1. Solder Connections – For connectors utilizing Solder Cups
2. Terminal strip Connectors – For termination of blunt cut cables, cable to be tinned prior to termination
3. Multi Pin connectors – Utilize connector manufacturers crimper
4. Crimp Cap Terminations – For Loudspeaker circuits at individual devices. Distribution cable termination to utilize terminal strip connectors.

U. Patch Panels

1. Patch Panel Assignments
 - a. All patch panels shall be wired so that signal “sources” (outputs from) appear on the upper row of a row pair; and all “loads” (inputs to) appear on the lower row of a row pair.

2. Patch Panel Designation Strips
 - a. All audio and video patch panel designation strips shall utilize alphanumeric identifications and descriptive information. The jack position in each horizontal row shall be numbered sequentially from left to right. The horizontal jack rows shall be lettered sequentially from top to bottom. The alphanumeric identification of each jack shall be included on the functional block drawings, as well as on reproductions of these drawings, which shall be mounted in an appropriate location near the patch bays.

V. Mounting Heights

1. Coordinate locations of the following with mounting heights as indicated on Architectural, Electrical and Audiovisual drawings.
 - a. Technical wall plates
 - 1) AV input/output connections
 - 2) Flat panel display panel connections
 - 3) Video projector connections
 - 4) Annotation panel connections
 - 5) Networked Digital Clocks
 - 6) PTZ cameras
 - 7) Wall mounted speaker boxes
 - b. Control panels
 - c. Pull boxes
 - d. Other devices as required

W. Grounding Procedures

1. In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, the following grounding practices shall be adhered to in order to maintain the integrity of the grounding system:
 - a. Because of the great number of possible variations in grounding systems, it shall be the responsibility of the Contractor to follow good engineering practice, as outlined below, and to deviate from these practices only when necessary to minimize crosstalk, ground loops, ground-induced noise, and to maximize signal-to-noise ratios in the audio, video, and control systems. All components must be tied back and grounded to the common building grounding system.
 - b. System Power Ground: A single primary "system ground" shall be established for the system in each particular area. All grounding conductors in that area shall connect to this primary system ground.
 - 1) The system ground shall be provided at the audio equipment rack for the area, and shall consist of a copper bar of sufficient size to accommodate all secondary ground conductors. A copper conductor having a maximum of 0.1 Ohms total resistance shall connect the primary system ground bar to the nearest approved ground. The Contractor shall be responsible for determining if the metallic conduit is properly electrically bonded to the building ground system.
 - 2) Secondary system grounding conductors shall be provided between all racks, audio consoles, and audiovisual system equipment local to the area. Each of these grounding conductors shall have a maximum of 0.1 Ohms total resistance.

- 3) Under no conditions shall the AC neutral conductor, either in the power panel or in a receptacle outlet, be used as a system ground, except as specifically defined by NFPA 70 for bonding.
- 4) Ungrounded equipment with either an inline transformer or a 2-prong plug, shall be bonded to the rack bus bar using #12awg cable.
- c. Audio Cable Shields
 - 1) All audio cable shields shall be grounded at one point only. There are no exceptions. For inter and intra-rack wiring, this requires that the shield be connected at one end only. For ungrounded portable equipment, such as microphones, the shield shall be connected at both ends but grounded at only one end.
- d. Video Receptacles
 - 1) All video receptacles that are provided and installed by the Contractor shall be insulated from the mounting panel, outlet box, or wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles.
- e. Audio Receptacles
 - 1) All audio receptacles that are provided and installed by the Contractor shall be insulated from the mounting panel, outlet box, or wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles.

3.3 WORKMANSHIP AND OBSERVATION

- A. Workmanship shall be of the best quality and none but competent and experienced Contractors shall be employed and shall be under the supervision of a competent and experienced foreman.
- B. Completed work shall represent a neat and orderly appearance.
- C. All work and materials shall be subject to observation at any and all times by representatives of the Architect, Owner and Consultant.
- D. The AV Contractor, upon receiving notice from Owner that the AV Contractor has furnished inferior, improper or unsound work or materials (including equipment), or work or materials at variance with that which is specified, will, within 24 hours, proceed to remove such work or materials and make good all other work or materials damaged thereby, and, at the option of the Owner, the AV Contractor shall immediately replace such work or materials with work or materials as specified. The removal, replacement, and repair shall be performed at such times and with manpower sufficient, in the judgment of the Owner, so as to avoid disturbance to occupants, or other ongoing work for the Project.
 1. If the AV Contractor does not remove such unsound Work within a reasonable time, the Owner may remove it and may store the material at the expense of the AV Contractor. If the AV Contractor does not pay the expenses of such removal within ten (10) days' time thereafter, the Owner may, upon written notice, sell such materials at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs and expenses that should have been borne by the AV Contractor and all expenses of the sale.
 2. The Owner shall have the authority at all times, until final completion and acceptance of the Work, to inspect and reject work and materials which in its judgment are not in conformity with the Drawings and Details, Room Data Sheets and Specifications, and its

decision in regard to character and value of Work shall be final and conclusive on both contracting parties. If the Owner permits said Work or materials to remain, the Owner shall be allowed the difference in value or shall at its election have the right to have said Work or materials repaired or replaced, as well as the damage caused thereby, at the expense of the AV Contractor, at any time within one (1) year after the completion of the entire project, or within such longer period as may be covered by any guaranty; and neither payments made to the AV Contractor, nor any other acts of the Owner, shall be construed as evidence of acceptance, waiver, or estoppels.

3. Any expense incurred by the Owner in connection with the foregoing, shall be borne by the AV Contractor, and the Owner may withhold money due to the AV Contractor or recover money already paid to the AV Contractor, to the extent of such expense.

- E. The Contractor shall keep the job adequately staffed at all times, including a designated field supervisor present at the job site, and in responsible charge during all phases of installation and checkout. This supervisor shall be the same individual throughout the execution of the work, unless illness, loss of personnel, or other circumstances beyond the control of the contractor intervene.

3.4 CUTTING BUILDING CONSTRUCTION

- A. Obtain permission from the Architect or Owner and coordinate with other trades prior to cutting. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. Cut concrete with diamond core drills or concrete saws except where space limitations prevent the use of such tools.
- B. All construction materials damaged or cut into during the installation of this work must be repaired or replaced with materials of like kind and quality as original materials by skilled labor experienced in that particular building trade.

3.5 PENETRATIONS OF FIRE RATED ELEMENTS

- A. Must be provided such as to retain that rating.

3.6 PAINTING

- A. Painting will generally be provided by the General Contractor, except for refinishing of items furnished under this Division which are scratched or marred in shipment or installation, in which case the Contractor is responsible.

3.7 CLEAN UP

- A. Contractor shall continually remove debris, cuttings, crates, cartons, etc. created by his work. Such clean up shall be done daily and at sufficient frequency to eliminate hazard to the public, other workers, the building, or the Owner's employees. Before acceptance of the installation, Contractor shall carefully clean cabinets, panels, lighting fixtures, wiring devices, cover plates,

etc. to remove dirt, cuttings, paint, plaster, mortar, concrete, etc. Blemishes to finished surfaces of apparatus shall be removed and new finish equal to the original applied.

- B. Remove dirt and debris from the interior of enclosures, outlet boxes, pull and junction boxes, and equipment cabinets.

3.8 SYSTEM TESTING & ADJUSTMENT

- A. Follow INFOCOMM 10-2013, AV Systems Performance Verification for all performance verification criteria and tests.
- B. Provide all required testing equipment and apparatus specified herein to complete successfully the tests and the equalization.
- C. All manufacturers' operation manuals shall be present during testing and adjustment procedures.
- D. Testing and adjustment of equipment shall be performed by qualified technicians with prior knowledge of the particular items of equipment, general knowledge of video and audio systems alignment and troubleshooting, and knowledge of the specific systems and installations of this project.
- E. Inspect and make adjustments after installation.
- F. Repair or replace defective equipment.

3.9 CRESTRON SYSTEM TESTING AND COMMISSIONING

- A. Testing
 - 1. A DigitalMedia Certified Engineer (DMC-E) shall perform the contractor verification tests.
 - 2. Contractor shall verify that all components of the system are installed according to manufacturer's specifications and are compliant with Division 27 specifications.
- B. Commissioning
 - 1. A DigitalMedia Certified Engineer (DMC-E) shall perform acceptance testing and commissioning.

3.10 TESTING AND COMPLETION REPORT

- A. Submit copies of the test results prior to final acceptance and training. Include copies of the test results in the O&M manuals

- B. When the work is complete and ready for acceptance testing, submit Completion Report for review and approval. Include:
 - 1. Letters from the Contractor and all Subcontractors, on their respective letterheads, certifying that the AV systems are substantially complete, fully tested and adjusted, fully operational, and ready for inspection, final testing, and tuning.
 - 2. The results of all tests, measurements, and adjustments which are specified within this section and related sections.
 - 3. List of personnel and test equipment used.
 - 4. List of discrepancies and corrective action taken.
- C. Submit the complete package of Completion Report to the Consultant for review prior to scheduling of the site visit by the Consultant for final observation and testing.
- D. The Consultant will not schedule a site visit until the Contractor's Completion Report has been submitted and approved. Allow at least 10 calendar days between receipt of Completion Report by Consultant and the earliest desired date for site visit by Consultant. The Contractor is encouraged to communicate informally with the Consultant prior to submission of Completion Report to coordinate the scheduling of the Consultant's site visit.

3.11 SYSTEM ACCEPTANCE TESTS

- A. System Acceptance Tests will not be performed until the Contractor's Completion Report has been submitted and the test results have been reviewed. The System Acceptance Tests will be supervised by the Consultant and will consist of the following:
 - 1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
 - 2. The operation of all system equipment shall be demonstrated by the Contractor.
 - 3. Both subjective and objective tests will be required by the Consultant to determine compliance with the specifications. The Contractor shall be responsible for providing test equipment for these tests.
 - 4. All final, "as-built" drawings, cable run sheets, manuals, and other required documents, as detailed in Paragraphs 3.12 and 3.13, shall be on hand. Two (2) complete sets of these documents shall be delivered to the Owner at this time. (One (1) complete set shall have been delivered to the Consultant prior to the scheduling of Acceptance Tests).
 - 5. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Consultant.
- B. Provide installation and operation manuals for all items of equipment, and a copy of the Completion Report.
- C. Provide on-site personnel who have participated in the installation and testing.
- D. Assist the Consultant in making final tests, equalization, and other adjustments. This shall include listening and viewing tests, including subjective tests by observers at various positions, under various operating conditions.
- E. Make any adjustments, including but not limited to re-wiring of speaker taps, adjustment of loudspeaker aiming, resetting of gain controls, changes in shielding or grounding, and minor

changes in wiring and termination, which are deemed necessary by the Consultant. Such work shall be included in the base bid contract amount.

- F. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Owner's Representative.
- G. Any charge for additional time incurred by the Owner's Representative required to over-see the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the contractor

3.12 WARRANTY

- A. Refer to General Conditions of the Contract.
- B. Guarantee all work installed under this specification. The Contractor shall make good, repair or replace, at his own expense, any defective work, materials or parts which may show themselves within one year after final acceptance, if in the opinion of the Architect or Consultant said defect is due to imperfection in material, design or workmanship. Any request for service or repair under this warranty shall be honored, except when damage has resulted from obvious vandalism or Acts of God.
- C. The warranty shall include all provisions of the standard manufacturer's backed warranty for each particular piece of equipment, and remain in effect for a period as stated by the manufacturer. Contractor shall be an authorized service representative for all equipment supplied as part of this project unless appropriate approval from Owner has been granted prior to equipment procurement or installation. The warranty shall also cover the accuracy of technical documentation, and signal quality as specified and documented during the testing process of this project.

3.13 OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The Contractor shall prepare Operations Manuals for each system/facility provided under these specifications.
- B. The Contractor shall prepare Maintenance Manuals for all equipment furnished under Division 1 of the specifications.
- C. Maintenance Manuals shall be separate from Operations Manuals.
- D. The information included must be the exact equipment installed, not the complete "line" of the manufacturer. Where sheets show the equipment installed and other equipment, the installed equipment shall be neatly and clearly identified on such sheets.

- E. These O & M Manuals shall contain all the information needed to operate and maintain all systems and equipment provided in the project. It shall be presented and arranged in a logical manner for efficient use by the Owner's operating personnel. The information provided shall include but not be limited to the following:
1. Equipment manufacturers, makes, model numbers, serial numbers, sizes, etc. Include addresses and telephone numbers for each manufacturer. List loose items separately.
 2. A copy of the delivery receipt for Loose Items.
 3. Description of system configuration and operation including component identification and equipment interconnect diagram.
 4. Manufacturers' recommended operation instructions for each item of equipment.
 5. Overall system operating instructions, custom written for this specific project.
 6. Warranty Information, including but not limited to:
 - a. An overall Statement of Warranty from the Contractor for the complete systems.
 - b. A copy of the Manufacturers' warranties for each item of equipment so covered.
 - c. Instructions for obtaining warranty service from the Contractor, and from each Manufacturer.
 7. Complete parts list including reordering information, recommended spares and anticipated useful life (if appropriate). Parts lists shall give full ordering information assigned by the original parts manufacturer. Relabeled and/or renumbered parts information as reassigned by equipment supplier not acceptable.
 8. "As-built" Shop Drawings, including point to point wiring diagrams.
- F. Wiring diagrams for each system shall be complete drawings for the specific system installed under the contract. "Typical" line diagrams will not be acceptable unless marked to indicate the exact field installation.
- G. The information contained in the manuals shall be grouped in an orderly arrangement by specification index. The manuals shall have a typewritten index and divider sheets between categories with identifying tabs. The completed manuals shall be bound in heavy-duty slant-ring binders (3 "D" rings), or with hardboard covers and screw-post bindings. O & M manuals shall not exceed 5" thickness. Provide two or more volumes if required. The covers shall be labeled with the name of the job, Owner, Architect, Consultant, Contractor and year of completion. The spine shall be labeled with the name of the job, Owner and year of completion. Labeling may be laser-printed inserts in clear plastic overlays, or imprinting by silk-screening or hot stamping. Include the following information:
1. Project Title
 2. Project Number
 3. Owner/Operator
 4. Architect
 5. Consultant
 6. Contractor
 7. Completion Date
- H. A preliminary copy in .pdf format shall be submitted fifteen days prior to completion of the project for checking and review. After checking and review, provide final bound and corrected copies. Deliver one (1) copy in .pdf format and remaining bound and digital copies in .pdf format to the Owner five days before instruction is to begin.

MANSFIELD ELEMENTARY SCHOOL

3.14 INSTRUCTION/TRAINING PERIODS

- A. After substantial completion of the work, and at least five days after the O & M manuals have been delivered to the Owner, and after all tests and final inspection of the work by the Authority(s) Having Jurisdiction; the Contractor shall demonstrate the systems and instruct the Owner's designated operating and maintenance personnel in their operation and maintenance. The Contractor shall arrange scheduled instruction periods with the Owner. The Contractor's representatives shall be superintendents or foremen knowledgeable in each system, and suppliers' representatives when so specified.
- B. At a minimum, provide the following sessions of training for systems users, covering operations. Each session shall be for at least the specified number of hours and number of attendees per session.
 - 1. General Operations: at least two 2-hour sessions for operations and management staff.
 - 2. Technical Operations: at least two 4-hour sessions for technical staff, covering detailed operations and maintenance, including operation of software for creating and editing content.
 - 3. At the completion of installation, submit a written request to the Owner to schedule the training sessions, at least two weeks in advance of the requested dates.
- C. At least one of each type of class (as selected by Owner's representative) shall be videotaped by the contractor, with DVD copies turned over to the Owner's representative as part of the O&M manuals.
- D. All maintenance and operational aspects of the systems shall be described and demonstrated to personnel selected by the Owner. The sessions shall be conducted by a representative thoroughly familiar with the characteristics of the system. O&M manual information regarding the system shall be submitted to the Owner prior to scheduling the instruction session. The training session should cover the following areas:
 - 1. General operation of all systems and functions.
 - 2. Explanation and orientation of all technical documentation.
 - 3. Basic system troubleshooting and preventive maintenance.
 - 4. Explanation of system warranty and process for owner to follow during system malfunctions to obtain customer support from the AV systems Contractor.

END OF SECTION 274116

SECTION 275126 - ASSISTIVE LISTENING SYSTEMS

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. Section Includes:
 - 1. Infrared (IR) Hearing Assistance System

1.3 SYSTEM LOCATIONS

- A. Supply and install the complete systems, detailed within this specification. Provide IR Systems at the following locations and areas:
 - 1. Gymnasium
 - 2. Classrooms and other spaces as required (Portable System)

1.4 COMPLIANCE

- A. In addition, the system shall comply with:
 - 1. 2010 Americans with Disabilities Act (Section 706)
 - 2. 2012 International Building Code (Section 1108.2)

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Power, signal, and control wiring.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Console layouts.
 - 4. Control panels.
 - 5. Rack arrangements.
 - 6. Wiring Diagrams: For power, signal, and control wiring.
 - a. Identify terminals to facilitate installation, operation, and maintenance.
 - b. Single-line diagram showing interconnection of components.
 - c. Cabling diagram showing cable routing.

MANSFIELD ELEMENTARY SCHOOL

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and reflected ceiling plans, drawn to scale, on which floor or ceiling-mounted items are shown and coordinated with each other, using input from installers of the items involved.
- B. Qualification Data: For Installer.
- C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For assistive listening systems to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017700 "Closeout Procedures" and Section 017823 "Operation and Maintenance Data," include the following:
 - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - b. Operating instructions laminated and mounted adjacent to operating console location.
 - c. Training plan.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Only Contractors that have completed and are currently certified under specific manufacturer training to test, install, and commission along with providing a Certificate of Conformity in accordance with the IEC 60118-4 standard shall be eligible to bid upon this portion of the contract.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain assistive listening system from single source from single manufacturer.
 - 1. Listen Technologies
 - 2. Williams Sound
 - 3. Sennheiser
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

2.2 RECEIVERS AND TEST EQUIPMENT

A. Receivers

1. For each system a receiver shall be provided for operational staff to check and monitor the performance of the system. The receiver shall have the following characteristics:
 - a. Headphone output and be provided with headphones or, ear piece.
 - b. Low frequency cut filter.
 - c. Field strength indicators at 0dB and -6dB (As required by the standard IEC 60118-4:2006)
2. For each system, receivers shall be provided for occupant use as outlined in the 2010 Americans with Disabilities Act (Section 706) and 2012 International Building Code (Section 1108.2) and detailed in the following table:

Table 1 - Receivers for Assistive Listening Systems

Capacity Of Seating In Assembly Areas	Minimum Required Number Of Receivers	Minimum Number Of Receivers Required To Be Hearing-Aid Compatible (Not Required With Induction Loop Systems)
50 or less	2	2
51 to 200	2, plus 1 per 25 seats over 50 seats*	2
201 to 500	2, plus 1 per 25 seats over 50 seats*	1 per 4 receivers*
501 to 1,000	20, plus 1 per 33 seats over 500 seats*	1 per 4 receivers*
1,001 to 2,000	35, plus 1 per 50 seats over 1,000 seats*	1 per 4 receivers*
Over 2,000	55 plus 1 per 100 seats over 2,000 seats*	1 per 4 receivers*

Note: * = or fraction thereof

2.3 IR ASSISTIVE LISTENING SYSTEM

A. Functional Requirements:

1. The assistive listening system shall be capable of broadcasting mono or stereo channels on up to 4 Upper Band IR carrier frequencies.
2. IR radiators shall come in Grey or White, have all needed hardware for mounting on wall, ceiling, table-top or mic stand and have auto-off feature to preserve LED life.
3. Stethoscope or Lanyard style IR Receivers shall be frequency agile and frequency set with a push button channel selector. The Lanyard style receivers will incorporate a stereo headset jack that allows the user to plug in a stereo headset.
4. The receivers shall incorporate automatic signal mute or squelch when no IR signal is received.
5. Receivers shall be powered by either standard AAA batteries offering up to 30 hours of use or NiMH battery packs offering up to 15 hours of use. Use of NiMH battery packs will require a recharging station.
6. Provide quantity of receivers per requirements listed in Table 1.

MANSFIELD ELEMENTARY SCHOOL

B. Rooms:

1. Gymnasium

C. Products:

1. Listen Technologies LT-82 Stationary IR Transmitter. (Qty: 2 ea.) or approved equivalent.
2. Listen Technologies LA-326 Rack mount kit (Qty: 2 ea.) or approved equivalent.
3. Listen Technologies LA-140 IR Radiator or approved equivalent. Mount as needed, can be mounted on ceiling, wall, remote base or mic stand. Radiator comes complete with 2 each 25ft. RG58 50 Ohm coaxial and CAT5 cables. (Qty: 2 ea. Or as needed). Note: Each LA-140 IR radiator covers approximately 10,000 square feet for a mono channel.
4. Listen Technologies LR-44 IR Lanyard 4 channel receiver (Qty: 4 each or as needed)
5. Listen Technologies LA-165 Stereo Headphones (Qty: 2 ea.) or approved equivalent.
6. Listen Technologies LA-166 Neck-loop. (Qty: 2 ea.) or approved equivalent.
7. Listen Technologies LA-350 8 unit charging station. (Qty: 1 ea.) or approved equivalent
8. Listen Technologies LA-364 Ni-MH rechargeable battery packs (Qty: 4 ea.) or approved equivalent.
9. Listen Technologies LA-304 ADA Access/Compliance signage kit. (Qty 1 ea.) or approved equivalent.

2.4 PORTABLE ASSISTIVE LISTENING SYSTEM

A. Functional Requirements:

1. A complete assistive listening solution wherever it is needed with the LS-88-01 Portable ListenIR iDSP system.
2. The setup meets all IBC and ADA requirements for small to medium-size rooms with a capacity of up to 50, and the entire system is easily transported and stored in its own carrying case.
3. Each system includes a ListenIR Transmitter/Radiator Combo as well as receivers, ear speakers, and neck loop lanyards for multiple users, in addition to other required equipment.

B. Rooms:

1. Classrooms and other teaching spaces as needed.

C. Products:

1. Listen Technologies LS-88 Portable Listenir IDSP System.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall:

1. Coordinate with other relevant contractors to ensure that all appropriate audio signals are connected to the induction loop system and transmitted clearly.
2. Provide appropriate cabling and/ or connection points for system integration.
3. Wire and connect to all items of equipment in accordance with the manufacturers' recommendations.

MANSFIELD ELEMENTARY SCHOOL

4. Ensure complete segregation of the Extra-Low Voltage (ELV) wiring system, from any other ELV or Low Voltage (LV) wiring system.
5. Provide all necessary and supplementary grounding conductors and connections to each component or item of equipment.
6. Follow good audio and other relevant practice to ensure that proper grounding and other cable system design does not cause degradation of this or other system performance by allowing interference in inappropriate paths.
7. Confirm locations of all local power supply requirements and equipment spatial requirements.
8. All wiring of loops and between equipment locations shall be installed and concealed in appropriate containment.
9. All wiring, including that inside equipment enclosures or racks, will be of a neat and tidy appearance. Wiring shall be identified at both ends of each cable.
10. Ensure that all aspects are in accordance with appropriate (AHJ) Authority Having Jurisdiction.

3.2 COMMISSIONING

A. The Contractor shall:

1. Include for testing and commissioning of the complete system(s) in accordance with IEC 60118-4:2006
2. Provide a method statement for testing and commissioning. Provide all necessary test equipment to complete the works, all test results to be fully recorded and copies provided with the Operation and Maintenance manuals.
3. Provide a minimum of 14 days' notice of all testing in order that a Client's representative may have reasonable option to attend and witness tests.
4. Provide operating instructions for all items of equipment and installed systems. Demonstrate all systems and methods of use to the end user.
5. Provide "As Installed" drawings and Operation and Maintenance manuals for all Hearing Loop Systems.
6. When carrying out commissioning tests, use a Field Strength measurement tool with a minimum specification as in section 7.2 above.
7. Issue Certificates of Conformity to IEC 60118-4:2006 that clearly state the results of testing and whether the system performance meets the relevant requirements of the standard.
8. Where the induction loops are to be installed prior to the driver/amplifier equipment, the loops shall be tested for continuity and for isolation from electrical ground and metal structures/containment. The Client shall have the opportunity to witness these tests which shall be recorded and documented.

3.3 TRAINING AND MAINTENANCE

- A. Training and instruction documentation shall be provided that enables operational staff to understand the proper use of the hearing loop system and how to ensure that people with TeleCoil or, T-Coil equipped hearing aids can make use of the system effectively.
- B. A test and maintenance schedule shall be provided.

MANSFIELD ELEMENTARY SCHOOL

- C. Training and instruction documentation shall be provided for operational staff such that they can use and perform regular functional tests on the system(s). This training shall include, but not be limited to, demonstrating the correct use of the test equipment and hearing loop drivers provided.

END OF SECTION 275126

SECTION 275313 – INTERCOMMUNICATIONS, PAGING AND CLOCK SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- A. Educational Specifications for the new Mansfield Elementary School – Revised on May 23, 2019. Contractor is responsible for obtaining this document and must provide a compliance review of all requirements during the bid process. All exceptions must be made in writing prior to bid submission. Contractor must comply with all requirements unless otherwise noted.
- B. The requirements in Section 26 00 00 and Section 26 05 00 shall also govern the work under this section.
- C. Examine all drawings and data and coordinate the work of this section with all related and adjoining work.
- D. Refer to the architect’s construction phasing plan. All work described in this section shall be coordinated with the phasing schedule.

1.2 GENERAL REQUIREMENTS

- A. Provide all equipment, accessories, and materials in accordance with these specifications and related documents to provide a complete and operating Public Address and Intercom System.
- B. The Public Address and Intercom System shall provide the school with state of the art technology for all Sound Systems specified. The system shall also provide telephonic features as specified once properly interfaced to a standard telephone system by others. The system shall be easy to learn and operate. All standard system programming shall be user friendly to allow the system administrator the ability to easily re-program station features.
- C. Provide complete and satisfactorily operating, Public Address and Intercom System as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers’ standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.
- D. Features offered by this system shall be implemented and controlled by software programs that can be changed and expanded as needs evolve.

MANSFIELD ELEMENTARY SCHOOL

- E. Interface the Public Address and Intercom System's battery backup power cord to an outlet in the MDF that is on the Emergency Generator.
- F. System Description:
 - 1. This Section includes requirements for programmable Public Address and Intercom System components including, but not limited to, the following:
 - a. Public Address and Intercom System head end.
 - b. Public Address and Intercom System Software.
 - c. Interface to Owners existing MITEL VOIP Telephone Solution (MITEL shall provide all peripheral devices for a loop start trunk interface).
 - d. Interface to Local Sound System(s).
 - e. Interface to Master Clock System.
 - f. Ceiling/Wall Mounted Speaker Assemblies with recess volume control
 - g. Administrative Intercom LCD Display Consoles.
 - h. Bell / Class Change Signaling System.
 - i. Public Address / Intercom System.
 - j. Controls, Amplifiers, and Terminal Equipment.
 - k. Power Supplies.
 - l. Battery Backup for System Programming.
 - m. Program Distribution System.
 - n. Audio Program Distribution.
 - o. Exterior Door Intercom System.
 - p. Accessories.
 - q. Miscellaneous Cabling.

1.3 SCOPE OF WORK

- A. The intent of this specification is to provide a Public Address and Intercom System. It is the responsibility of the contractor to supply a complete and properly operating Intercom system and properly interface with Clock System.
- B. The Public Address and Intercom System shall be located in the MDF all of the cabling infrastructure for this system shall be home run to this area. See the product section for the list of expansion cards relay board and cable assembly.
- C. All raceways, back boxes, and wiring required for the system are to be provided under this contract.

1.4 SUBMITTALS

- A. Submit complete shop drawings, data and samples in accordance with SECTION 01 33 00 SUBMITTALS.

- B. Submit all related Submittal information at one time.
 - 1. **SUBMIT ALL ITEMS IN A SPECIFICATION SECTION AT THE SAME TIME.** An incomplete submittal will be held until a complete submittal is accumulated, or may be rejected without further review and returned to the applicable parties. Include a copy of the Specification Paragraphs pertaining to the items submitted.

- C. Product Data: Specification Sheets shall be submitted on all items, including cable types. Submit catalog data sheets or other published materials showing appearances, electrical ratings characteristics and connection requirements, performance characteristics, dimensions, weights, installation methods, and space requirements of equipment and its accessories, as listed below and required by the individual paragraphs:
 - 1. Identification Methods
 - 2. Grounding and Bonding
 - 3. Electrical Connections for Equipment
 - 4. Supports and Supplementary Steel
 - 5. Electrical Identification
 - 6. Test Report Formats
 - 7. Test Equipment

- D. Shop Drawings: Submit shop drawings that indicate physical size and arrangement, (plans and elevations) construction details, provisions for conduits, access requirements for installation and maintenance, finishes, and materials used in fabrication. Supplement shop drawings with wiring diagrams and information as described under Product Data. Provide shop drawings as required by the individual paragraphs.

- E. Provide a Submittal Bill of Materials, with column headings that clearly identify the information requested herein for each and every item submitted.
 - 1. Each and every specification sheet submitted shall include a page number in the lower outside corner of the sheet. Double-sided specification sheets shall be identified by two (2) separate page numbers.
 - 2. On each and every specification sheet submitted, indicate the applicable part numbers (s) on the sheet (s) by one of the following methods:
 - a. Circling the applicable part number (s)
 - b. Placing an arrow next to the applicable part number (s)
 - c. Highlighting the applicable part number (s)

- F. The Submittal Bill of Materials Index/Equipment List column headings shall identify the following minimum information. Submittals must be submitted using the following “headings” in the order indicated from left-to-right on the Bill of Materials Index/Equipment List:
 - 1. All Bill of Material items shall be listed in the Bill of Material Index/Equipment List, in the same order as they appear in the specification.
 - 2. “Specification Section #”, reference specification section number/location that identifies each individual item, for every item specified and submitted.
 - a. Example of Specification Section number/location: 2.13, B., 7., c., 4), e)
 - 3. “Description” of each item
 - 4. Manufacturer’s “Name” for each item
 - 5. Manufacturer’s “Model #” for each item
 - 6. “Quantity” of each item being provided
 - 7. Submittal Page Number(s) of specification sheet(s) for each item

MANSFIELD ELEMENTARY SCHOOL

- G. Any submittal that does not include a submittal Bill of Materials, and provides a minimum of the information requested herein, shall be rejected without further review and returned to the applicable parties.
- H. Submittal shall include complete Specifications and all applicable addendums, including type of materials, electrical characteristics, capacities, performance, and power requirements, to determine compliance with Contract Documents. All data submitted, including wiring diagrams, shall be complete for all equipment, and shall apply only to this specific project. All extraneous material shall be deleted or marked out. Items to be supplied shall be specifically indicated, using a method that will be visible after photocopying.
- I. Maintain at the job site the latest equipment submittal showing the action taken by the Architect. Make this submittal available to Architect.
- J. Regardless of any information included in the submittal submitted for review, the requirements of the Drawings and Specifications shall not be superseded in any way by the review. Review by the Architect does not relieve responsibility for submittal errors or from meeting the requirements of the Contract Documents.
- K. It is intended that Submittal data be complete and accurate at the first submission. If the Submittal is returned marked "Resubmit" only one additional submission will be permitted.

1.5 QUALIFICATIONS

- A. The system shall be supplied by the manufacturer's authorized representative. Certification shall be submitted verifying that the contractor is the manufacturer's authorized representative. Included shall be certificates for attendance of manufacturer's installation / maintenance training by the contractor's directly employed personnel.
- B. The system assemblies shall be completely factory built and tested by manufacturers of established reputation, who have and can refer to similar systems which are currently installed and functioning properly. The factory pre-assembled cabinets, consoles, and power supplies shall be approved and listed by a National Recognized Testing Laboratory (NRTL) such as ETL or UL.
- C. The manufacturer's warranty shall be for a period of one year from the date of acceptance or first beneficial use, whichever is first, against defects in materials, workmanship, design and improper adjustment. Any defects in the system shall be corrected at no expense to the Owner, provided the system does not show signs of abuse. During the guarantee period any work found not to be in conformance with the plans, specifications and addenda shall be brought into conformity with same at no additional cost to the owner.
- D. The communications contractor shall furnish all equipment, accessories and material required for the installation of a comprehensive Intercom/Clock System in strict compliance with these specifications and applicable contract drawings. Any material and/or equipment, not specified or described herein necessary for the proper operation of the system shall be deemed part of this specification.

MANSFIELD ELEMENTARY SCHOOL

- E. The contractor shall make available, and maintain a service department capable of furnishing equipment inspection and timely service at the Owner's location. The contractor shall be prepared to offer a service contract for the maintenance of the system beyond the factory warranty period.
- F. The contractor shall instruct personnel designated by the owner in the proper use, basic care, and maintenance of the equipment. Such training shall be provided as an integral component of the system. These training sessions will be on both the general operation and basic programming of these systems.
- G. Training shall be provided on the project at the convenience of the owner in blocks of two hours, 6 hours total training.

1.6 OPERATIONS AND MAINTENANCE MANUALS:

- A. Provide 3 complete bound O&M manuals describing maintenance and operation of the system. Include descriptions and service data on all component parts. Manual shall also include the following:
 - 1. Warranty Statement indicating effective dates.
 - 2. Complete engineering data on all systems furnished including schematics of all equipment, shop drawings on all specially fabricated items, wiring diagrams of the system in its "as built" condition.
 - 3. Instructions on operational procedures, including standard and special codes and alarm or maintenance indications and procedures.
 - 4. All system programming information and forms.

1.7 EQUIPMENT WARRANTY

- A. The contractor shall warrant the equipment to be new and free from defects in material and workmanship, and will, within one year from date of installation, repair or replace any equipment found to be defective. This warranty shall not apply to any equipment that has been subject to misuse, abuse, negligence, accident, or unauthorized modification.

1.8 SUBSTITUTIONS

- A. Any system and/or equipment proposed as an equal to that specified must be proven to conform to the standards contained herein. The contractor must obtain the owners approval in writing, prior to bidding equipment other than that specified. The manufacturer's name, model numbers, and three (3) copies of shop/working drawings complete with catalog sheets, technical and installation data shall be submitted for approval.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturers:
 - 1. The Intercom System is accordingly the below manufacturer.
 - a. Bogen Multicom 2000 - Public Address and Intercom Systems
- B. The integrated communication and program clock system Bogen MULTICOM 2000, and BCMA wireless master clock. This specified system shall provide a comprehensive communication network between administrative and staff locations. The central processor and switching unit shall be of the modular plug-in printed circuit board type, using HMOS microprocessor and TTL logic and HCMOS memory and sensing. HCMOS circuitry shall be protected with transient suppression devices on all inputs and outputs. Nonvolatile EPROM shall store permanent memory and nonvolatile EPROM shall store field-programmable memory. System, which uses a battery to maintain system configuration information, shall not be acceptable.
- C. The system shall provide no less than the following features and functions: Telephonic communication, complete with DTMF signaling, dial tone, ringing and busy signals, and data display on administrative stations, shall use two wires (one is ground). Systems, which use more than two wires for communication, tones and data display shall not be acceptable.
- D. Amplified-voice communication with loudspeakers shall use a shielded audio pair. Loudspeakers shall have twenty-five (25) volt matching transformers. Any wattage tap (0.125 to 10) may be used, provided that the total rating of the internal classroom speakers not exceed 20 watts per 24 stations. Systems using 4 ohm speakers will not be accepted.
- E. There shall be provisions for individual amplification and circuit wiring, so that the corridor and external speakers are not wired together. (Each requiring a separate home run to the head end equipment)
- F. There shall be provisions for automatically overriding local sound systems so that any all call paging will have priority. (Gymnasium)
- G. The system shall be available in the following configurations: Wall-mounted in a custom enclosure. Station capacity shall be from 24 to 120 stations in increments of 24.
- H. Rack-mounted. Station capacity shall be from 24 to 840 stations in increments of 24. All telephone stations shall have the ability to support displays.
- I. The system shall consist of any combination of staff, enhanced staff, and administrative stations (minimum of administrative telephone required per system).
- J. Staff stations shall consist of wall clock speaker units or ceiling-mounted loudspeakers.

MANSFIELD ELEMENTARY SCHOOL

2.2 CEILING SPEAKER

- A. The speakers shall be 8" full range loudspeakers with recessed volume control / baffle combination. 6 oz nominal magnet weight, 7 watt continuous power, with matching dual 25/70 volt transformer. Transformer shall be capable of delivering at least 6 separate wattage taps from 1/8 watt to 4 watts. Quantity as shown on plans. NOTE provide booster amplifier for corridor speakers.
 - 1. Bogen S86t725PG8UVR
 - 2. Bridges TB8 and Enclosure RE84
 - 3. Bogen HTA-125 Amplifier for Corridor/Hallway speakers

2.3 WALL SPEAKERS

- A. Shall be 8" full range loudspeaker, Bogen MB8TSQ Enclosure. Quantity as shown on plans.

2.4 OUTDOOR WEATHERPROOF PAGING/PROGRAM SPEAKER

- A. Shall be surface mount moisture resistant type paging speakers for voice and tones with matching transformer. Quantity as shown on plans. Note - Provide booster amplifier for outside speakers.
 - 1. Surface mount BOGEN SPT-15A
 - 2. Flush mount FMH15t with enclosure
 - 3. Provide necessary amplifications as required.

2.5 MULTICOM 2000 BILL OF MATERIALS

- A. (1) MCRMF card cage
- B. (1) QSPC1 processor card
- C. (1) MC512 power supply
- D. (1) MC2626B power supply
- E. (5) MCRRP relay boards
- F. (5) MCACB voice amplified cards
- G. (1) MCSC station cards
- H. (1) MCTC Telephone Interface Card

2.6 EQUIPMENT CABINETS

- I. Manufacturer: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Chatsworth Products Inc.

2. Great Lakes
 3. Hubbell
 4. Middle Atlantic
 5. Approved equal.
- J. Free Standing Equipment Cabinets
1. Provide for PA/Intercom system plus additional systems as indicated on drawings.
 2. All rack-mountable equipment shall be installed utilizing tamper-proof screws into an equipment cabinet.
 3. Equipment Cabinets shall be seven feet (2134 mm) high, 24 inches (600 mm) wide, 31.5 inches (800 mm) deep, free standing cabinets as indicated on the drawings. Cabinet features shall include the following:
 - a. Cabinets shall be welded construction, steel or aluminum, piano-hinged doors with keyed locks and access handles on front and rear. Door locks shall be keyed alike. Color shall be approved by the Architect. Front door shall have integral shatter-proof vision panels in a metal frame. Rear door shall be steel with the upper half having ventilation louvers.
 - b. Integral EIA nineteen inch (518 mm) wide, four (4) post equipment rack. Rack shall be as described herein this specification. Rack shall be located within the cabinet in order to properly mount all passive and active electronic components.
 - c. Shelves for electronic equipment with load-carrying capacity to support at least 125 percent of each piece of electronic equipment weight. Shelves shall have adequate openings within them to dissipate heat and allow for adequate electronic equipment ventilation.
 - d. Mounting brackets (rails) shall be adjustable and specifically designed to support the equipment installed within the cabinet.
 - e. Hook and loop (Velcro) cable strain-relief system on rear of rack to support horizontal and backbone cables. Tie-wraps are specifically prohibited.
 - f. Hook and loop (Velcro) horizontal and vertical cable management on front of rack to support patch cable and cross-connect wiring. Tie-wraps are specifically prohibited.
 - g. Hook and loop (Velcro) cable management system independent of telecommunications cabling management to properly dress the electronic equipment power cords through the cabinet, maintaining as much clearance between the two as possible. Tie-wraps are specifically prohibited.
 - h. Integral fans and louvers to adequately ventilate the equipment within the cabinets. The individual cabinet shall have adequate ventilation in order to have a temperature within the cabinet be no greater than 88 degrees F based on an ambient room temperature of 78 degrees F in the warmer months of the year and 68 degrees F in the colder months of the year.
 - i. Bonding and grounding cables for all equipment not directly bolted to equipment rack (i.e. shelf mounted electronic equipment, etc.).
 - j. Bonding and grounding bus bar with individual set screw terminals for at least six #6 Cu. bonding cables.
 - k. Surge protected power strip as described in this specification.
 - l. Patch panels as described in this specification.
 - m. Blank/louvered panels, where required, to fill gaps between equipment within the rack.
 - n. All hardware, supplementary steel, channel and supports as required properly assembling the cabinet and securing it to the building structure.

MANSFIELD ELEMENTARY SCHOOL

4. All equipment cabinets and their hardware shall be properly assembled and match in appearance and shall be provided by the same manufacturer.

2.7 SURGE-PROTECTED POWER STRIPS

- A. Manufacturer: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Leviton #5500-192
 2. Great Lakes # 7219-20AR
 3. Approved equal.
- B. Surge-protected power strip shall be 19" rack-mount type.
- C. Surge protected power strip with six NEMA 5-20R outlets 20 amp capacity, 120 volts, UL 1449 listed, maximum surge current of 33,000 amps, clamping voltage of 260 volts, maximum 5 picoseconds response time, reset-able overload circuit breaker, surge suppression warning light, surge protection for line to neutral, line to ground, neutral to ground, EMI/RFI filters.
- D. Power cord shall have a NEMA 5, 20A twist lock plug.
- E. Provide a minimum of one (1) for cabinet installed.

2.8 BONDING AND GROUNDING JUMPER CABLE

- A. Refer to Division 26, Section 26 00 00 General Electrical.
- B. Provide proper cable and termination of Bonding and Grounding Jumper Cable to all Equipment Racks, Equipment Cabinets and other equipment.
- C. Manufacturer: Provide products meeting the requirements of the Drawings and Specifications from the following manufacturers or an approved equal:
- D. Belden (No. 8669)
- E. Jumper cable shall be hollow-braided, 60-amp capacity copper.
- F. Provide equal conductor as described in "B" above for aluminum equipment.
- G. Jumpers shall have compression or exothermic-type terminals on both ends of cables. Terminals shall be compatible with jumper cable material and equipment material in order to not have any degenerative reaction.

2.9 SYSTEM REQUIREMENTS, EQUIPMENT AND MATERIALS:

- A. Provide UPS for Public Address and Intercom System.
 1. APC Smart-UPS #SU SUA2200RM2U, or equal
 - a. Output Power Capacity: 1980 Watts / 2200 VA

- b. Nominal Output Voltage: 120V
- c. Output Voltage Distortion: Less than 5% at full load
- d. Output Frequency (sync to mains): 47 - 53 Hz for 50 Hz nominal, 57 - 63 Hz for 60 Hz nominal
- e. Waveform Type: Sine wave
- f. Output Connections: (2) NEMA 5-20R and (6) NEMA 5-15R
- g. Nominal Input: Voltage 120V
- h. Input Frequency: 50/60 Hz +/- 3 Hz (auto sensing)
- i. Input Connections: NEMA 5-20P
- j. Surge energy rating: 480 Joules
- k. Filtering: Full time multi-pole noise filtering: 0.3% IEEE surge let-through: zero clamping response time: compliant with UL 1449
- l. Regulatory Approvals: BSMI, CSA, UL 1778, FCC Part 15 Class A
- m. Interface Port(s): DB-9 RS-232, Management Interface Slot, USB
- n. Management interface: included
- o. Manufacturer's Warranty: 2 years repair or replace

2.10 CABLING AND INTERFACES TO OTHER SYSTEMS:

- A. Provide and terminate all cabling per manufacturers' recommendations for a completely operational system as specified.
- B. At all backbox locations, cables shall have a minimum 18" service loop coiled in backbox.
- C. Aiphone Video Intercom System Interface – Third party audio signal will be required to be reproduced system wide.
- D. Public Address And Intercom Systems Cabling and Interfaces:
 - 1. Sound/Speaker cabling shall be home-run and looped directly to applicable head end termination board, as specified. All cable runs shall be free from in-line splices. Insulate all cable shields (at field device end) from field grounds by cutting and taping shields.
 - a. Classroom speakers, office speakers, conference room speakers, work room speakers, exterior horn speakers, and others areas that have only one (1) public address speaker shall each be individually home-run, without splices, back to the Public Address/Intercom head end. Provide 22 AWG stranded shielded speaker cables.
 - b. Hallways and other areas that have multiple speakers may have a maximum of eight (12) speakers per speaker loop home-run, without splices, back to the PA/Intercom head end. Provide 18 AWG-stranded speaker cables.
 - c. Horn Speaker areas that have multiple speakers may have a maximum of four (4) speakers per speaker loop home run, without splices, back to the PA/Intercom head end. Provide 18 AWG-stranded speaker cables.
- E. Master Clock System Interface.
 - 1. Provide interface between Master Clock System and Public Address System to allow master clock class change schedules (tones or bells), to be broadcast over applicable public address speakers.
 - 2. Provide four (4) inputs on the Public Address System for interface to the Master Clock System.

3. The Master Clock System Contractor shall provide applicable interface cables between these two systems and interface to the Master Clock System.
 4. Public Address System Contractor shall provide applicable interface ports for the Public Address and Intercom Systems and provide proper interface/programming to their system.
 5. Once properly interfaced, the Master Clock class change schedules (tones or bells), shall be broadcast over applicable Public Address Speakers.
- F. Local Sound System Interface: Provide a 10dB balanced-audio, line-level output from the public address system to each local sound system rack/cabinet/amplifier for interface.
1. Public Address system Contractor shall provide all cabling and interface to the public address system.
 2. Local sound system Contractor shall interface cabling to the local sound systems to be used for muting of local sound systems audio during public address announcements or for interfacing public address audio to the local sound systems speakers.
- G. Fire Alarm System interface: provide and terminate a Cat 6 cable between the Public Address/Intercom System and the Fire Alarm Control Panel (FACP). Interface can be used to allow secondary annunciations of Fire Alarm Signals over the Public Address/Intercom System Speakers.
1. Fire Alarm system Contractor shall provide applicable interface ports on the Fire Alarm System for the Public Address/Intercom System and proper interface/programming to their Fire Alarm System.

2.10 DEVICES

- A. Type "IMS" - Provide PA/Intercom Master Station Console indicated on the drawings. Also, provide one (1) IMS unit at the Public Address, Intercom Systems head end; IMS unit shall be mounted on the outside of the rack/cabinet, which shall provide functions as scheduled below:
1. The associated digital display shall provide a 16-character display of numerals or letters.
 2. The unit shall be a multi-button console with industry standard Twelve-(12) button DTMF matrix keys.
 3. Provide built-in soft tone ringer with volume control.
 4. Instrument shall include "Last Number Redial" key to permit user to automatically redial most recently dialed number.
 5. Provide single button activation of the following features.
 - a. All-call paging button.
 - b. Zone page button
 - c. Class change signal button
 - d. Emergency evacuation signal button
 - e. Program (Music) distribution button.
 6. Program Distribution System
 - a. System shall provide the maximum capacity of function as stated herein.
 - b. School shall have the ability to provide selective programming.
 - c. The school shall be provided with a minimum of two (2) program channels, eight (8) time channels, sixteen (16) zone-page channels, and multiple linkage for telecommunications.
 - d. Time zones may be easily selected and easily accessed by designated administrative control units. A means of programming any or all loudspeakers for

the separate zone functions shall allow for easily arranging and rearranging zones. Simultaneous administrative control unit functions and channel programming shall in no way cause system interference.

- e. Capability for assigning speaker locations within any one or more of the zones for zone-paging or time signal reception; this assignment to be a programmable function. Systems without this feature will not be acceptable.
 - f. Time signal tones shall be generated throughout zone selected for time signaling over programmed loudspeakers on a manual or automatic basis.
 - g. Emergency tones shall be distributed from designated administrative control units.
 - h. All power amplifiers shall utilize 25-volt industry standard outputs to all public address and intercom speakers in the system, and shall meet all specifications exactly as specified herein, including power capacity and count. Power amplifiers shall also provide a minimum of 25-volt, half-watt power to all speaker locations, 15 watts of power to all horn-type speaker locations, plus 15% spare wattage for future expansion.
 - i. The system shall be equipped with one (1) rack-mounted AM/FM tuner, one (1) rack-mounted CD player and one (1) front-mounted monitor panel.
 - 1) A front-mounted monitor panel shall include: a back-lit digital readout that displays the time; a monitor speaker that permits these audio programs to be monitored before they are transmitted to classrooms or other locations; and a four-position monitor switch offering the following selections: send program; send/monitor program; monitor program only, and "OFF" position.
 - 2) See Electrical drawings and Technology riser for location of a dedicated roof-mounted, twin dipole, omni-directional FM Antenna shall be provided. Two half-wave dipole elements mounted 90 degrees to one another on the antenna mast give this antenna an omni-directional reception pattern. The antenna shall be supplied with the following accessories: connector cable, an 18" boom, vertical mounting bracket and horizontal mounting bracket. The Antenna shall be a Blonder Tongue FM Omni-Directional Antenna #BTY-2-FM.
 - j. Antenna location shall be determined by Architect.
7. Audio Program Distribution
- a. The system shall provide capability to distribute program material (i.e., music, CD player, radio broadcasts, etc.) to a room, multiple rooms, zone, or all zones serviced by the system speakers.
 - b. The system shall provide non-restrictive program-distribution channels.
 - c. The user shall cue remotely located music source or select radio station.
 - d. From an PA/Intercom Master Station Console or a properly interfaced telephone, the user can select the room(s) or areas to which to distribute program.
 - e. Systems that require manually operated switch-banks for distribution shall not be acceptable.

2.11 CLOCK SYSTEM

- A. Master Control Unit: Microprocessor based unit with solid-state switching circuits, program control and clock controls.
 - 1. The master clock shall be microprocessor based and programmable via a 16-pad waterproof, 20-character X 2 row LCD display, and 0.56-inch LED display. The master clock shall include frequency stability of 5 ppm and aging of 5 ppm per year. The master

clock shall have a frequency tuning circuit to allow for time base corrections with changes in temperature. The master clock shall also provide field enable/disable daylight savings time. The programmable master clock shall be capable of storing, in a non-volatile memory, and controlling up to 800 events (3,000 as option), each set with precise second resolution. Special programs shall be readily programmed for up to 255 different schedules and holidays, and 50 scheduling changes can be set in advance.

The master clock shall be capable of controlling two different clock systems simultaneously, in addition to RS485 input and output and two wire output for controlling Bogen RS485 and Bogen digital communication analog clocks. The master clock shall have a ten-year battery backup for timekeeping, an RS232 computer interface port, and an input port to interface with other systems and WWVB/GPS interface capability.

- a. Operating Voltage: 110/24 VAC, Two D batteries
- b. Time Base: Crystal Control
- c. Frequency Aging: 5 ppm/year
- d. Frequency Stability: 5 ppm/year
- e. Standby time keeping: 10 years
- f. Program retention: Non-volatile/unlimited
- g. Auxiliary circuits: 4 standard up to 12 maximum
- h. Interfaces: RS232, G.P.S./WWVB, Interface with other systems
- i. Mounting: Surface/semi-flush or rack
- j. Signal duration: 2 programmable signals per circuit, 1-3 sec. or on/off
- k. Size: EIA 19" Rack Mountable in racks as specified
- l. Options: Up to 12 auxiliary outputs; 3000 event capability.

B. Clocks: Analog synchronous clocks, with minute and second hands.

1. The secondary clock shall be a Bogen CAL series clock with field-selectable correction protocols. It shall be designed to be used in either a 2-wire, 3-wire or battery system with Bogen 2000 or 3000 series Master Clock. Bogen digital communication protocol. Upon receipt of the digital signal, the clock shall immediately selfcorrect. When a loss of the communication signal is detected, the clock shall move the second hand once every two seconds in two-second increments. The secondary clock shall also accept sync-wire communication protocols with hourly and daily correction. The secondary clock shall have a microprocessor-based movement and shall be capable of being used as a stand-alone clock. The clock shall have a low-profile/semi-flush smooth surface metal case. The crystal shall be shatterproof polycarbonate with no visible molding marks. Glass is unacceptable. The clock shall have black hour and minute hands and a red second hand. The clock shall have U.L., cUL, and F.C.C. compliances:
 - a. Time base: 60 Hz (three wire system)
 - b. Power Input: 85-135 VAC/60Hz; 7-28VAC/60Hz
 - c. Power Consumption: 15mA @ 110VAC; 20mA @ 24VAC
 - d. Correction: 10mA (current consumption)
 - e. Display: 12-hour format – hour, minute and second hand
 - f. Color: Standard Black
 - g. Clock Size: 12" diameter unless otherwise noted.
 - h. Case: Shallow profile smooth surface metal case
 - i. Crystal: Shatter-proof, side molded polycarbonate cry

PART 3 - EXECUTION

3.1 GENERAL

- A. The requirements of Part One and Part Two of the Specifications also apply to the execution of the work.
- B. Verify the exact location prior to bid of all items that may be indicated and determine exact location of all electrical items that are not indicated on the Drawings.
- C. Include the cost of all work in order to avoid work stoppages and jurisdictional disputes. The work shall conform to precedent agreements and decisions of record. Jurisdictional assignment shall be a responsibility under this Section's contractual obligation.
- D. Do not install equipment and materials that have not been reviewed by the Architect. Equipment and materials that are installed without the Architect's review, or without complying with comments issued with the review, shall be removed from the project when so instructed by the Architect. No payment will be made for unapproved equipment or materials, or removal if they are ordered removed. The Installer shall be responsible for any ancillary costs incurred because of its removal, and for the installation of the correct equipment and materials.
- E. At the start of construction, consult with the General Contractor and all Trades, and determine and verify the electrical characteristics of all equipment that is supplied under the Contract.
- F. Obtain detailed information on installation requirements from the manufacturers of all equipment to be furnished, installed, or provided. At the start of construction, check all Contract Documents, including all Drawings, and all Sections of the specifications, for equipment requiring electrical connections and service, and verify electrical characteristics of equipment prior to roughing.
- G. Request the General Contractor to provide, as soon as possible after approval, two copies of approved submittals of equipment that requires electric service, electric connections, or electric controls. Review these submittals for characteristics and return the submittals to the General Contractor, noting any non-agreement within two weeks of receipt.
- H. Equipment and systems shall not be installed without first coordinating the location and installation of equipment and systems with the General Contractor and all other Trades.
- I. Any and all material installed, or work performed, in violation of above requirements shall be re-adjusted and corrected by the Installer without charge.
- J. Refer to all Drawings associated with the project, prior to the installation or roughing-in of the electrical outlets, conduit, and equipment, to determine the exact location of all outlets.
- K. After installation, equipment shall be protected to prevent damage during the construction period. Openings in conduits and boxes shall be closed to prevent the entrance of foreign materials.

- L. Home runs indicated are not to be combined or reduced without written consent from the Architect.
- M. All connections to equipment shall be made as required, and in accordance with the approved submittal and setting drawings.
- N. Delivery, Storage, and Handling:
 - 1. Deliver, store, protect, and handle products in accordance with recommended practices listed in Manufacturer's Installation and Maintenance Manuals.
 - 2. Deliver equipment in individual shipping splits for ease of handling; mount on shipping skids and wrap for protection.
 - 3. Inspect and report concealed damage to carrier within specified time.
 - 4. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Provide heat enclosures to prevent condensation. Meet the requirements and recommendations of NFPA 70B and the Manufacturer. Location shall be protected to prevent moisture from entering enclosures and material.
 - 5. Handle products in accordance with NEMA and the Manufacturer's recommendations and instructions to avoid damaging equipment, installed devices, and finish.
 - 6. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the Manufacturer shall be required to brace the equipment suitably to ensure that the tilting does not impair the functional integrity of the equipment.
- O. Site Observation:
 - 1. Site observation visits will be performed randomly during the project by the Architect. Reports will be generated noting observations. Deficiencies noted on the site visit reports shall be corrected. All work shall comply with the Contract Documents, applicable Codes, regulations, and local Authorities, whether or not a particular deficiency has been noted in a site visit report.
 - 2. Be responsible to notify the Architect ten working days prior to closing-in work behind walls, raised access floors, ceilings, etc., so that installed work can be observed prior to being concealed.
 - 3. Work concealed prior to observation and correction of deficiencies shall be made accessible for review at the discretion of the Architect. Contractor shall bear all costs for reviewing work.
 - 4. Areas shall stay accessible until deficiencies are corrected and accepted. Notify the Architect when all deficiencies are corrected. Return reports with items indicated as corrected prior to re-observation by the Architect.
- P. Change Orders, Modifications, Revisions, and Directives:
 - 1. When change orders, modifications, revisions, or Architect's Directives are issued or authorized, provide the required additional material, equipment, personnel, and workers to prevent delays in the work, and to complete the work within the time limit of the Contract, unless a specific time extension is requested with the change and accepted. Include costs for expediting deliveries, where required.
 - 2. Requests for additional compensation shall be submitted broken down and associated by item, task and Drawing, or sketch number, with material and labor costs, so that quantities can be easily verified.

3. Requests shall be properly and adequately identified so the scope of work can be clearly determined. Indicate who originated change in work.
4. Cost breakdowns shall be submitted complete with backup for material and labor units and costs. Backup shall consist of actual vendor invoices or quotes, or from well-known national organizations such as R.S. Means Company, National Trade Service, Union labor rates or approved equal. Installing firm's in-house standard database for labor units may be used if consistent with the national organizations.
5. Submit on all credits, broken down as requested for adds. Credits shall be separately identified and accounted for. Do not indicate as net changes with adds.
6. Unit costs for labor and material shall be equal for adds, deletes and credits.

3.2 EQUIPMENT CABINETS

- A. Securely mount freestanding and wall-mounted equipment racks and cabinets to the building structure. Equipment racks shall be secured to the building structure at the top and bottom of the rack. 3/8" lag screws and expansion anchors shall be used. Proper quantity of supports shall be utilized. Dry wall screws and other types of supports not specifically approved to support equipment are specifically prohibited. Submit mounting supports for approval before installation.
- B. Position racks, cabinets, and wall-mounted relay brackets in order to have minimum three-foot clearance for easy access. Equipment racks, cabinets, and relay brackets mounted on or against walls shall have three-foot clearance in front of deepest component. Free-standing equipment racks and cabinets shall have three-foot clearance in front and rear of deepest components. Provide clearance between free-standing equipment racks or cabinets and any other obstruction to allow access from front to rear of rack or cabinet for maintenance.
- C. The Electrical Contractor shall provide ladder rack over each rack and cabinet as required to facilitate a neat and orderly installation of cables, and to secure the top of the racks to the structure. Cables shall drop straight down to equipment racks. Ladder racks shall be secured to the structure at both ends, and connected together as required for a complete, contiguous installation. Utilize proper supports to support the ladder rack to the building structure, as well as the equipment rack and cabinet. Submit mounting supports for approval before installation.
- D. Install terminating components such as patch panels (UTP, Fiber optic), cable management, etc. into the racks, cabinets and wall-mounted relay brackets.
- E. Patch Panels: Mount patch panels onto the rack(s) in top-to-bottom fashion with the first patch panel mounted at the top of the rack. Uniquely label each patch panel according to the numbering convention outlined in the Labeling Section. Each port shall also have color-coded identifiers. Refer to details on the Drawings.
- F. Cable Management: All cables shall enter the wiring closet to within the equipment racks and/or brackets. Secure the bundle(s) to the rack strain relief and wire management behind the patch panels, and cross-connect block panels. Install horizontal and side-mounted vertical cable management panels and brackets for routing and management of patch cables. Maintain EIA/TIA and BICSI standards on bundling, supporting, and bend radii.

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- G. Once the cabling system has been installed and terminated, install all active components and surge-protected power strips into the racks, cabinets and wall-mounted relay brackets.
- H. Surge-Protected Outlet Strips: Mount UPS and surge-protected outlet strips per Manufacturer's directions. Refer to details on the Drawings for mounting location.

3.3 INSTALLATION

- A. Provide all required labor and materials to wire, mount and install all equipment specified within this specification and as shown on drawings.
- B. Intercom system supplier shall provide minimum of 6 hours of in-service training.
- C. Intercom system supplier shall provide minimum of one year warranty to cover all hardware and software.
- D. Intercom system supplier shall provide with bid, documentation and certificates showing staff associated with this project have completed factory training on all systems.

3.4 SERVICE FACILITIES

- A. The contractor shall make available, and maintain a satisfactory service department capable of furnishing equipment inspection and service. The contractor shall be prepared to offer a service contract for the maintenance of the system beyond the warranty period.

3.5 TESTING AND TRAINING:

- A. Upon completion of the installation the contractor shall test each room station speaker, handset or call switch for proper operation. All consoles, programming and functions are to be tested for proper operation. All emergency and program functions are to be tested. Any malfunction shall be corrected prior to final acceptance.
- B. Operational guidelines shall be given in written form in sufficient numbers so that all key personal have operational instructions for programming, use and special features. Copies of these instructions shall be provided for permanent record in the operations and maintenance manuals specified herein.

END OF SECTION 275313

SECTION 281300 - ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

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. Section Includes:
 - 1. Security access controllers connected to high-speed electronic-data transmission network.
- B. Related Requirements:
 - 1. Section 281500 "Access Control System Hardware Devices" for access control system hardware, such as keypads, card readers, and biometric identity devices.

1.3 DEFINITIONS

- A. Credential: Data assigned to an entity and used to identify that entity.
- B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- D. Location: A Location on the network having a workstation-to-controller communications link, with additional controllers at the Location connected to the workstation-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
- E. Workstation: Personal computer. Applies to the central station, workstations, and file servers.
- F. RAS: Remote access services.
- G. RF: Radio frequency.
- H. ROM: Read-only memory. ROM data are maintained through losses of power.
- I. TCP/IP: Transport control protocol/Internet protocol.

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- J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.
- K. WMP: Windows media player.
- L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Diagrams for cable management system.
 - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
 - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
 - 4. Cable Administration Drawings: As specified in "Identification" Article.
 - 5. Battery and charger calculations for central station, workstations, and controllers.
- C. Product Schedules.
- D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Workstation operating system documentation.
 - 2. Workstation installation and operating documentation, manuals, and software for the workstation and all installed peripherals. Software shall include system restore,

emergency boot diskettes, and drivers for all installed hardware. Provide separately for each workstation.

3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on [USB] [cloud] media of the hard-copy submittal.
4. System installation and setup guides with data forms to plan and record options and setup decisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 1. Cable installer must have on staff an RCDD certified by Building Industry Consulting Service International.
- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Central Station, Workstations, and Controllers:
 1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
 2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
 3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
 4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.10 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
 2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor

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environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

3. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

PART 2 - PRODUCTS

2.1 ACCESS CONTROL SYSTEM SOFTWARE

- A. Products: Subject to compliance with requirements, provide the following:
 1. S2 Enterprise Product (S2 Security Corporation) - Software Version 5.2.2 with Node Revision 169 Access Control System Software (existing school system)
 2. The system software is sole source and no substitution is allowed.
- B. Contractor to integrate all new controllers and field devices into the existing campus Access Control Software. Programming shall comply with Mansfield Elementary School standard naming conventions and system functions.

2.2 SURGE AND TAMPER PROTECTION

- A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.
 1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
- B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

2.3 CONTROLLERS

- A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation.
- B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.

- C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.
- D. Entry-Control Controller:
 - 1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.
 - a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
 - b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
 - 1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
 - 2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.
 - c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
 - 2. Inputs:
 - a. Data from entry-control devices; use this input to change modes between access and secure.
 - b. Database downloads and updates from the central station that include enrollment and privilege information.
 - 3. Outputs:
 - a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
 - b. Grant or deny entry by sending control signals to portal-control devices.
 - c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.
 - d. Door Prop Alarm: If a portal is held open for longer than time listed in a schedule, alarm sounds.
 - 4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
 - 5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
 - a. Store up to 10,000 card and 25,000 event transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.
 - 6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.
 - a. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.

- b. Backup Power-Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.
- c. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
 - 1) Trouble Alarm: Normal power-off load assumed by battery.
 - 2) Trouble Alarm: Low battery.
 - 3) Alarm: Power off.

2.4 DOOR HARDWARE INTERFACE

- A. Exit Device with Alarm: Operation of the exit device shall generate an alarm. Exit device and alarm contacts are specified in Section 087100 "Door Hardware."
- B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Section 087100 "Door Hardware."
- C. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Section 087100 "Door Hardware."

2.5 TRANSFORMERS

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to workstations, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.

- B. Comply with TIA 606-C, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.
 - 1. Record setup data for control station and workstations.
 - 2. For each Location, record setup of controller features and access requirements.
 - 3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
 - 4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
 - 5. Assign action message names and compose messages.
 - 6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
 - 7. Prepare and install alarm graphic maps.
 - 8. Develop user-defined fields.
 - 9. Develop screen layout formats.
 - 10. Propose setups for guard tours and key control.
 - 11. Discuss badge layout options; design badges.
 - 12. Complete system diagnostics and operation verification.
 - 13. Prepare a specific plan for system testing, startup, and demonstration.
 - 14. Develop acceptance test concept and, on approval, develop specifics of the test.
 - 15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.3 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-C.
- B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- C. At completion, cable and asset management software shall reflect as-built conditions.

3.4 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
 - 1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
 - 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.6 PROTECTION

- A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."
- B. Develop separate training modules for the following:
 - 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
 - 2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
 - 3. Security personnel.
 - 4. Hardware maintenance personnel.
 - 5. Corporate management.

END OF SECTION 281300

SECTION 281353.10 - VIDEO INTERCOM 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. Section Includes
 - 1. IP Video Intercom. (Aiphone IX Series)
- B. Related Requirements:
 - 1. Section 281500 "Access Control System Hardware Devices" for access control system hardware, such as card readers and door position switches.

1.3 SYSTEM DESCRIPTION

- A. IP Network Compatible Video Intercom System: A network-based communication and security system featuring video entry security, internal communication, emergency stations, and paging. All units and app in the systems shall be able to unlock doors remotely on a network, assist onsite visitors from an offsite location, broadcast emergency announcements, and communicate using a PoE network.
 - 1. Power Source: Power over Ethernet (802.3af).
 - 2. Network Interface: 10 BASE-T / 100 BASE-TX Ethernet (RJ-45).
 - 3. Network Protocols: IPv4, IPv6, TCP, UDP, SIP, HTTP, HTTPS, MJPEG, RTSP, RTP, RTCP, IGMP, MLD, SMTP, DHCP, NTP, DNS.
 - 4. Bandwidth Usage:
 - a. G.711: 64Kbps x 2 per video call.
 - b. 4Kbps per monitor.
 - c. H.264: 24Kbps ~ 2,048Kbps.
 - 5. Communication: Hands-free (VOX), push-to-talk (simplex), or handset (full-duplex).
 - 6. Video Display: 7 inch color LCD.
 - 7. Camera: Type:
 - a. 1/3 inch color CMOS. 1.23 Megapixels.
 - b. View Area at 0 degree camera angle mounted at 4 feet 11 inches (1500 mm) AFF: 2 feet 3 inches (700 mm) vertical x 3 feet 9 inch (1150 mm) horizontal at 19 inches (500 mm).
 - 8. Video Stream: ONVIF Profile S.
 - 9. Door Release: Programmable Form C dry contact, 24V AC/ DC, 500mA (use RY-24L for larger contact rating, which requires 24V DC power supply) or use RY-IP44 with 4 multipurpose relays.
 - 10. Wire Type: CAT-6.

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11. Distance:
 - a. Any station to Network Node: 330 feet (100 meters).

1.4 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- B. Shop Drawings: Submit the following:
 1. Wiring Diagrams: Indicate wiring for each item of equipment and interconnections between items of equipment.
 2. Include manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
- C. Installation and Operation Manuals:
 1. Submit manufacturer's installation and operation manual, including operation instructions and component wiring diagrams.
 2. Provide detailed information required for Owner to properly operate equipment.
- D. Warranty: Submit manufacturer's standard warranty.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001:2015 certified company.
- B. Installer Qualifications: Factory trained and experienced with system installations of scope and size required for the Project.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
- C. Handling: Protect materials during handling and installation to prevent damage.

1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Aiphone Corp., which is located at: 6670 185th Ave. NE; Redmond, WA 98052 ; Toll Free Tel: 800-692-0200; Tel: 425-455-0510; Fax: 425-455-0071; Email: request info (marketing@aiphone.com); Web: http://www.aiphone.com
- B. Requests for substitutions will be considered in accordance with provisions of Section 016000 - Product Requirements.
- C. IP Video Intercom System: IX Series Intercom System as manufactured by Aiphone Corporation.

2.2 SYSTEM DESIGN

- A. Provide Audio/video streaming via ONVIF Profile S.
- B. Provide ONVIF Profile S camera input (max 500).
- C. Provide Overhead paging.
- D. Provide Contact input at door station.

2.3 FUNCTIONAL COMPONENTS:

- A. Functional Components: As indicated on the drawings or as required to complete system.
 - 1. Audio Video Door Stations:
 - a. Model IX-DVF (Video Door Station – Flush Mount – Hands Free)
 - 2. Video Master Station Series IX-MV7:
 - a. Model IX-MV7-HB (Master Station - Black w/Handset).
 - b. An IP addressable video master station with a 7 inch color LCD monitor. It can be wall or desk mounted (desk stand included). The IX-MV7 offers handset (duplex) and hands-free (VOX/PTT) communication and call up to 500 other IX stations. It connects directly to a network using CAT-5e/6 cable. This station requires a 802.3af compliant Power-over-Ethernet network.
 - 3. IXW-MA IP Programmable Relay Adapter: Multi-purpose adaptor - PoE - screen only.
 - 4. Network Paging Adapter Model IX-PA:
 - a. Address book that supports up to 50 stations and can be connected to 3rd party devices. Can be accessed by an IX-MV7 master station or an instance of the IX Mobile App to allow messages to be broadcast through the IX-PA 600u or 8u output. A 3rd party device can be connected to the audio input to send messages to the paging adaptor address book.
 - 5. Stainless Steel Enclosure Model SBX-IDVF:
 - a. 18-Gauge Stainless Steel Surface Mount Box for IS-SS/IS-DVF/IS-IPDVF/IX-DF(SS)/IX-DF-HID/RP10 designed for surface mounting door stations.

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- b. Size: 10-7/16 inches x 5-15/16 inches x 3-5/16 inches (top); 2-5/16 inches (bottom) (265 mm x 151 mm x 84 mm (top); 59 mm (bottom).
- c. Weather resistant.
- d. Vandal-resistant.
- e. Inside space for cabling.
- f. Mounts to flat wall surface.
- g. Opening at bottom for drainage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive integrated security and communication system.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

- A. Verify the following compliance before starting installation.
 - 1. The unit turns inoperative during power failure.
 - 2. Keep the intercom wires at least 1 foot (30 cm) away from strong electrical wiring (AC 100-240 V) including, in particular, wiring for inverter electrical appliances. Noise and malfunction could result.
 - 3. If a strong light shines on the main unit screen, the picture may turn white or only silhouettes will be visible.
 - 4. Other manufacturer's devices (such as sensor, detectors, door releases) used with this system, comply with the manufacturer's installation requirements.
 - 5. The LCD panel is manufactured with very high precision techniques, inevitably will have a very small portion of its picture elements always lit or not lit at all. This is not considered a unit malfunction. Please be aware of this in advance.

3.3 INSTALLATION

- A. Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

3.4 SET-UP AND ADJUSTING

- A. Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

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3.5 DEMONSTRATION AND TRAINING

- A. Demonstration:
 - 1. Demonstrate that integrated security and communication system functions properly.
 - 2. Perform demonstration at final system inspection by qualified representative of manufacturer.

- B. Instruction and Training:
 - 1. Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
 - 2. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
 - 3. Provide instruction and training by qualified representative of manufacturer.

3.6 PROTECTION

- A. Protect installed integrated security and communication system from damage during construction.

END OF SECTION

SECTION 281500 - ACCESS CONTROL HARDWARE DEVICES

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. Section Includes:
 - 1. Access Control Panels
 - 2. Card Readers
 - 3. Door Position Switches
 - 4. Cables
 - 5. Transformers
- B. Related Requirements:
 - 1. Section 281300 "Access Control System Software and Database Management" for control and monitoring applications, workstations, and interfaces.

1.3 DEFINITIONS

- A. Credential: Data assigned to an entity and used to identify that entity.
- B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- D. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
- E. PC: Personal computer. Applies to the central station, workstations, and file servers.
- F. RAS: Remote access services.
- G. RF: Radio frequency.
- H. ROM: Read-only memory. ROM data are maintained through losses of power.

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- I. TCP/IP: Transport control protocol/Internet protocol.
- J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.
- K. WMP: Windows media player.
- L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Diagrams for cable management system.
 - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
 - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
 - 4. Cable Administration Drawings: As specified in "Identification" Article.
 - 5. Battery and charger calculations for central station, workstations, and controllers.
- C. Product Schedules.
- D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on USB media of the hard-copy submittal.
 - 2. System installation and setup guides with data forms to plan and record options and setup decisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. The extra materials shall not be permitted for reimbursement.
 - 1. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 - 1. Cable installer must have on staff an RCDD certified by Building Industry Consulting Service International.
- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
- B. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
- C. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
- D. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

MANSFIELD ELEMENTARY SCHOOL

1.10 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
 - 2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
 - 3. Outdoor Environment: NEMA 250, NEMA 250, Type 4 enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph.
 - 4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

PART 2 - PRODUCTS

2.1 OPERATION

- A. Security access system hardware shall use a single database for access-control and credential-creation functions.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70, "National Electrical Code."
- C. Comply with SIA DC-01 and SIA DC-03 and SIA DC-07.

2.3 ACCESS CONTROL PANEL

- A. Products: Subject to compliance with requirements, provide the following:
 - 1. S2 Enterprise Product (S2 Security Corporation);
 - a. S2 M1-3200 node
 - b. S2 MicroNode+
 - c. S2 Standard Node
 - 2. The system panels are sole source and no substitution is allowed.

2.4 CARD READERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. HID Global.
- B. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.
- C. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.
- D. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:
 - 1. Indoors, controlled environment.
 - 2. Indoors, uncontrolled environment.
 - 3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.
- E. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
- F. Touch-Plate and Proximity Readers:
 - 1. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
 - 2. The card reader shall read proximity cards in a range from direct contact to at least 6 inches from the reader.
 - 3. HID iCLASS SE R40 - standard wall-mount reader.
 - 4. HID iCLASS SE R15 – mullion-mount reader.
- G. Communication Protocol: Compatible with local processor.

2.5 CABLES

- A. General Cable Requirements: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and as recommended by system manufacturer for integration requirement.
- B. PVC-Jacketed, TIA 232-F.
 - 1. Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Polypropylene insulation.
 - 3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
 - 4. PVC jacket.
 - 5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with UL 1581.

- C. Plenum-Rated TIA 232-F Cables:
 - 1. Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PE insulation.
 - 3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
 - 4. Fluorinated ethylene propylene jacket.
 - 5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with NFPA 262.

- D. PVC-Jacketed, TIA 485-A Cables:
 - 1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. NFPA 70 Type: Type CM.
 - 6. Flame Resistance: Comply with UL 1581.

- E. Plenum-Rated TIA 485-A Cables:
 - 1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Fluorinated ethylene propylene insulation.
 - 3. Unshielded.
 - 4. Fluorinated ethylene propylene jacket.
 - 5. NFPA 70 Type: Type CMP
 - 6. Flame Resistance: NFPA 262, Flame Test.

- F. Paired, Plenum-Type, Reader Cables:
 - 1. Three pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum-foil/polypropylene-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.
 - 2. NFPA 70, Type CMP.
 - 3. Flame Resistance: NFPA 262 flame test.
 - 4. Six conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
 - 5. NFPA 70, Type CMP.
 - 6. Flame Resistance: NFPA 262 flame test.

- G. LAN Cabling:
 - 1. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

2.6 TRANSFORMERS

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA 606-C, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.3 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Install cables and wiring according to requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Install LAN cables using techniques, practices, and methods that are consistent with Category 5e rating of components and optical fiber rating of components, and that ensure Category 6 and optical fiber performance of completed and linked signal paths, end to end.
- E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

- F. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.4 CABLE APPLICATION

- A. Comply with TIA 569-E, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. between terminations.
- D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. between terminations.
- E. Card Readers:
 - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft..
 - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
 - 4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. between terminations.
- G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft. between terminations.

3.5 GROUNDING

- A. Comply with Section 270526 "Grounding and Bonding for Communications Systems."
- B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Bond shields and drain conductors to ground at only one point in each circuit.
- E. Signal Ground:
 - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
 - 2. Bus: Mount on wall of main equipment room with standoff insulators.
 - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

MANSFIELD ELEMENTARY SCHOOL

3.6 INSTALLATION

- A. Install card readers and door position switches.

3.7 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-C.
- B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, cable and asset management software shall reflect as-built conditions.

3.8 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use tester approved for type and kind of installed cable. Test for faulty connectors, splices, and terminations. Test according to TIA 568.1-E, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for balanced twisted-pair cables must comply with minimum criteria in TIA 568.1-E.
 - 2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated

MANSFIELD ELEMENTARY SCHOOL

battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.

3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
 1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."
- B. Develop separate training modules for the following:
 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
 2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
 3. Security personnel.
 4. Hardware maintenance personnel.
 5. Corporate management.

END OF SECTION 281500

MANSFIELD ELEMENTARY SCHOOL

SECTION 282000 - VIDEO SURVEILLANCE

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. Section includes a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.
- B. Related Requirements:
 - 1. Section 281300 "Access Control System Software and Database Management" to integrate access control system interface and control.
 - 2. Section 283100 "Intrusion Detection" to integrate video surveillance used for intrusion detection.

1.3 DEFINITIONS

- A. AGC: Automatic gain control.
- B. BNC: Bayonet Neill-Concelman - type of connector.
- C. B/W: Black and white.
- D. CCD: Charge-coupled device.
- E. FTP: File transfer protocol.
- F. IP: Internet protocol.
- G. LAN: Local area network.
- H. MPEG: Moving picture experts group.
- I. NTSC: National Television System Committee.
- J. PC: Personal computer.
- K. PTZ: Pan-tilt-zoom.
- L. RAID: Redundant array of independent disks.

MANSFIELD ELEMENTARY SCHOOL

- M. TCP: Transmission control protocol - connects hosts on the Internet.
- N. UPS: Uninterruptible power supply.
- O. WAN: Wide area network.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. VMS network storage calculations.
- C. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
 - 2. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
 - 3. Wiring Diagrams: For power, signal, and control wiring.
- D. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Product Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
 - 2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
 - 1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
- B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NECA 1.
- C. Comply with NFPA 70.

- D. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

2.3 CAMERAS

- A. Products: Subject to compliance with requirements, provide the following:
 - 1. Axis Communications
 - a. Indoor 8 MP multidirectional network camera shall be Axis P3717-PLE.
 - b. Outdoor 1080p PTZ network camera shall be Axis P5655-E.
 - 2. Axis Communications solution is sole source and no substitution is allowed.
- B. Indoor 8 MP multidirectional network camera
 - 1. The network camera shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
 - b. The camera shall be equipped with four progressive scan megapixel sensors.
 - c. The camera shall provide automatically removable IR-cut filter, providing day/night functionality.
 - d. The camera shall provide flexible positioning of four varifocal camera heads.
 - e. The camera shall provide the following field of view:
 - 1) 4x 1080p
 - 2) Horizontal: 96° - 49°
 - 3) Vertical: 53° - 27°
 - 4) Diagonal: 113°-55°
 - f. The camera shall provide motorized focus and zoom functionality.
 - g. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - h. The camera shall be manufactured with an IP66-, NEMA 4X- and IK09-rated Die-casted aluminum casing.
 - i. The camera shall provide:
 - 5) 1. Pan $\pm 90^\circ$
 - 6) Tilt 5° - 65°
 - 7) Rotate 5° - 95°
 - 8) Twist $\pm 20^\circ$
 - 2. The network camera shall meet or exceed the following performance specifications:
 - a. Illumination
 - 1) The camera shall meet or exceed the following illumination specifications:
 - a) 0.17 lux in color
 - b. Resolution
 - 1) The camera shall be designed to provide 4x video streams in HDTV 1080p (1920x1080) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.
 - 2) The camera shall support video resolutions including:
 - a) 1920x1080 (HDTV 1080p)
 - b) 1280x720 (HDTV 720p)
 - 3) The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

c. Encoding

- 1) The camera shall support the following video encoding algorithms:
 - a) Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second in all resolutions.
 - b) Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - c) Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - d) Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
 - e) Support H.264 with automatic scene adaptive bitrate control in up to 25/30 frames per second.
- 2) The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
- 3) The camera shall in H.264 support combining Average Bit Rate (ABR) and Maximum Bit Rate (MBR)
- 4) The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
 - a) The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.
- 5) The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate budget over the whole retention time.
- 6) The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly above the configured average bitrate during significant parts of the retention time.
 - a) The camera shall in H.264 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.
 - b) When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
 - c) The camera shall in H.264 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same basic stream parameters.
 - d) When using Average Bit Rate (ABR), the camera shall in H.264 support multiple parallel stream with independent ABR-history.
 - e) The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
 - unrealistic
 - not fulfilling basic quality requirements
 - not fulfilling the bitrate budget
- 7) The camera shall provide configurable compression levels.
- 8) Support standard baseline profile H.264 with motion estimation.
- 9) Support motion estimation in H.264/MPEG-4 Part 10/AVC.
- 10) The camera shall for its H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.

- d. Transmission
 - 1) The camera shall allow for video to be transported over:
 - a) HTTP (Unicast)
 - b) HTTPS (Unicast)
 - c) RTP (Unicast & Multicast)
 - d) RTP over RTSP (Unicast)
 - e) RTP over RTSP over HTTP (Unicast)
 - 2) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- e. Image
 - 1) The camera shall incorporate automatic and manual white balance.
 - 2) The camera shall incorporate forensic wide dynamic range functionality.
 - 3) The camera shall incorporate an electronic shutter operating in the range of:
 - a) 1/32500 s to 2 s with 50 Hz
 - b) 1/32500 s to 2 s with 60 Hz
 - 4) The camera shall incorporate capture mode with the following settings:
 - a) HDTV 1080p 25/30 fps
 - 5) The camera shall support manually defined values for:
 - a) Saturation
 - b) Contrast
 - c) Sharpness
 - d) Brightness
 - 6) The camera shall incorporate a function for optimization of low light behavior.
 - 7) The camera shall allow for rotation of the image in steps of 90°.
 - 8) The camera shall incorporate local contrast functionality.
- f. Audio
 - 1) The camera shall support two-way audio connectivity via portcast technology with an accessory audio and I/O interface device.
- g. User Interface
 - 1) Web server
 - a) The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b) Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services, such as Verisign, Inc.
 - 2) Language Specification
 - a) The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
 - 3) IP addresses
 - a) The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b) The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c) The camera shall provide support for both IPv4 and IPv6.

- h. Event functionality
 - 1) The camera shall be equipped with an integrated event functionality:
 - a) Detectors functionality
 - 2) Video motion detection
 - a) Hardware functionality
 - b) Input Signal functionality
 - 3) Manual trigger / virtual Inputs
 - 4) Live stream accessed
 - 5) Camera tampering
 - a) Storage functionality
 - b) System functionality
 - 6) Embedded third-party applications
 - 7) Edge storage fail-over recording detection
 - a) Time functionality
 - 8) Scheduled time
 - 9) Response to triggers shall include:
 - a) Send notification, using FTP, HTTP, HTTPS, SFTP, network share or email
 - b) Send images, using FTP, HTTP, HTTPS, SFTP, network share or email
 - c) Send video clip, using FTP, HTTP, HTTPS, SFTP, network share or email
 - d) Recording to local storage and/or network attached storage
 - e) Day and night mode
 - f) Overlay Text
 - g) Status LED
 - 10) The camera shall provide memory for pre & post alarm recordings.
- i. Edge storage
 - 1) The camera shall support continuous and event controlled recording to:
 - a) Local memory added to the cameras SD-card slot
 - b) Network attached storage, located on the local network
 - 2) The camera shall incorporate encryption functionality for the SD card.
 - 3) The camera shall be able to detect and notify edge storage disruptions.
- j. Protocol
 - 1) The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, LLDP, MQTT.
 - 2) The SMTP implementation shall include support for SMTP authentication.
- k. Text overlay
 - 1) The camera shall:
 - a) Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - b) Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
 - c) Provide the ability to manually set up and configure privacy masks to the image.
 - d) Allow for the overlay of a graphical image, such as a logotype, into the image.

1. Security
 - 1) The camera shall support the following:
 - a) Secure web browsing
 - 2) The use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - 3) Restrict access to the built-in web server by usernames and passwords at three different levels.
 - a) Certificate management
 - 4) Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 - a) Enhanced security features
 - 5) The use of signed firmware validates the firmware's integrity before accepting to install it.
 - 6) The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
 - a) Authentication
 - 7) IEEE 802.1x (EAP-TLS) authentication.
 - 8) Restrict access to pre-defined IP addresses, commonly known as IP address filtering.
 - a) Brute force delay protection
 - 9) Firmware support
 - a) The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
 - b) The device should maintain high-level cybersecurity without introducing any significant functional changes or affecting any existing integrations.
- m. API support
 - 1) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.
 - 2) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
 - 3) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
- n. Embedded applications
 - 1) The camera shall provide a platform allowing the upload of third-party applications into the camera.
- o. Installation and maintenance
 - 1) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 - 2) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 - 3) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.

- 4) The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 - 5) The camera shall provide remote zoom and remote focus functionality.
 - 6) The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 - 7) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- p. Access log
- 1) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 - 2) Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- q. Camera diagnostics
- 1) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 - 2) The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 - 3) The camera shall send a notification when the unit has re-booted and all services are initialized.
- r. Hardware interfaces
- 1) Network interface
 - a) The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Ethernet-port, using a standard male RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 - 2) Inputs/Outputs
 - a) The camera shall provide I/O connectivity via portcast technology with an accessory audio and I/O interface device.
 - 3) Audio
 - a) The camera shall provide audio connectivity via portcast technology with an accessory audio and I/O interface device.
- s. Enclosure
- 1) The camera shall:
 - a) Be manufactured with an IP66-, IP67-, NEMA 4X- and IK09-rated impact-resistant, repaintable aluminium and plastic casing.
 - b) Be fitted with polycarbonate hard-coated dome with PC/ASA sunshield.
- t. Power
- 1) Power over Ethernet IEEE 802.3af/802.3at Type 2 Class 4
 - a) IR illumination on: class 4, typical 11.1 W, max 17.0 W
 - b) IR illumination off: class 3, typical 8.6 W, max 11.0 W
- u. Environmental
- 1) Operate in a temperature range of -30 °C to +50 °C (-22 °F to 112 °F).

- 2) Operate in a humidity range of 10–100% RH (condensing).

C. Outdoor 1080p PTZ network camera

1. The specified product shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source and Linux-based platform, and include a built-in web server.
 - b. The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.
 - c. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - d. The camera shall be equipped with a varifocal 4.3-137.6 mm lens with autofocus and auto-iris.
 - e. The camera shall be equipped with a motorized 32x optical zoom lens, providing a horizontal field of view between 58.7 and 2.4 and a vertical field of view between 35.7 and 1.4.
 - f. The camera shall be manufactured with a repaintable metal casing.
 - g. The camera shall provide local video storage utilizing a SD/SDHC/SDXC memory card expansion.
 - h. The camera shall be manufactured with an UV-resistant IP66 and NEMA 250 4X and IK10-rated aluminum enclosure.
2. The specified product shall meet or exceed the following performance specifications:
 - a. Resolution
 - 1) The camera shall be designed to provide video streams in HDTV 1080p (1920x1080) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264, H265 or Motion JPEG.
 - 2) The camera shall support video resolutions including:
 - a) 1920x1080 (16:9, HDTV 1080p)
 - b) 1280x720 (16:9, HDTV 720p)
 - c) 800x450 (16:9)
 - d) 480x270 (16:9)
 - e) 320x180 (16:9)
 - 3) The camera shall provide landscape format as well as the possibility to adjust the image to stream in corridor format.
 - b. Encoding
 - 1) The camera shall provide independently configured simultaneous H.264, H.265 and Motion JPEG streams.
 - 2) The camera shall provide configurable compression levels.
 - 3) The camera shall support standard baseline profile with motion estimation.
 - 4) The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
 - 5) The camera shall support the following video encoding algorithms:
 - a) Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second.
 - b) Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second.
 - c) Main Profile H.264 and H.265 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 50/60 frames per second.
 - d) High Profile H.264 encoding with motion estimation up to 50/60 frames per second.

- 6) The camera shall in H.264 and H.265 support combining Average Bit Rate (ABR) and Maximum Bit Rate (MBR)
 - 7) The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
 - a) The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.
 - The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate budget over the whole retention time.
 - The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly above the configured average bitrate during significant parts of the retention time.
 - b) The camera shall in H.264 and H.265 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.
 - c) When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
 - d) The camera shall in H.264 and H.265 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same basic stream parameters.
 - e) When using Average Bit Rate (ABR), the camera shall in H.264 and H.265 support multiple parallel stream with independent ABR-history.
 - f) The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
 - unrealistic
 - not fulfilling basic quality requirements
 - not fulfilling the bitrate budget
 - 8) The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage:
 - a) Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - b) Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
 - c) Automatic dynamic Frames per Second to lower bandwidth and storage requirements
- c. Transmission
- 1) The camera shall allow for video to be transported over:
 - a) HTTP (Unicast)
 - b) HTTPS (Unicast)
 - c) RTP (Unicast & Multicast)
 - d) RTP over RTSP (Unicast)
 - e) RTP over RTSP over HTTP (Unicast)
 - f) SRTP (Unicast & Multicast)
 - 2) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.

- d. Image
 - 1) The camera shall incorporate automatic and manual white balance.
 - 2) The camera shall incorporate an electronic shutter operating in the range of 1/66500s to 2s.
 - 3) The camera shall incorporate capture mode with the following settings:
 - a) HDTV 1080p (1920x1080) with WDR: 25/30 fps (50/60 Hz)
 - b) HDTV 1080p (1920x1080) without WDR: Up to 50/60 fps (50/60 Hz)
 - 4) The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
 - 5) The camera shall support manually defined values for:
 - a) Saturation
 - b) Brightness
 - c) Sharpness
 - d) Contrast
 - 6) The camera shall incorporate a function for optimization of low light behavior at different light levels.
 - 7) The camera shall incorporate a function for optimization of low light behavior.
 - 8) The camera shall allow for rotation of the image in steps of 90°.
 - 9) The camera shall allow for rotation of the image.
 - 10) The camera shall incorporate a function for Electronic Image Stabilization (EIS) for real-time image stabilization.
 - 11) The camera shall incorporate automatic defog functionality.
- e. Audio
 - 1) The camera shall support two-way full duplex audio:
 - a) Input sources
 - External microphone
 - External line device
 - b) Output sources
 - External line device
 - 2) The camera shall support automatic gain control.
 - 3) Encoding
 - a) The camera shall support:
 - AAC LC at 8/16/32/48 kHz
 - 24-bit LPCM 48 kHz
 - G.711 PCM at 8 kHz
 - G.726 ADPCM at 8 kHz
 - Opus at 8/16/48kHz
- f. User Interface
 - 1) Web server
 - a) The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b) Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services.

- 2) Language Specification
 - a) The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
- 3) IP addresses
 - a) The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b) The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
 - c) The camera shall provide support for both IPv4 and IPv6.
 - d) The camera shall provide support for IPv6 USGv6.
- g. PTZ functionality
 - 1) The camera shall:
 - a) Provide more than 255 manually set preset positions.
 - b) Provide On-screen directional indicator (OSDI) functionality.
 - c) Be equipped with accurate pan and tilt functionality with a range of:
 - Pan: 360 endless
 - Tilt 180
 - d) Provide pan and tilt speed in a range of:
 - Pan: 0.1 - 350/sec
 - Tilt: 0.1 - 350/sec
 - e) Provide optical and digital zoom functionality:
 - Optical zoom: 32x
 - Digital zoom: 12x
 - Total 384x zoom
 - f) Provide a guard tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.
- h. Event functionality
 - 1) The camera shall be equipped with an integrated event functionality:
 - a) Device status
 - Operating temperature
 - Fan
 - IP address
 - Network lost
 - Shock detection
 - Storage failure
 - System ready
 - b) Edge storage
 - Recording ongoing
 - Storage disruption
 - c) I/O
 - Digital input
 - Manual trigger
 - Virtual inputs

- d) PTZ
 - Malfunctioning
 - Movement
 - Preset position reached
 - Ready
- e) Scheduled and recurring
- f) Video
 - Day-night mode
 - Live stream open
- 2) Response to triggers shall include event actions:
 - a) Record video: SD card and network share
 - b) Upload of images and video clips: FTP, SFTP, HTTP, HTTPS, email or network share
 - c) Send notification: email, HTTP, HTTPS, TCP
 - d) Start/stop guard tour
 - e) Overlay text
 - f) Play audio clip
 - g) Day-night mode
 - h) Toggle I/O
 - i) Go to preset positions
 - j) Prioritized text
 - k) Send SNMP trap message
 - l) Toggle WDR mode
- i. Edge storage
 - 1) The camera shall support continuous and event controlled recording to:
 - a) Local memory added to the cameras SD-card slot
 - b) Network attached storage, located on the local network
 - 2) The camera shall incorporate encryption functionality for the SD card.
 - 3) The camera shall be able to detect and notify edge storage disruptions.
- j. Protocol
 - 1) The camera shall incorporate support for at least IPv4, IPv6 USGv6, HTTP, HTTP/2, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SRTP, TCP, UDP, IGMP, RTCP, ICMP, DHCPv4/v6, ARP, SOCKS, SSH, NTCIP, LLDP, CDP, MQTT, Syslog.
 - 2) The SMTP implementation shall include support for SMTP authentication.
- k. Text overlay
 - 1) The camera shall:
 - a) Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - b) Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
 - c) Provide the ability to manually set up and configure privacy masks to the image.
 - d) Allow for the overlay of a graphical image, such as a logotype, into the image.

1. Security
 - 1) The camera shall support the following:
 - a) Secure web browsing
 - The use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - Restrict access to the built-in web server by usernames and passwords at three different levels.
 - b) Certificate management
 - Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 - c) Enhanced security features
 - The use of signed firmware validates the firmware's integrity before accepting to install it.
 - The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
 - d) Authentication
 - IEEE 802.1X authentication.
 - Restrict access to pre-defined IP addresses, commonly known as IP address filtering.
 - e) Brute force delay protection
 - 2) Long-Term Supported (LTS) firmware
 - a) The manufacturer must provide LTS firmware that only contains corrections for critical bugs, security flaws and performance issues.
 - b) The device should maintain cybersecurity without introducing any significant functional changes or affecting any existing integrations.
- m. API support
 - 1) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.
 - 2) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
 - 3) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
- n. Embedded applications
 - 1) The camera shall provide a platform allowing the upload of third-party applications into the camera.
- o. Installation and maintenance
 - 1) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 - 2) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 - 3) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.

- 4) The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 - 5) The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 - 6) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- p. Access log
- 1) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 - 2) The camera shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- q. Camera diagnostics
- 1) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 - 2) The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 - 3) The camera shall send a notification when the unit has rebooted and all services are initialized.
- r. Hardware interfaces
- 1) Network interface
 - a) The camera shall be equipped with one 10BASE-T/100BASE-TX Ethernet-port using an RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 - 2) Inputs/Outputs
 - a) The camera shall be equipped with four configurable I/O ports, accessible via a removable terminal block. These inputs/outputs shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts. The output shall be able to provide 12 V DC, 50 mA.
 - 3) Audio
 - a) The camera shall be equipped with one 3.5 mm jack for line/mic input and one 3.5 mm jack for line output.
 - 4) Power
 - a) The camera shall be equipped with an I/O connector for DC or AC input.
- s. Enclosure
- 1) The camera shall:
 - a) Be manufactured with an IP66-, NEMA250 4X- and IK10-rated aluminum enclosure.
- t. Power
- 1) The camera shall provide power over Ethernet IEEE 802.3at Type 2 Class 4
 - a) Max: 19 W

- b) Typical: 10.5 W
 - 2) 20 - 28 V DC
 - a) Max: 18 W
 - b) Typical: 10 W
 - 3) 20-24 V AC
 - a) Max: 26 VA
 - b) Typical: 15.5 VA
 - 4) The camera shall be connected to a separate midspan and obtain power through a network cable. The midspan shall use 100-240 V AC/50-60 Hz, max 37 W.
 - u. Environmental
 - 1) The camera shall:
 - a) Operate in a temperature range of -30 °C to +50 °C (-22 F to 122 F)
 - b) Operate in a maximum temperature (intermittent) of 55 °C (131 °F)
 - c) Operate in a humidity range of 10–100% RH (condensing).

2.4 CAMERA-SUPPORTING EQUIPMENT

- A. Products: Subject to compliance with requirements, provide the following:
 - 1. Axis Communications.
- B. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.
- C. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.
- D. Camera Accessories
 - 1. Indoor 8 MP multidirectional network camera Axis P3717-PLE
 - a. Axis T94N01D Pendant Kit
 - b. Axis T91D61 Wall Mount 1.5” NPS
 - 2. Outdoor 1080p PTZ network camera Axis P5655-E.
 - a. Axis T91G61 Wall Mount
 - b. Axis T91B57 Pole Mount

2.5 NETWORK VIDEO RECORDERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Milestone Professional Plus Software (existing school VMS).
 - 2. The system software is sole source and no substitution is allowed.
- B. Provide additional network video storage to the existing Milestone VMS. Storage quantity shall be based on the following parameters:
 - 1. Contractor shall include a new video storage server to be installed to support this project’s cameras. Calculate server storage size based on the following camera recording parameters.
 - a. 2160p resolution (8MP) for indoor cameras and 1080p resolution for outdoor cameras (see drawings for quantities and locations)

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- b. Frame rate - 15 frames-per-second frame
 - c. 30 days retention of video storage
 - d. Cameras record on motion (approximately 30% recording)
 - e. Video storage provided shall be minimum of 18 Terabytes.
- C. Contractor to size network video storage based on the above parameters, plus an additional 50% extra storage. Provide sizing calculations with product submittals.
- D. Include all necessary camera and VMS licenses to provide a complete system for this project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN, WAN, and IP network before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

- A. Wiring Method: Install cables in raceways unless otherwise indicated.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- C. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. 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-486B.
- D. For communication wiring, comply with the following:
 - 1. Section 271313 "Communications Copper Backbone Cabling."
 - 2. Section 271323 "Communications Optical Fiber Backbone Cabling."
 - 3. Section 271513 "Communications Copper Horizontal Cabling."
- E. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install cameras and infrared illuminators level and plumb.

- B. Install cameras with 84-inch- minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
- C. Coordinate final camera installation locations with Architect and Security design Engineer.
- D. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.
- E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.
- F. Identify system components, wiring, cabling, and terminals according to Section 270553 "Identification for Communications Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
 - 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
 - a. Prepare equipment list described in "Informational Submittals" Article.
 - b. Verify operation of auto-iris lenses.
 - c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
 - d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
 - e. Set and name all preset positions; consult Owner's personnel.
 - f. Set sensitivity of motion detection.
 - g. Connect and verify responses to alarms.
 - 3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
 - 4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

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- C. Video surveillance system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
 - 1. Check cable connections.
 - 2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
 - 3. Adjust all preset positions; consult Owner's personnel.
 - 4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
 - 5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
- B. Engage school Security system vendor to provide labor costs to assist with programming and integration of this system into the existing school Headend.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION 282000

SECTION 283100 - INTRUSION DETECTION

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. Section Includes:
 - 1. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
 - 2. Integration of other electronic and electrical systems and equipment.
- B. Related Sections:
 - 1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for power cabling between master control units and field-mounted devices and control units.
 - 2. Section 271313 "Communications Copper Backbone Cabling" for Category 5e, 6, and 7 backbone (riser-rated) cabling.
 - 3. Section 271323 "Communications Optical Fiber Backbone Cabling" for multi- and single-mode backbone (riser-rated) optical fiber.
 - 4. Section 271513 "Communications Copper Horizontal Cabling" for Category 5e, 6, and 7 horizontal (general use, riser-, and plenum-rated) cabling.
 - 5. Section 281300 "Access Control System Software and Database Management" for applications, interfaces, and workstations.
 - 6. Section 282000 "Video Surveillance" for CCTV cameras that are used as devices for video motion detection.

1.3 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. PIR: Passive infrared.
- C. RFI: Radio-frequency interference.
- D. UPS: Uninterruptible power supply.
- E. Control Unit: System component that monitors inputs and controls outputs through various circuits.
- F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

- G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
- H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
- I. Standard Intruder: A person who weighs 100 lbs. or less and whose height is 60 inches or less; dressed in a long-sleeved shirt, slacks, and shoes.
- J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
- K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
- L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.4 ACTION SUBMITTALS

- A. Product Data: Components for sensing, detecting, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
 - 1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify and control interface devices and media to be used. Describe characteristics of network and other data communication lines.
 - a. Indicate methods used to achieve systems integration.
 - b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
 - c. Describe characteristics of network and other data communication lines.
 - d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.
 - 2. UPS: Sizing calculations.
 - 3. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building.
 - 4. Device Address List: Coordinate with final system programming.
 - 5. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
 - 6. Details of surge-protection devices and their installation.
 - 7. Sensor detection patterns and adjustment ranges.

MANSFIELD ELEMENTARY SCHOOL

- C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.
- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Samples for Verification: For each type of exposed finish required.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For intrusion detection systems integrator.
- B. Product Warranty: Sample of special warranty.
- C. Field Test Reports: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Data for each type of product, including features and operating sequences, both automatic and manual.
 - 2. Master control-unit hardware and software data.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
 - 2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
 - 1. At least one of whom is a Certified Systems Integrator.
- C. Testing Agency Qualifications: Certified by BICSI.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
 - 2. Interior, Controlled Environment: System components, except master control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambients of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
 - 3. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambients of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturer: Sonitrol Verified Electronic Security: FlexiBase IP Control Panel with Smart Audio and Loop expansion modules as required.
- B. Sonitrol Verified Electronic Security solution is sole source and no substitution is allowed.

2.2 SYSTEM COMPONENT REQUIREMENTS

- A. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:
 - 1. Door hardware specified in Section 087100 "Door Hardware."
 - 2. Access control system specified in Section 281300 "Access Control System Software and Database Management."
 - 3. Fire alarm system specified in Section 283111 "Digital Addressable Fire-Alarm Systems."
 - 4. Video surveillance system specified in Section 282000 "Video Surveillance."

- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
 - 1. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.
- C. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
- D. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.
- E. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.
- F. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.
- G. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.
- H. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.
- I. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.3 ENCLOSURES

- A. The Control Panel shall be enclosed in a metal cabinet, suitable for wall mounting. The dimensions shall not exceed 14.5 inches (36.8 cm) in height, 12.5 inches (31.8 cm) in width or 3 inches (7.6 cm) in depth
- B. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
- C. Interior Electronics: NEMA 250, Type 12.

2.4 ALARM KEYPAD CONSOLE

- A. Products: Subject to compliance with requirements, provide the following:
 - 1. Sonitrol Verified Electronic Safety
 - a. Standard Keypad – Part No. SONIP KP
- B. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

2.5 DOOR SWITCHES

- A. Products: Subject to compliance with requirements, provide the following:
 - 1. Interlogix
 - a. Door Contacts – Part No. 1078C
 - b. Overhead Door Contacts – 2200 series
- B. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of three encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.
- C. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.
- D. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.
- E. Remote Test: Simulate movement of actuating magnet from master control unit.

2.6 MICROWAVE-PIR DUAL-TECHNOLOGY SENSORS

- A. Products: Subject to compliance with requirements, provide the following:
 - 1. Bosch Security
 - a. Blue Line Gen 2 TriTech Motion Detectors
- B. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.
- C. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
- D. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
 - 1. Minimum Detection Pattern: A room 20 by 30 feet.
 - 2. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps across two adjacent segments of detector's field of view.
 - 3. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps. Sensor sensitivity

adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.

4. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
5. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.7 ACOUSTIC-TYPE, GLASS-BREAK SENSORS

- A. Products: Subject to compliance with requirements, provide the following:
 1. Sonitrol Verified Electronic Security
 - a. Glass Break Sensor – Part No. SON GBD-ST
- B. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.
- C. Device Performance: Detect unique, airborne acoustic energy spectrum caused by breaking glass.
 1. Sensor Element: Microprocessor-based, digital device to detect breakage of plate, laminate, tempered, and wired glass while rejecting common causes of false alarms. Detection pattern shall be at least a 20-foot range.
 2. Hookup Cable: Factory installed, not less than 72 inches.
 3. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit or at master control unit.
 4. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
 5. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

2.8 DURESS-ALARM SWITCHES

- A. Products: Subject to compliance with requirements, provide the following:
 1. Inovonics
 - a. Panic Buttons – Part No. EN1235S
- B. Description: A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master control unit, with no visible or audible indication when activated. Switch shall lock in activated position until reset with a key.
 1. Minimum Switch Rating: 50,000 operations.
 2. Foot Rail: Foot activated, floor mounting.
 3. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

2.9 MASTER CONTROL UNIT

- A. Products: Subject to compliance with requirements, provide the following:
 1. Sonitrol Verified Electronic Security: FlexiBase IP Control Panel with Smart Audio and Loop expansion modules as required.

- B. Description: The FlexIP Control Panel is a primary communications processor and control unit for the SONIP Security System. Equipped with Plug & Play features that allow for ease of installation and service, the panel communicates with the Central Station using high-speed internet connections, a high-speed v.34 modem, or by using a separate module for a high speed cellular connection. The FlexIP Control Panel communicates internally with the expansion modules using ethernet topology. It can be used for both Central Station monitored intrusion and managed access control. The FlexIP Control Panel can supervise and control 16 Audio or GlassBreak sensors (Audio Sensor or GBD-ST), 16 Alarm inputs as well as 4 Auxiliary Outputs. The modular design ensures that the system can be tailored to the customers' requirements with the addition of the associated expansion modules.
- C. Construction: Wall-mounted, modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.
- D. Comply with UL 1076.
- E. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Annunciator and Display: LCD, three line(s) of 80 characters, minimum.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
 - 3. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
 - 4. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
 - 5. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
 - a. Acknowledge alarm.
 - b. Silence alarm.
 - c. System reset.
 - d. LED test.
 - 6. Timing Unit: Solid state, programmable, 365 days.
 - 7. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
 - 8. Alarm Indication: Audible signal sounds and an LED lights at master control unit identifying the protected zone addressable detector originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.
 - 9. Alarm Indication: Audible signal sounds and a plain-language identification of the protected zone addressable detector originating the alarm appears on LED or LCD display at master control unit. Annunciator panel displays a common alarm light and sounds an audible tone.

- 10. Alarm Indication: Audible signal sounds and a plain-language identification of the protected zone addressable detector originating the alarm appears on LED LCD or cathode-ray-tube display at master control unit. Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.
 - 11. Alarm activation sounds a bell or siren and strobe.
- F. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.
 - G. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.
 - H. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch high. Identify, with permanent labels, individual components and modules within cabinets.
 - I. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
 - J. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- 2.10 EXTERNAL POWER SUPPLY FOR PERIPHERAL MODULES OF FLEXIBASE IP CONTROL PANEL
- A. Products: Subject to compliance with requirements, provide the following:
 - 1. Sonitrol Verified Electronic Safety;
 - a. Power Hub Module Part No. SONIP POWER HUB
- 2.11 SECURITY FASTENERS
- A. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.

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- B. 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:
 - 1. Acument Global Technologies; Acument Intellectual Properties, LLC.
 - 2. Safety Socket LLC.
 - 3. Tamper-Pruf Screws.
- C. Drive System Types: Pinned Torx-Plus.
- D. Socket Flat Countersunk Head Fasteners:
 - 1. Heat-treated alloy steel, ASTM F835.
 - 2. Stainless steel, ASTM F879, Group 1 CW.
- E. Socket Button Head Fasteners:
 - 1. Heat-treated alloy steel, ASTM F835.
 - 2. Stainless steel, ASTM F879, Group 1 CW.
- F. Socket Head Cap Fasteners:
 - 1. Heat-treated alloy steel, ASTM A574.
 - 2. Stainless steel, ASTM F837, Group 1 CW.
- G. Protective Coatings for Heat-Treated Alloy Steel:
 - 1. Zinc chromate, ASTM F1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
 - 2. Zinc phosphate with oil, ASTM F1137, Grade I, or black oxide unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.
- D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.
 - 1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
 - 2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.
- E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEM INSTALLATION

- A. Comply with UL 681 and NFPA 731.
- B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 70548.16 "Seismic Controls for Communications Systems."
- C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."
- D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.
 - 1. Connect new equipment to existing control panel in existing part of the building.
 - 2. Connect new equipment to existing monitoring equipment at the Supervising Station.
 - 3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

3.3 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
- B. Wiring Method: Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
- C. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

- E. Wires and Cables:
 - 1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
 - 2. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
 - 3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 4. Data and Television Signal Transmission Cables: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- G. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.
- H. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 270553 "Identification for Communications Systems."

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 270553 "Identification for Communications Systems."
- B. Install instructions frame in a location visible from master control unit.

3.5 GROUNDING

- A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.
- B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.

3.6 FIELD QUALITY CONTROL

- A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
 - 1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."
 - 1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
 - 2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."
- D. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."
- E. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 283100

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM 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. Section Includes:
 1. Fire-alarm control unit.
 2. Manual fire-alarm boxes.
 3. System smoke detectors.
 4. Heat detectors.
 5. Notification appliances.
 6. Magnetic door holders.
 7. Remote annunciator.
 8. Addressable interface device.
 9. BACnet Gateway
 10. Digital alarm communicator transmitter.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

- A. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

1.5 SUBMITTALS

- A. General Submittal Requirements:
 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, Level II minimum.
 - c. Licensed or certified by authorities having jurisdiction.

- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - 2. Include voltage drop calculations for notification appliance circuits.
 - 3. Include battery-size calculations.
 - 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 - 6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 - 7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
- D. Delegated-Design Submittal: For smoke and heat detectors 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. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
 - 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
- E. Qualification Data: For qualified Installer.
- F. Field quality-control reports.
- G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 - 3. Record copy of site-specific software.
 - 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 - 5. Manufacturer's required maintenance related to system warranty requirements.
 - 6. Abbreviated operating instructions for mounting at fire-alarm control unit.
 - 7. Copy of NFPA 25.

- H. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.7 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
 - 2. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
 - 3. Keys and Tools: One extra set for access to locked and tamper proofed components.
 - 4. Audible and Visual Notification Appliances: One of each type installed.

5. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by Honeywell, Notifier series, model NFS2-640 with Digital Voice Command (DVC), or comparable product by one of the following manufacturers in the next paragraph. System shall be configured with an additional network panel located in the maintenance garage.
- B. Manufacturers: Subject to compliance with performance and site condition requirements, one of the manufacturers listed below may be provided in lieu of the Basis of Design manufacturer. Naming these products does not imply that their standard construction or configuration is acceptable or meets the specifications. Alternate equipment proposed must meet the specifications including all architectural, acoustic, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications, and space constraints.
 1. EST by Edwards.
 2. Siemens Building Technologies, Inc.; Fire Safety Division.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices:
 1. Manual stations.
 2. Heat detectors.
 3. Smoke detectors.
 4. Duct smoke detectors.
 5. Verified automatic alarm operation of smoke detectors.
 6. Automatic sprinkler system water flow.
 7. Heat detectors in elevator shaft and pit.
- B. Fire-alarm signal shall initiate the following actions:
 1. Continuously operate alarm notification appliances.
 2. Identify alarm at fire-alarm control unit and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Unlock electric door locks in designated egress paths.
 5. Release fire and smoke doors held open by magnetic door holders.
 6. Activate voice/alarm communication system.
 7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 9. Recall elevators to primary or alternate recall floors.
 10. Record events in the system memory.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
 1. Valve supervisory switch.
 2. Low-air-pressure switch of a dry-pipe sprinkler system.

3. Elevator shunt-trip supervision.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
 1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of primary power at fire-alarm control unit.
 4. Ground or a single break in fire-alarm control unit internal circuits.
 5. Abnormal ac voltage at fire-alarm control unit.
 6. Break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at fire-alarm control unit or annunciator.
 9. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.

2.3 FIRE-ALARM CONTROL UNIT

- A. General Requirements for Fire-Alarm Control Unit:
 1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder.
 2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 1. Annunciator and Display: Liquid-crystal type, 2 line(s) of 40 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. Circuits:
 1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
 - a. Initiating Device Circuits: Style D.
 - b. Notification Appliance Circuits: Class A.
 - c. Signaling Line Circuits: Style 6.
 - d. Install no more than 50 addressable devices on each signaling line circuit.

- D. Smoke-Alarm Verification:
 - 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 - 2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
 - 3. Sound general alarm if the alarm is verified.
 - 4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- E. Notification Appliance Circuit: Operation shall sound in a code 3 temporal pattern.
- F. Elevator Recall:
 - 1. Smoke detectors at the following locations shall initiate automatic elevator recall.
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.
 - c. Smoke detectors in elevator hoistway.
 - 2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
 - 3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
 - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.
- G. Elevator Controls: Heat detector operation shuts down elevator power by operating a shunt trip fused disconnect in the elevator machine room. Monitor shunt trip power loss.
- H. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.
- J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- K. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.
 - 1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
 - a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."

- d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones.
 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- L. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- M. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- N. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
1. Batteries: Sealed lead calcium.
- O. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 2. Station Reset: Key- or wrench-operated switch.
 3. Integral Addressable Module: Arranged to communicate pull station status to fire-alarm control unit.

2.5 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
 2. Detectors shall be two-wire type.

3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 5. Non self-Restoring: Detectors do require resetting or readjustment after actuation to restore them to normal operation.
 6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
 7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - c. Provide multiple levels of detection sensitivity for each sensor.
- B. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
 4. Each sensor shall have multiple levels of detection sensitivity.
 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
 7. Provide remote alarm LED indicators and/or remote test station at each location of a concealed duct detector. Include conduit and wire to be able to locate the indicator or remote test switch within 5'-0" horizontally from the vertical centerline of the duct detector. Exact location to be coordinated with architect and owner.

2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
- B. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall mounted unless otherwise indicated.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finished, red.
- C. Voice/Tone Notification Appliances:
 - 1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
 - 2. High-Range Units: Rated 2 to 15 W.
 - 3. Low-Range Units: Rated 1 to 2 W.
 - 4. Mounting: semirecessed.
 - 5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.8 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting and are complete with matching doorplate.
 - 1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
 - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 - 3. Rating: 24-V ac or dc.
- B. Material and Finish: Match door hardware.

2.9 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown.

2.11 BACNET GATEWAY

- A. Description: Interface between fire alarm system and the building management system network using the BACnet/IP communication protocol. Coordinate with division 23 for interface requirements and for sequence of operations. Provide all required BACnet points to Division 23.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.

MANSFIELD ELEMENTARY SCHOOL

- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.
 - 4. Loss of ac supply or loss of power.
 - 5. Low battery.
 - 6. Abnormal test signal.
 - 7. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 - 1. Factory fabricated and furnished by manufacturer of device.
 - 2. Finish: Paint of color to match the protected device.

2.14 WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer, in raceway.
- C. Non-Power-Limited Circuits:
 - 1. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Equipment Mounting: Install fire-alarm control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.

- C. Smoke- or Heat-Detector Spacing:
 - 1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 - 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 - 3. Smooth ceiling spacing shall not exceed 30 feet.
 - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.
 - 5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
 - 6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
- D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- G. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.
- I. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- J. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.
- K. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

3.2 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated air-conditioning duct systems.

2. Alarm-initiating connection to elevator recall system and components.
3. Alarm-initiating connection to activate emergency lighting control.
4. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
5. Supervisory connections at valve supervisory switches.
6. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
7. Supervisory connections at elevator shunt trip breaker.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by Architect, authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

MANSFIELD ELEMENTARY SCHOOL

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
 - F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 - G. Prepare test and inspection reports.
 - H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
 - I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

MANSFIELD ELEMENTARY SCHOOL

SECTION 311000 - SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Clearing and protection of vegetation.
- B. Removal of existing debris.

1.02 RELATED REQUIREMENTS

- A. Section 024113 - Selective Site Demolition: Removal of built elements and utilities.
- B. Section 312300 - Earthwork
- C. Section 329300 - Plants: Pruning of existing trees to remain.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Site Plan: Showing:
 - 1. Areas for temporary construction and field offices.

1.04 QUALITY ASSURANCE

- A. Clearing Firm: Company specializing in the type of work required.
 - 1. Minimum of 5 years of documented experience.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Fill Material: As specified in Section 312300 - Earthwork.

PART 3 EXECUTION

3.01 SITE CLEARING

- A. Comply with other requirements specified in Section 017000 - Execution and Closeout Requirements.
- B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 EXISTING UTILITIES AND BUILT ELEMENTS

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are not to be removed.

3.03 VEGETATION

- A. Remove trees, shrubs, brush, and stumps in areas to be covered by building structure and all site improvements.
- B. Remove 20 Additional Trees selected by the Architect after the new building and site improvements are staked out in the field by the Contractor.
- C. Unit Price: Indicate on the Bid Form the Unit Price for each tree that may be added to or deducted from the 20 Additional Trees. See also Section 012200 - Unit Prices.
- D. Do not remove or damage vegetation beyond the limits indicated on drawings.

MANSFIELD ELEMENTARY SCHOOL

- E. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.
- F. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
 - 1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
 - 2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
 - 3. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
 - 4. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
 - 5. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.
- G. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.04 DEBRIS

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 311000

MANSFIELD ELEMENTARY SCHOOL

SECTION 312300 - EARTHWORK

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Rough grading the site for improvements.
- B. Excavating for slabs-on-grade, paving, and site structures.
- C. Rock removal.
- D. Filling, backfilling, and compacting for slabs-on-grade, paving, and site structures.
- E. Trenching for utilities outside the building to utility main connections.
- F. Backfilling and compacting for utilities outside the building to utility main connections.
- G. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.
- H. Disposal of unsuitable material.
- I. Disposal of surplus suitable material, if required.
- J. This section does not include soil materials placed under buildings.

1.03 RELATED REQUIREMENTS

- A. Section 311000 - Site Clearing.
- B. Section 321216 - Asphalt Paving
- C. Section 321616 - Concrete Paving
- D. Section 321400 - Unit Paving
- E. Section 329200 - Turf and Grasses: Finish ground cover.
- F. Section 329115 - Soil Preparation (Performance Specification): Rain garden soil types and compaction requirements.
- G. Section 329300 - Plants

1.04 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength 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 pavement.
- 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. 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 changes in the Work.
 - 2. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.

3. 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.
- F. Fill: Soil materials used to raise existing grades.
- G. Finish Grade Elevations: Indicated on Drawings.
- H. Rock: Rock in definite ledge formation and boulders, or the portion of boulders, 1 cubic yard or more in volume.
- I. 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.
- J. 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.
- K. 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.
- L. Subgrade Elevations: 4 inches below finish grade elevations indicated on Drawings, unless otherwise indicated.
- M. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.05 REFERENCE STANDARDS

- A. Geotechnical Report: "Geotechnical Study for New Mansfield Elementary School, 134 Warrenton Road, Mansfield, CT" prepared by Welti Geotechnical, P.C.
- B. Standard Specifications: "Form 818, Standard Specifications for Roads, Bridges and Incidental Construction, State of Connecticut, Department of Transportation" and supplements.
- C. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.
- D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012.
- E. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.
- F. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.
- G. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 1999a (Reapproved 2014).
- H. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles; 2011.
- I. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; 2015a.
- J. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile; 2012.
- K. ASTM D4759 - Standard Practice for Determining the Specification Conformance of Geosynthetics; 2002.
- L. ASTM D4833/D4833M - Standard Test Method for Index Puncture Resistance of Geomembranes, and Related Products; 2007 (Reapproved 2013).

- M. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2010.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate requirements for special foundations and load bearing elements specified in other Sections.
- B. Preinstallation Meeting: Conduct a preinstallation meeting minimum one week prior to the start of the work of this Section; require attendance by all affected installers, and Owner's geotechnical engineering consultant.
 - 1. Convene under general provisions of Section 01 7000.
 - 2. Discuss all earthwork requirements specified, and document any additional requirements or modified requirements received from Owner and Owner's geotechnical engineer which require a modification of the Contract.

1.07 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Material Test Reports - Physical: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated. Prepare separate reports for each type and application of material.
 - 1. Classification according to ASTM D2487.
 - 2. Laboratory compaction curve according to ASTM D1557.
 - 3. Sieve analysis according to ASTM C136 for the gradation of coarse aggregates.
 - 4. Washed sieved analysis according to ASTM C117 and ASTM C136 for soil and processed materials.
 - 5. Classification, sieve analysis and laboratory compaction curve for on-site material, in accordance with the above requirements, when requested by the Architect or Engineer.
- C. Material Test Reports - Chemical Analysis:
 - 1. Obtain one composite sample for every 500 cu yd of soil/material with at least three samples for each soil/material type from each borrow source location. Analyze each for pesticides (EPA Method 8081), Chlorinated Herbicides (EPA Method 8151), Polyaromatic Hydrocarbons (EPA Method 8270), Total Petroleum Hydrocarbons (CTETPH method), Total RCRA 8 Metals (EPA Method 6010 / 7421 / 7470), Volatile Organic Compounds (EPA Method 8260), and Polychlorinated Biphenyls (EPA Method 8082). Based on the results of this testing, additional Synthetic Precipitation Leaching Procedure (SPLP) or Toxicity Characteristic Leaching Procedure (TCLP) testing may be required at the discretion of the Architect. Owner reserves the right to reject material based on the results of this testing.
 - 2. Satisfactory Soil/Material:
 - a. Not to exceed laboratory detection limits for concentrations of Pesticides, Chlorinated Herbicides, Polyaromatic Hydrocarbons, Total Petroleum Hydrocarbons, Volatile Organic Compounds, and Polychlorinated Biphenyls.
 - b. Not to exceed naturally occurring background levels for concentrations of RCRA-8 Metals in native soils on site.
 - c. In no case to exceed any GA pollutant mobility criteria (GA PMC) or residential direct exposure criteria (RES DEC) established in Sections 22a-133k-1 through 22a-133k-3 of the regulations of Connecticut state agencies.
- D. Soil/Material Origin: Provide a description for each originating off-site location or project from which imported soil/material is obtained, including known historical activities occurring on the site, and any possible releases that have occurred.

MANSFIELD ELEMENTARY SCHOOL

1. The following are not acceptable:
 - a. Soils/materials originating from sites subject to any Federal or State remediation program.
 - b. Soils/materials that have undergone any treatment process for one or more chemical constituents listed within the CT RSRs.
- E. Site Plan: Showing excavation limits and areas for temporary construction and field offices.
 1. Excavation and soil removal limits.
- F. Product Data: For each type of the following manufactured products required:
 1. Geotextiles.
 2. Detectable warning tapes.
- G. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.
- H. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.08 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.09 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving 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 traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect 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.
 3. Contact "Call Before You Dig" at 1-800-922-4455 before excavating. Proceed with excavation only after utility locator service completes marking of utility locations.
- D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- E. Do not commence earth moving operations until temporary erosion and sedimentation control measures are in place.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. Locate stockpiles where indicated.
 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 2. Prevent contamination.
 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 SOIL MATERIALS - GENERAL

- A. Soil materials, whether from sources on or off site must be approved by Owner's geotechnical engineer as suitable for intended use.

2.02 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations free from foreign or recycled materials (glass, clinker, asphalt, and concrete), and not from a hydraulically dredged borrow source.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487 or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
- D. Backfill and Fill: Satisfactory soil materials.
- E. Granular Fill: Broken or crushed stone gravel or a mixture thereof; CTDOT Form 818, Section M.02.01, and M.02.06, Grading A.
- F. Rain Garden Media: Refer to Specification Section 329115 - Soil Preparation (Performance Specification).
- G. Processed Aggregate Base: CTDOT Form 818, Section M.05.01.
- H. Gravel Subbase: CTDOT Form 818, Section M.02.02, Grading A or to the grading indicated in the Geotechnical Report.
- I. Stone Materials: Refer to CTDOT Form 818, Section M.01.01:
 - 1. 2 inch Stone: Form 818, Section M.01.01, No. 3.
 - 2. 1-1/4 inch Stone: Form 818, Section M.01.01, No. 4.
 - 3. 3/4 inch Stone: Form 818, Section M.01.01, No. 6.
 - 4. 1/2 inch Stone: Form 818, Section M.01.01, No. 67.
 - 5. 3/8 inch Stone: Form 818, Section M.01.01, No. 8.
 - 6. Screenings: Form 818, Section M.01.01, Screenings.
 - 7. Stone Dust: Form 818, Section M.01.01, Dust.
- J. Pipe Bedding: Refer to CTDOT Form 818:
 - 1. 3/4 inch Stone: Form 818, Section M.01.01, No. 6.
 - 2. Sand: Form 818, Section M.08.03-1.
- K. Drainage Sand:
 - 1. Comply with Free-Draining Materials: Form 818, Section M.02.07.
 - 2. Uniformity coefficient of less than 5 ($C_u = D_{60}/D_{10}$).
 - 3. Laboratory permeability greater than 25 feet/day.

2.03 GEOTEXTILES

- A. Separation Fabric: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; and with the following minimum properties determined according to ASTM D4759 and referenced standard test methods:
 - 1. Minimum Grab Tensile Strength: 200 lbf; ASTM D4632/D4632M.
 - 2. Minimum Tear Strength: 75 lbf; ASTM D4533.
 - 3. Minimum Puncture Resistance: 80 lbf; ASTM D4833/D4833M.
 - 4. Minimum Water Flow Rate: 4 gpm per sq. ft.; ASTM D4491/D4491M.
 - 5. Maximum Apparent Opening Size: No. 40; ASTM D4751.

- B. Filter Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D4759 and referenced standard test methods:
 - 1. Minimum Grab Tensile Strength: 150 lbf; ASTM D4632/D4632M.
 - 2. Minimum Tear Strength: 50 lbf; ASTM D4533.
 - 3. Minimum Puncture Resistance: 100 lbf; ASTM D4833/D4833M.
 - 4. Minimum Water Flow Rate: 75 gpm per sq. ft.; ASTM D4491/D4491M.
 - 5. Maximum Apparent Opening Size: No. 80; ASTM D4751.
- C. Stabilization Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D4759 and referenced standard test methods:
 - 1. Minimum Grab Tensile Strength: 250 lbf; ASTM D4632/D4632M.
 - 2. Minimum Tear Strength: 100 lbf; ASTM D4533.
 - 3. Minimum Puncture Resistance: 100 lbf; ASTM D4833/D4833M.
 - 4. Minimum Water Flow Rate: 75 gpm per sq. ft.; ASTM D4491/D4491M.
 - 5. Maximum Apparent Opening Size: No. 100; ASTM D4751.

2.04 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches wide and 4 mils thick, continuously in-scribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep.
 - 1. Identifying Colors for Utilities:
 - a. Red: Electric.
 - b. Orange: Telephone and other communications.
 - c. Blue: Water and geothermal systems.
 - d. Green: Sewer systems.

2.05 SOURCE QUALITY CONTROL

- A. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance .
- B. If tests indicate materials do not meet specified requirements, change material and retest.
- C. Provide materials of each type from same source throughout the work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Protect and maintain erosion and sediment controls during earth moving operations.
- C. Locate, identify, and protect from damage above- and below-grade utilities that remain.
- D. Notify utility company to remove and relocate utilities as indicated on Drawings.
- E. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, and ball fields, from damage by grading equipment and vehicular traffic.

- F. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.
- G. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.03 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.
 - 1. Do not remove topsoil when wet.
- B. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
- C. When excavating through roots, perform work by hand and cut roots with sharp axe.
- D. Benching Slopes: Horizontally bench existing slopes greater than 1.5:1 (34 degrees) to key fill material to slope for firm bearing.
- E. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.04 SOIL REMOVAL AND STOCKPILING

- A. Remove excavated material that is unsuitable for re-use from site.
- B. Remove excess excavated material from site.
- C. Stockpile excavated topsoil to be re-used on site; remove remainder from site.
- D. Stockpile excavated subsoil to be re-used on site; remove remainder from site.
- E. Stockpiles: Use areas designated on site; pile depth not to exceed 6 feet; protect from erosion.

3.05 ROCK REMOVAL

- A. Excavate and remove rock by mechanical methods only; use of explosives is not permitted.
 - 1. Mechanical Methods: Drill holes and utilize expansive tools, wedges, or mechanical disintegration compound to fracture rock.
- B. If rock is uncovered requiring the explosives method for rock disintegration, notify the Architect.
- C. Correct unauthorized rock removal to directions of Architect.
- D. Form level bearing at bottom of excavations.
- E. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.
- F. Remove excavated materials from site or reuse for site landscaping as directed by the Architect.

3.06 EXCAVATING

- A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.
 - 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
 - a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6 inches beneath bottom of concrete slabs-on-grade.
 - f. 12 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.
- B. Excavate to accommodate new structures and construction operations.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Hand trim excavations. Remove loose matter.
- E. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- F. Excavate surfaces under walks and pavement to indicated lines, cross sections, elevations, and subgrades.
- G. Prepare excavated pavement areas prior to backfilling; scarify and proof roll subgrade surfaces to a depth of 6 inches to identify soft spots.
 1. Cut out soft areas of subgrade not capable of compaction in place. Backfill with granular fill.
 2. Moisture condition and re-compact subgrade to density equal to or greater than requirements for subsequent fill material, unless otherwise specified.
 3. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.07 TRENCHING

- A. Slope banks of excavations deeper than 5 feet to angle of repose or less until shored; comply with local, State and Federal regulations for excavation support.
- B. Excavate trenches to indicated gradients, lines, depths, and elevations.
 1. Do not interfere with 45 degree bearing splay of foundations.
- C. 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 higher than top of pipe or conduit unless otherwise indicated.
 1. Clearance: As indicated on Drawings.
- D. Cut trenches wide enough to allow inspection of installed utilities.
- E. Trench Bottoms: Excavate trenches deeper than bottom of pipe and conduit elevations as indicated on the Drawings to allow for bedding course. Hand-excavate deeper for bells of pipe.
 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
 2. Cut out soft areas of subgrade not capable of compaction in place. Backfill with pipe bedding.
- F. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- G. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

- H. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

3.08 BACKFILLING

- A. Backfill to contours and elevations indicated using satisfactory soils on subgrades free of mud, frost, snow, or ice.
- B. Employ a placement method that does not disturb or damage other work.
- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- D. Moisture Content: Maintain moisture content of fill and backfill materials, expressed as a percentage in relation to optimum moisture content, to attain required compaction density.
 - 1. Moisture content of backfill prior to and during compaction to be within plus or minus 2 percentage points dry of optimum and uniform throughout each layer.
- E. Fill Lift Thickness:
 - 1. Heavy, Self-Propelled Equipment: Place and compact materials in equal continuous layers not exceeding 5 to 12 inches loose depth. Refer to Geotechnical Report for lift thickness.
 - 2. Hand-Guided Equipment: Place and compact material in equal continuous layers not exceeding 4 to 6 inches loose depth.
- F. Correct areas that are over-excavated.
 - 1. All Areas: Use granular fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.
- G. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Density measured according to ASTM D1557.
 - 2. Under Paving, Slabs-on-Grade, Underground Utilities, and Similar Construction: 95 percent of maximum dry density.
 - 3. At Other Locations: 95 percent of maximum dry density.
- H. Reshape and re-compact fills subjected to vehicular traffic.

3.09 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. General: Comply with local jurisdiction requirements for earthwork bedding and fill work in public rights-of-way.
- B. At storm drains within 10' of subsurface wastewater system components:
 - 1. Non-free draining material.
- C. At Rain Gardens:
 - 1. Refer to Specification Section 329115 - Soil Preparation (Performance Specification).

3.10 FINISH GRADING

- A. Before Finish Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove soil contaminated with petroleum products.
- C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 6 inches.
- D. Complete finish grading to elevations and slopes indicated. Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements.

3.11 REPAIR AND RESTORATION

- A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.
- B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Architect as to remedy.
- C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.12 FIELD QUALITY CONTROL

- A. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.
- B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests:
 - 1. Conduct at least one test for each strata of soil on which site improvements will be placed, to verify required design bearing capacities.
 - 2. Conduct at least one field density test for each 200 cubic yard of backfill for trenches at each compacted backfill lift, and not less than one test for each 150 lineal feet of trench.
 - 3. Pavement Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
- F. Proof roll compacted fill at surfaces that will be under slabs-on-grade.

3.13 PROTECTION

- A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

3.14 MAINTENANCE

- A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerance.
 - 1. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.
 - 2. Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.
- B. Base Course Thickness: Plus or minus 0.04 foot (1/2 inch).
- C. Top Surface of Base Course: Plus or minus 0.04 foot (1/2 inch).

MANSFIELD ELEMENTARY SCHOOL

D. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.16 CLEANING

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION 312300

MANSFIELD ELEMENTARY SCHOOL

SECTION 321216 - ASPHALT PAVING

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. Section Includes:
 - 1. Bituminous Concrete Pavement.
 - 2. Heavy Duty Bituminous Concrete Pavement.
 - 3. Bituminous Concrete Replacement.
 - 4. Bituminous Concrete Curbs.
 - 5. Bituminous Concrete Sidewalks.
 - 6. Bituminous Concrete Four Square and Hopscotch Court Base – Bituminous Concrete Sidewalk.
- B. Related Requirements:
 - 1. Section 31 23 00 “Earthwork” for subgrade preparation, fill materials, pavement subbase and processed aggregate base.
 - 2. Section 32 17 23 "Painted Pavement Markings".
 - 3. Section 32 18 28 “Athletic Courts Surfaces” for basketball, four square and hopscotch court striping.

1.3 REFERENCE STANDARDS

- A. CDOT Form 817: State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges, Facilities and Incidental Construction Form 817; including latest Supplements.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include technical data and tested physical and performance properties.
 - 2. Job-Mix Designs: For each job mix proposed for the Work.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each paving material from manufacturer. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.
- B. Material Test Reports: For each paving material, by a qualified testing agency.

MANSFIELD ELEMENTARY SCHOOL

1.6 QUALITY ASSURANCE

- A. **Manufacturer Qualifications:** A paving-mix manufacturer qualified annually by the Connecticut Department of Transportation for the production of hot-mixed asphalt paving mixtures for use on Department projects.
- B. **Regulatory Requirements:** Comply with materials, workmanship, and other applicable requirements of the State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges, Facilities and Incidental Construction Form 817, including current Supplements.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.7 FIELD CONDITIONS

- A. **Environmental Limitations:** Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Prime Coat: Minimum surface temperature of 60 deg F.
 - 2. Tack Coat: Minimum surface temperature of 60 deg F.
 - 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
 - 4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. **General:** Use materials and gradations that have performed satisfactorily in previous installations.
- B. **Coarse Aggregate:** ConnDOT Form 817 Subarticle M.04.01-1.
- C. **Fine Aggregate:** ConnDOT Form 817 Subarticle M.04.01-2.
- D. **Mineral Filler:** ConnDOT Form 817 Subarticle M.04.01-3.

2.2 ASPHALT MATERIALS

- A. **Asphalt Binder:** ConnDOT Form 817 Subarticle M.04.01-4.
- B. **Emulsified Asphalts:** ConnDOT Form 817 Subarticle M.04.01-5.
- C. **Water:** Potable.

MANSFIELD ELEMENTARY SCHOOL

2.3 AUXILIARY MATERIALS

- A. Reclaimed Asphalt Pavement (RAP) Recycle Option: ConnDOT Form 817 Subarticle M.04.01-6.
- B. Joint Seal: ConnDOT Form 817 Subarticle M.04.01-8.

2.4 MIXES

- A. Hot-Mix Asphalt: dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Curb Mix: ConnDOT Form 817 Subarticle M.04.02-1.
 - 3. Superpave Mixes: ConnDOT Form 817 Subarticle M.04.02-2.
 - a. Base/Binder Course (1.5" lifts): HMA S0.375.
 - b. Base/Binder Course (2.5" lifts): HMA S0.5.
 - c. Surface Course (1.5" lifts): HMA S0.375.
 - d. Sidewalk Mix: HMA S0.375.

2.5 FORMS

- A. Wood or metal; straight, free from warp, and of sufficient strength to resist springing from the impact of the roller. Wood forms shall be 2-inch surfaced plank except that thinner material may be used at sharp curves. Forms shall be of a depth equal to the depth of the finished pavement section.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that aggregate base course is dry and in suitable condition to begin paving.
- B. Adequately protect and leave in clean condition manhole frames and covers, catch basin grates, valve and meter boxes, curbs, walks, and walls.
- C. Adjust manhole covers, catch basin grates, valve boxes and similar items to conform with pavement grade or as directed by the Engineer.
- D. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 BITUMINOUS CONCRETE REPLACEMENT

- A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

MANSFIELD ELEMENTARY SCHOOL

- B. 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.
 - 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.
- C. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 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. Tack Coat: Apply uniformly to all contact surfaces, and to all pavement surfaces that have been in place longer than 5 calendar days, at a rate of 0.05 to 0.15 gal./sq. yd.
 - 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.

3.4 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. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 - 2. Place hot-mix asphalt surface course in single lift.
 - 3. Spread mix at a minimum temperature of 250 degrees F.
 - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
 - 6. Forms shall be used when hot mix asphalt is spread by hand. Forms shall be cleaned and oiled each time they are used. Forms shall be securely staked, braced, and held firmly to the required line and grade.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
 - 2. Complete a section of asphalt base course before placing asphalt surface course.
- 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.

3.5 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.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 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."

3.6 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.
- 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. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 ASPHALT CURBS

- A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F.

MANSFIELD ELEMENTARY SCHOOL

- B. Place hot-mix asphalt to special curb cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.8 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 3/8 inch.
 - 2. Surface Course: Plus 1/4 inch, 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 straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Replace and compact hot-mix asphalt where core tests were taken.
- D. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321216

MANSFIELD ELEMENTARY SCHOOL

SECTION 321313 - CONCRETE PAVING

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. Section Includes Concrete Paving. Including the Following:
 - 1. Concrete pavement
 - 2. Heavy duty concrete pavement
 - 3. Expansion joint materials and sealant.
 - 4. Concrete walks and integral curbs.
 - 5. Concrete base under unit pavers.
 - 6. Provision and Installation of tactile warning surfacing.
 - 7. Two-Component stair nosing systems for all cast in place concrete site stairs.
 - 8. Water repellent and chloride screen.
- B. Related Requirements:
 - 1. Section 03 30 00 "Cast-in-Place Concrete" for concrete structures.
 - 2. Section 31 23 00 "Earthwork" for granular base and subbase courses under pavements.

1.3 DEFINITIONS

- A. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.
- B. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Admixtures.
 - 4. Curing compounds.
 - 5. Joint fillers.
 - 6. Joint sealants.

MANSFIELD ELEMENTARY SCHOOL

1.6 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. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
 - 2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches (2400 mm) by 96 inches (2400 mm).
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Establish and maintain the required lines and grades during construction operations.
- C. Do not install concrete over wet, saturated, muddy or frozen ground.
- D. Do not install concrete when air temperature is below 40 degrees F. Use of calcium-chloride, salt or any other admixture to prevent concrete from freezing is prohibited.
- E. Protect adjacent work from damages, splatter and all other concrete operations.
- F. Provide temporary barricades and warning lights as required for protection of project work and public safety.
- G. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- H. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

MANSFIELD ELEMENTARY SCHOOL

2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

- A. Recycled Content: Postconsumer recycled content plus one-half preconsumer recycled content not less than 25 percent.
- B. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel
- C. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 (Grade 420) deformed bars.
- D. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated.
- E. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 plain-steel bars.
- F. Tie Bars: ASTM A 615/A 615M, Grade 60; deformed.
- G. 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, and as follows:
 1. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- H. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement

MANSFIELD ELEMENTARY SCHOOL

2.4 CONCRETE MATERIALS

- A. Regional Materials: Concrete shall be manufactured within 500 miles (800 km) of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150/C 150M, gray Portland cement Type II.
- C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: 1 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C 260/C 260M.
- 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.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
- F. Water: Potable and complying with ASTM C 94/C 94M.

2.5 CURING MATERIALS

- A. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- B. Water: Potable.
- C. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.6 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.
- B. Joint Sealant for horizontal applications: Two component polyurethane elastomeric type complying with FS-TT-S00227, self-leveling designed for foot traffic, as manufactured by SIKA, Pecora, or approved equal.
 - 1. Color to be selected by Landscape Architect.
- C. Joint Sealant for vertical applications: Two component polyurethane elastomeric type complying with FS-TT-S-00230, non-sag, 2c NS EZ Mix, as manufactured by SIKA, Pecora. Subject to compliance with requirements, provide the specified product or comparable product of BASF MasterSeal NP2 Sealant or LymTal International Iso-Flex 881 R Sealant.
 - 1. Color to be selected by Landscape Architect.

MANSFIELD ELEMENTARY SCHOOL

- D. Sealant Backer Rod: Compressible rod stock or polyethylene foam, polyethylene jacketed, butyl rubber foam, or neoprene foam, as recommended by sealant manufacturer where required for back-up of sealant.
- E. Grout: Non-shrink, non-staining grout. Conform to CT DOT Form 817-2016, Article M.03.05.
 - 1. Color to be selected by Landscape Architect.
- F. Water repellent and chloride screen: Consolideck Saltguard WB, water based salt guard densifier, silane/siloxane water repellent and chloride screen as manufactured by Prosoco. Subject to compliance with requirements, provide the specified product or comparable product of Foundation Armor SX5000 WB or Ghostshield Siloxa-Tek 8500.

2.7 DETECTABLE WARNING SQUARE CAST IRON PAVER

- A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.
 - 1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.
- B. Source Limitations: Obtain each type of tactile warning surfacing from single source with resources to provide materials and products of consistent quality in appearance and physical properties.
- C. Cast-in-Place Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. East Jordan Iron Works, Inc.
 - b. Neenah Foundry.
 - c. Iron Dome ADA Solutions.
 - 2. Material: Cast Iron: Gray iron, ASTM A 48/A 48M, CL 35.
 - 3. Coating: Undipped Grey iron with rust conditioner.
 - 4. Shapes and Sizes:
 - a. Rectangular panels, 24 by 24 inches and 24 by 30 inches to be combined as needed to match width of ramp.
 - b. Radius panel, nominal 24 inches deep by outside radius indicated on Drawings.
 - 5. Dome Spacing and Configuration: ADA II/ABA-compliant.
 - 6. Mounting: Manufactured with integral anchor lugs to ensure solid attachment to cast-in-place concrete.
- D. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Furnish Type 304 stainless-steel fasteners for exterior use.
 - 2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

2.8 TWO-COMPONENT STAIR NOSING SYSTEMS

- A. Basis-of-Design Product: subject to compliance with requirements, provide product indicated on drawings, Model DST-330 Two-component Stair Nosing by Balco Inc, 2626 S. Sheridan, PO Box 17249, Wichita, Kansas, 67217 (316) 945-9328. Subject to compliance with requirements, provide the specified product or comparable product of American Safety Tread or Nystrom Inc.
- B. Stair nosing system:
 - 1. Aluminum: ASTM B 221, alloy 6063-T5 for extrusions.
 - 2. Cast Aluminum: Cast Aluminum alloy 319, tread plate.
- C. Abrasive:
 - 1. Standard Abrasive: Two (2) part Epoxy combined with aluminum oxide grit standard.
- D. Fasteners required for complete installation to manufacturer's instructions:
 - 1. Two Component Stair Nosings: Standard and Tread plate securing screws.
- E. Finishes:
 - 1. Aluminum subchannels and tread plates shall be:
 - a. Mill finish.
 - b. Heat-treated for strength.
 - c. Clear acrylic lacquer coated for components to be embedded in concrete. This does not include cast nosings.
 - 2. Cast abrasive nosings and tread plates shall be:
 - a. Cast aluminum standard surface and nose cross-hatched abrasive.
 - b. Cast aluminum shall have a natural sand cast finish.
 - 3. Abrasive ribs shall be: C-10 Black standard.

2.9 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
- B. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. 4.0-7.0 percent for 1-1/2 inch nominal maximum aggregate size.
 - 2. 4.5-7.5 percent for 1-inch nominal maximum aggregate size.
 - 3. 4.5-7.5 percent for 3/4-inch nominal maximum aggregate size.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

MANSFIELD ELEMENTARY SCHOOL

- E. Design Mixtures: Normal-weight concrete.
 - 1. Compressive Strength (28 Days): 4500 psi.
 - 2. Maximum W/C Ratio at Point of Placement: 0.45.
 - 3. Minimum sacks of cement per cubic yard: 6-1/2.
 - 4. Slump Limit: 3 to 5 inches.

2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install concrete paving to the lines, dimensions and grades shown on the drawings. At points where changes in rates of grades is more than 2% introduce approved vertical curve. No abrupt changes in grade will be accepted.
- B. Conform to the applicable provisions of Article 8.11.03 and Section 9.21.03 of CT DOT Form 817-2016.
- C. Insure that all improvements and related work are accurately and properly positioned to specified line and grade prior to concrete placement. Poor or incorrect positioning will cause rejection of pavement.

3.2 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Coordinate with compaction testing by Owner. Do not install forms until subgrade has been tested and approved.
- C. Verify that manholes, handholes, valves, grates, and other such units are at their proper finished grade elevations. Set flush with the surface of adjoining pavement.
- D. Verify that the prepared granular base, as detailed is true to line and grade, and is compacted to the required density. Surface is to be smooth, free of irregularities, depressions or unsuitable material which cannot compact or will become impervious. Insure proper drainage at all times. If required, form, shape and roll with a 10 ton roller or equivalent.
- E. Insure thorough and proper compaction around all manholes, structures, utility valves, and other appurtenances.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

MANSFIELD ELEMENTARY SCHOOL

3.3 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.4 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.
- C. Approval of formwork is required prior to pour.

3.5 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.

3.6 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.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints 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.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 - 2. Provide tie bars at sides of paving strips where indicated.
 - 3. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

MANSFIELD ELEMENTARY SCHOOL

- 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.
 - 1. Locate expansion joints at intervals of 20-feet on center unless otherwise indicated on Drawings.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 5. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

- 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, as follows:
 - 1. Tooled Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 - 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

3.7 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. 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.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

MANSFIELD ELEMENTARY SCHOOL

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Integral Curbs:

1. Excavation shall be made to the required depth, and the base upon which the curbing is to be set shall be compacted to a firm, even surface.
2. Concrete shall be placed only on a moist base. Concrete shall not be placed on a soft, muddy, or frozen base.
3. Concrete shall be placed in forms, struck off with a template, compacted by approved means, and finished to a smooth, even surface.
4. Curbs and integral curbs shall be constructed in sections having a uniform length of approximately 10-feet, unless otherwise directed, and so arranged that a joint in the curbing shall come opposite a joint in the adjoining concrete pavement slab and be similar to it. The lengths of curb and integral curb sections may be varied slightly where necessary for closures, but no section less than 6 feet in length will be permitted.
5. Forms shall be so constructed that the form for exposed faces may be removed before the concrete has taken final set to permit correction of surface irregularities.

3.8 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater 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. 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.

3.9 DETECTABLE WARNING SQUARE CAST IRON PAVER

A. Install detectable warning in accordance with manufacturer's instructions at locations indicated on the drawings.

B. Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 32 13 13 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of tile.
2. Where cutting tiles is required, the cut seams shall fall between the domes. Dry fit the cut pieces to ensure tight joints between plates prior to installing tiles in wet concrete.
3. Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments into wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.

MANSFIELD ELEMENTARY SCHOOL

4. Set surface of tile flush with surrounding concrete, flush curbing, and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch from flush.
5. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
6. Clean tiles using methods recommended in writing by manufacturer.

C. CLEANING AND PROTECTION

1. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.
2. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

3.10 TWO-COMPONENT STAIR NOSING SYSTEMS

- A. Install stair nosings in accordance with the governing regulations, the industry standards applicable to the work, and the manufacturer's written installation instructions.
 1. Sub-channels of two component stair nosings shall be installed with the pour.
 2. Abrasive tread plates of two component stair nosings shall be installed in the final stages of construction.
- B. Work shall be aligned plumb, level, and, where required, flush with adjacent surfaces and rigidly anchored to the substrate.

3.11 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-retaining-cover curing, curing compound, or a combination of these as follows:
 1. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
 2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

MANSFIELD ELEMENTARY SCHOOL

3.12 WATER REPELLANT AND CHLORIDE SCREEN

- A. Apply water-based water repellent and chloride screen per manufacturer's instructions.

3.13 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 1. Elevation: 3/4 inch.
 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 3. Surface: Gap below 10-feet-long; unlevelled straightedge not to exceed 1/2 inch.
 4. Joint Spacing: 3 inches.
 5. Contraction Joint Depth: Plus 1/4 inch, no minus.
 6. Joint Width: Plus 1/8 inch, no minus.

3.14 SEALANT INSTALLATION

- A. Install joint sealant in all expansion joints in accordance with manufacturer's installation instructions. Remove dust, dirt and loose material. Clean and prime joints.
- B. Apply sealants in continuous beads, without open joints, voids, or air pockets. Hand tool and finish all joints.
- C. Confine materials to joint areas with masking tape or other precautions. Insure joint sealing is cleanly executed with no override onto adjacent pavement.
- D. Remove excess compound promptly as work progresses and clean adjoining surfaces. Protect until fully cured.
- E. In rough surfaces or joints of uneven widths, hold joint sealant well back into joints

3.15 FIELD QUALITY CONTROL

- A. Testing and Inspection: conform to Section 03 30 00 requirements.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
 1. Testing Frequency: Obtain at least one composite sample for each day's pour of each concrete class exceeding 5 cubic yards, but not less than 25 cubic yards; plus one set for each additional 50 cubic yards or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

MANSFIELD ELEMENTARY SCHOOL

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- D. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- E. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- H. Concrete paving will be considered defective if it does not pass tests and inspections.

3.16 REPAIR 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

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SECTION 321400 - UNIT PAVING

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. Section Includes:
 - 1. Concrete pavers on concrete base set in aggregate setting beds.
 - 2. Edge restraints for concrete pavers.
- B. Related Sections:
 - 1. Section 32 13 13 "Concrete Paving" for concrete base under unit paving.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Pavers.
 - 2. Edge restraints.
- B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.
- C. Samples for Initial Selection: For the following:
 - 1. Each type of unit paver indicated.
 - 2. Joint materials involving color selection.
- D. Samples for Verification:
 - 1. Full-size units of each type of unit paver indicated. Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints.
 - 2. Joint materials.
 - 3. Exposed edge restraints involving color selection.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Installer shall have not less than three years' experience with at least 75-100,000 square feet installed. Successful completion of five similar paver installations similar in design which are to be documented. Installer shall include the specified product(s) in their bid.
- B. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.
- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Construct a mockup of not less than 10' x 10'. The Mockup shall include the field pattern and banding. Use mock-up(s) to determine pre-compaction setting bed level, joint sizes, lines, laying patterns, color and texture range, and workmanship. Do not start work until mock-up has been approved. Remove mock-up and dispose of materials at the completion of the work or as directed.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

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- D. Preinstallation Conference: Conduct pre-installation meeting one week prior to commencing work of this Section to verify project requirements, substrate condition, coordination with other trades, installation instructions, and warranty requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- C. Store asphalt cement and other bituminous materials in tightly closed containers.

1.6 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- B. Protection of Finished Surfaces: Finished surfaces adjacent to the paving work shall be adequately protected from soiling, staining, and other damage during construction.

PART 2 - PRODUCTS

2.1 CONCRETE PAVERS

- A. Concrete Pavers: Solid paving units, made from normal-weight concrete with a compressive strength not less than 8000 psi, water absorption not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.

Basis-of-Design: Subject to compliance with requirements, provide nominal 4"x8" "Holland Stone" concrete unit pavers manufactured by Nicolock, Lindhurst, NY or comparable products "Hollandstone" by Unilock New York, Inc. or "Prest Brick" by Hanover Architectural Products, Hanover PA.

- 1. Thickness: 2 3/8-inches.
- 2. Face Size and Shape:
 - a. Nominal 4x8 paver
- 3. Edge: Beveled.
- 4. Color and Finish:
 - 1) Nicolock – Premium colors, including a combination of three different blends, to be selected by the Architect.
 - 2) Unilock – Special order premium colors to be selected by the architect.
 - 3) Hanover – Combination of three standard color blends to be selected by the architect, Tudor finish.
- 5. Spacer lugs: unit pavers shall include spacer lugs compatible with the paving pattern as shown on the drawings.

2.2 ACCESSORIES

- A. Pea Stone: Crushed stone conforming to CT DOT Form 817-2016, Article M.01.01, gradation No.8.
- B. Geotextile: For separation and drainage use, complying with Connecticut Department of Transportation Standard Specifications for Roads, Bridges, Facilities and Incidental Construction Form 817-2016 subarticle M.08.01-19.

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- C. Polymeric Sand for joints: High Performance Polymeric Jointing Sand for pavers, comprised of a mixture of polymer binders and calibrated sand: Gator Maxx Bond by Alliance Designer Products, Techniseal RG+, or SEK PolySweep. Color to be selected by Architect.

2.3 AGGREGATE SETTING-BED MATERIALS

- A. Sand for Leveling Course: Sound, sharp, washed, natural sand complying with gradation requirements in ASTM C 33 for fine aggregate.

2.4 EDGE RESTRAINTS

- A. Aluminum Edge Restraints: Manufacturer's heavy-duty aluminum paver edge restraint. Paver edge restraint shall be extruded aluminum, 6063 alloy, T6 hardness and capable of both straight and curvilinear applications in a corrugated L-shaped profile. Horizontal base shall have holes spaced 4 inches apart along its length to receive spikes or fasteners.
 1. Length: 8 foot.
 2. Height – 2-1/4 inch high
 3. Thickness – 3/16 inch gage section shall have 0.210 inch thick exposed top lip.
 4. Finish – Mill Finish
 5. Include all connectors and anchors.
 - a. Connection Method: Section ends shall splice together with horizontal 0.060 inch thick by 1 inch wide by 4 inches long aluminum sliding connector.
 - b. Anchoring: For hardened surfaces, use 3/16 inch x 1-1/2 inches or longer Ardox concrete nails or drive pin fastener equal to Hilti DX 40 powder actuated pin., Ramset Trakfast Automatic Fastening System Pin, or Tapcon.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Verify that concrete surfaces are free of oil, grease, paint, wax, curing compounds, primer, sealers, form release agents, or any deleterious substances and debris which may prevent or reduce bonding.
- C. Verify that concrete surfaces are cured, free from hydrostatic pressure, and have a moisture content of less than 5 percent.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Core-drill weep holes in concrete substrates at 6-feet to 10-feet on center in a staggered pattern, and at 24-inches on center at lowest elevations, and against curbs, walls, and other permanent structures. Fill holes with washed pea gravel and cover with 6" x 6" squares of geotextile tacked in place to prevent ingress of setting bed material or neoprene adhesive.
- B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

MANSFIELD ELEMENTARY SCHOOL

- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- D. Joint Pattern: As indicated.
- E. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- F. 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. Install joint filler before setting pavers.
- G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
 - 1. Install edge restraints to comply with manufacturer's written instructions. Install stakes or anchors at intervals required to hold edge restraints in place during and after unit paver installation.

3.4 AGGREGATE SETTING-BED APPLICATIONS

- A. Install concrete base as per Section 32 13 13 CONCRETE PAVING. Broom finish and edging are not required.
- B. Core drainage holes, fill with pea gravel and place geotextile fabric on the surface.
- C. Place leveling course and screed to a thickness of 25 to 38 mm (1 to 1-1/2 inches), taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
- D. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- E. Install edge restraints before placing unit pavers.

3.5 PAVERS

- A. Do not use pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. If pavers are not factory-blended, the installer must blend from a minimum of three pallets of each color in the blend as they are placed to produce uniform blend of colors and textures.
- C. Cut pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- D. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.
- E. Pavers shall be set true to the required lines and grades in the pattern detailed on the Drawings. Lay full pavers first and adjust pavers to form straight bond lines and appropriate joint widths. Provide 1/16" to 3/16" polymeric sand filled joints between pavers. Do not exceed 1/8-inch unit-to-unit offset from flush (lippage) nor 3/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- F. String lines or chalk lines must be used to keep paver bond lines straight and true. The straight and true bond lines shall not deviate more than +/- 1/2" at the end of 50 feet. Establish a center line working outward setting parallel string lines or chalk lines every 2 to 6 feet, depending on the area, to continuously check and adjust paver bond lines.

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- G. Roll or compact aggregate-set pavers to achieve full bond with the setting bed, reduce lippage and improve the overall flatness of the surface. Fill the spaces between pavers in conformance with the polymeric sand producer's installation instructions and recommendations as soon as possible after the pavers have been placed. Clean joints of all debris with power air blowers or vacuums to ensure full penetration of the polymeric jointing sand. Sweep dry polymeric joint filling sand over surface of paving until all joints are completely filled. Once the initial filling of the joints is completed, roll the surface of the pavers to fully compact the pavers into place. Utilize a light rubber-tired roller with sufficient pressure to achieve a full bond to the setting bed or a 4-5000 LBF plate tamper with a protective mat attached. Do not operate the roller in a vibrating mode, as this may cause cracking of the pavers. Protect the surface with plywood or other suitable materials to prevent damage to the edges of the pavers. After rolling, add dry polymeric sand to the joints as necessary to ensure that the sand has penetrated to the bottom of the joints. Do not vibrate the pavers after they or the sand have been placed on the setting bed. Roll the surface when the sand shows no sign of further settlement. Add additional polymeric sand as necessary. Mist and rinse in conformance with the polymeric sand producer's installation instructions and recommendations.
- H. Do not permit traffic, including construction equipment, on pavers before joint filling. Disturbed areas of pavers should be taken up, the setting bed re-set and pavers re-laid. Remove cracked or damaged pavers and replace with new units. Protect areas where joints have not been filled with waterproof covering overnight.
- I. Completed paver areas within the path of travel of any construction equipment shall be protected with steel road plates.
- J. Discontinue laying operations when weather conditions are such that pavement performance may be compromised. On laying operations recommencement, verify acceptable setting bed condition before further pavers are laid.

3.6 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION 321400

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SECTION 321500 - AGGREGATE SURFACING

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. Section includes:
 - 1. Crushed granite surfacing.
 - 2. Maintenance strip stone.
 - 3. River stone for stone filter strips and rain garden curb cuts.
 - 4. Geotextile fabric for stone filter strips, rain garden curb cuts and maintenance strips.
 - 5. Aggregate edge restraints/landscape edging.
- B. Related Requirements:
 - 1. Section 312300 "Earthwork" for subgrade preparation, fill material, and unbound-aggregate subbase course.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Selection: For each type of stone:
 - 1. 2-quart volume of each type and size of stone required; in sealed plastic bags labeled with product name and source of material. Each sample shall be typical of the lot of material to be furnished and provide an accurate representation of color and size ranges.
 - a. Crushed granite cover aggregate and base aggregate.
 - b. River stones.
 - c. Maintenance strip stone.

1.4 INFORMATIONAL SUBMITTALS

- A. Sieve Analyses: for crushed granite cover aggregate and base aggregate, according to ASTM C 136.

1.5 QUALITY ASSURANCE

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- A. Source Limitations: Obtain each type of material from a single source with the resources to provide materials and products of consistent quality in appearance and physical properties in the quantities needed for the Project.
- B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Build mockups of full-width and full-thickness sections.
 - a. Maintenance strips and stone filter strips. Length: 3 feet.
 - b. Crushed granite surfacing: Length: 5 feet.
 - c. Rain garden curb cut: Full size, in place, including precast concrete curbs.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Bulk materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Regional Materials: Provide aggregates that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

2.2 CRUSHED GRANITE AGGREGATE

- A. Crushed granite aggregate to be used for crushed granite surfacing.
- B. Hard, durable crushed granite, free of loam, sand, clay, and other foreign substances.
 - 1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated in the Work include, but are not limited to, Stony Creek Quarry.
 - 2. Sizes:
 - a. Cover Aggregate: washed 3/8-inch crushed stone.
 - b. Base aggregate: 3/8-inch minus crushed stone.
 - 3. Color: to be selected by Landscape Architect, to complement building finishes.

2.3 RIVER STONE

- A. Rounded river stone to be used for stone filter strips and rain garden curb cuts, and maintenance strip where noted on Drawings.

MANSFIELD ELEMENTARY SCHOOL

- B. Hard, durable, smooth and rounded stone, washed free of loam, sand, clay and other foreign substances.
 - 1. Stone Sizes:
 - a. Maintenance Strip (where noted on Drawings): 2 inch minimum to 3 inch maximum.
 - b. Rain Garden Curb Cuts: 3 inch minimum to 5 inch maximum.
 - c. Stone Filter Strip: 3 inch minimum to 5 inch maximum.
 - 2. Color: to be selected by Landscape Architect, blend of tans and greys to complement building finishes.

2.4 CRUSHED STONE

- A. Crushed stone to be used for maintenance strips.
- B. Hard, durable, smooth stone, washed free of loam, sand, clay and other foreign substances.
 - 1. Stone Sizes: 3/4-inch crushed stone.
 - 2. Color: to be selected by Landscape Architect, blend of tans and greys to complement building finishes.

2.5 GEOTEXTILE

- A. For separation and drainage, complying with Connecticut Department of Transportation Standard Specifications for Roads, Bridges, Facilities and Incidental Construction Form 817-2016, M.08.01-19.
- B. Staples for use in securing geotextile: 4" x 1" x 4" wire staple.

2.6 AGGREGATE EDGE RESTRAINTS/LANDSCAPE EDGING

- A. Aluminum Edge Restraints: Standard-profile extruded-aluminum edging, ASTM B221, Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.
 - 1. Finish: Mill (natural aluminum).
 - 2. Stakes: Aluminum, ASTM B221, Alloy 6061-T6, approximately 1-1/2 inches wide by 12 inches long.
 - 3. Size: As detailed.
 - 4. 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. Permaloc Corporation.
 - b. Sure-loc Edging Corporation.
 - c. J.D. Russel Company

PART 3 - EXECUTION

3.1 EXAMINATION

MANSFIELD ELEMENTARY SCHOOL

- A. Examine areas indicated to receive aggregate surfacing with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Excavate to lines, grades and depths as specified on the Drawing.
- B. Compact subgrade uniformly beneath areas to receive aggregate surfacing.
- C. Install aluminum edging where indicated and according to manufacturer's written instructions. Anchor with aluminum stakes to hold edge restraints in place during and after aggregate installation and spaced according to manufacturer's written instructions, driven below top elevation of edging.
- D. Install geotextile, covering area to receive aggregate surfacing and wrap up sides as indicated on Drawings, over-lapping and pinning edges of geotextile at least 6 inches and according to manufacturer's written instructions.
- E. Place indicated thickness of aggregate fully covering the geotextile. Rake aggregate to a uniform surface level with adjacent finish grades, unless otherwise indicated on Drawings.

3.3 INSTALLATION OF CRUSHED GRANITE SURFACING

- A. Base Aggregate: Spread base aggregate evenly over prepared subgrade. Compact at optimum moisture content to required grades, lines, cross section, and thickness to not less than 95 percent of maximum dry density unit weight according to ASTM D 1557.
- B. Cover Aggregate: Spread layer of cover aggregate over the base aggregate and roll with heavy steel wheel roller. Use sufficient number of passes to thoroughly bind surface. Broadcast additional cover aggregate in any deficient areas and continue rolling.
- C. Edge Restraints: Install edge restraints where indicated according to manufacturer's written instructions. Maintain a 3/8-inch gap between sections to allow for thermal expansion. Install stakes at intervals required to hold edge restraints in place during and after aggregate surfacing installation. Drive stakes at least 1 inch below top edge.

3.4 CLEANING

- A. 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.

MANSFIELD ELEMENTARY SCHOOL

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.5 INSTALLATION TOLERANCES – CRUSHED GRANITE SURFACING

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 1. Base Course: Plus or minus ½-inch.
 2. Surface Course: Plus ¼-inch, no minus.
- B. Surface Smoothness: compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 1. Base Course: 3/8-inch.
 2. Surface Course: ¼-inch.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Replace and compact crushed granite surfacing where core tests are taken.
- C. Remove and replace or install additional crushed granite surfacing where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321500

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SECTION 321613 - PRECAST CONCRETE CURBING

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. Section includes
 - 1. Precast concrete curbs in straight, radial and transition pieces.
 - 2. Precast concrete flush curbs in straight, radial and transition pieces.
- B. Related Requirements:
 - 1. Section 321313 "Concrete Paving".

1.3 REFERENCE STANDARDS

- A. Form 817-2016 shall mean the State of Connecticut, Department of Transportation Standard specifications for Roads, Bridges and Incidental Construction, Form 817-2016 or its latest edition and any supplemental specifications.

1.4 PERMITS/APPROVALS

- A. Obtain approval of construction and secure all permits for work in R.O.W. areas. Contractor shall be licensed to R.O.W. holder and pay all fees.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, curb layout, dimensions of individual components and profiles, and finishes for curbing pieces.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store precast concrete curbing on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.

MANSFIELD ELEMENTARY SCHOOL

1.7 FIELD CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- B. Weather Limitations for Mortar and Grout:
 - 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.
 - a. When ambient temperature exceeds 100 deg F (38 deg C), or when wind velocity exceeds 8 mph (13 km/h) and ambient temperature exceeds 90 deg F (32 deg C), set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of curb, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 CURBS

- A. Precast Concrete Curbs: conform to Form 817-2016 Article M.03.01 Class F and the following:
 - 1. Minimum 28 days compressive strength of 5,000 psi
 - 2. Air entrainment: 5 to 7 percent.
- B. Minimum length:
 - 1. Straight curbing – 80% of the curbs shall be furnished in lengths of not less than 6 feet, and the remaining 20% in lengths of not less than 4 feet, interspersed at random, to allow for closures.
 - 2. Radius curbing – curbs to be set on a radius **of 100 feet or less** shall be cast to the curve required, and their ends shall be cast on radial lines. Requirements for length of individual curbs in curved curbing vary with radii of curves.
 - 3. Provide inside and outside radius curb where indicated on the drawings.**
- C. Special pieces: provide slope transition curbs, 180-degree bullnose, 90-degree driveway corners, and other special pieces as indicated.

2.3 ACCESSORIES

- A. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

PART 3 - EXECUTION

MANSFIELD ELEMENTARY SCHOOL

3.1 EXAMINATION

- A. Examine areas indicated to receive curbing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Do not use curbing with chips, cracks, voids, discolorations, or other defects that might be visible in finished work.

- B. Curbing:

- 1. Install curbing to the lines, grades, and details shown in the drawings. Conform to Form 817-2016 Article 8.11.03, for precast concrete curbing; and the following requirements:

- a. Subgrade

- 1) Ensure all utility conduit have been installed prior to backfill/subgrade preparation. Prepare subgrade by removing all soft or spongy material and backfilling with suitable material.
 - 2) Compact the surface uniformly to 95% Modified AASHTO Laboratory density (ASTM D-1557, Method C).
 - 3) Coordinate testing of subgrade and base with the Owner. Do not install base materials until schedule testing procedures are complete.

- b. Base

- 1) Place maximum 6" layers.
 - 2) Compact each layer uniformly to 95% Modified AASHTO Laboratory density (ASTM D-1557, Method C).

- c. Curb Installation

- 1) Set on edge. Settle into place with a heavy wooden hand rammer.
 - 2) Joints:
 - a) Place concrete at the curb joints as shown on the drawings. Insure that top exposed edge of curb face is consistent and true to line and grade. Support curb as required until concrete cures and all backfill operations have been completed.
 - b) Point joints with mortar for the full depth and width of curbing. Conform to the details on the drawings.
 - c) Omit concrete bed and mortar joint at 50 (+/-) foot intervals along curb installation to allow for expansion.
 - 3) Backfill with approved material.

3.3 REPAIRING AND CLEANING

- A. Remove and replace curbing sections that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

MANSFIELD ELEMENTARY SCHOOL

- B. Cleaning: Remove excess grout from exposed curbing surfaces; wash and scrub clean.

END OF SECTION 321613

MANSFIELD ELEMENTARY SCHOOL

SECTION 321723 - SITE PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Parking lot markings, including parking bays, crosswalks, arrows, and Symbol of Access.
- B. Site driveway markings and crosswalk markings.

1.03 RELATED REQUIREMENTS

- A. Section 321216 - Asphalt Paving.
- B. Section 321313 - Concrete Paving.
- C. Section 321726 - Tactile Warning Surfacing:

1.04 REFERENCE STANDARDS

- A. Form 818: State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction.
- B. 2018 Connecticut State Building Code.
- C. FHWA MUTCD - Manual on Uniform Traffic Control Devices for Streets and Highways; U.S. Department of Transportation, Federal Highway Administration; Current Edition.

1.05 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- B. Certificates: Submit for each batch of paint stating compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Hot-Applied Waterborne Pavement Marking Paint:
 - 1. Hot-Applied: Article M.07.21 of Form 818, with a 2 minute drying time.
 - 2. Color: As indicated on Drawings or for roadway repair, match existing conditions.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- B. Clean surfaces thoroughly prior to installation.
 - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
- C. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.
- D. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.

3.03 INSTALLATION

- A. Comply with Form 818, Section 12.10, Epoxy Resin Pavement Markings and Form 818, Section 12.09, Painted Pavement Markings.
- B. Comply with FHWA MUTCD manual (<http://mutcd.fhwa.dot.gov>) for details not shown.
- C. Driveway Traffic Lanes: Use suitable mobile mechanical equipment that provides constant agitation of paint and travels at controlled speeds.
 - 1. Conduct operations in such a manner that necessary traffic can move without hindrance.
 - 2. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.
 - 3. If paint does not dry within expected time, discontinue paint operations until cause of slow drying is determined and corrected.
 - 4. Use hand application by pneumatic spray for application of paint in areas where a mobile paint applicator cannot be used.
- D. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.
 - 1. Mark the Symbol of Access at indicated parking spaces.
 - 2. Hand application by pneumatic spray is acceptable.
- E. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.04 DRYING, PROTECTION, AND REPLACEMENT

- A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
- B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.
- C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.
- D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.

MANSFIELD ELEMENTARY SCHOOL

E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.

F. Replace removed markings at no additional cost to Owner.

END OF SECTION 321723

SECTION 321816.13 - PLAYGROUND PROTECTIVE SURFACING

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. Section Includes:

1. Unitary, synthetic poured rubber, seamless surfacing.
2. Engineered wood fiber surfacing.

B. Related Requirements:

1. Section 312300 "Earthwork" for subgrade preparation and processed aggregate base for safety surfacing base course.

1.3 DEFINITIONS

- A. Definitions in ASTM F2223 apply to Work of this Section.
- B. Critical Height: Standard measure of shock attenuation according to ASTM F2223; same as "critical fall height" in ASTM F1292. According to ASTM F1292, this approximates "the maximum fall height from which a life-threatening head injury would not be expected to occur."
- C. SBR: Styrene-butadiene rubber.
- D. EPDM: Ethylene propylene diene monomer rubber.
- E. Unitary Surfacing: A protective surfacing of one or more material components bound together to form a continuous surface; same as "unitary system" in ASTM F2223.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of protective surfacing.
 1. Include plans, sections, placement and penetration details, and attachment to substrates.
 2. Include accessories and edge terminations.
 3. Include patterns made by varying colors of surfacing and details of graphics.

MANSFIELD ELEMENTARY SCHOOL

4. Include fall heights and use zones for equipment and structures specified in Section 116800 "Play Field Equipment and Structures," coordinated with the critical heights for protective surfacing.
- C. Samples for Initial Selection: For each type of exposed finish.
1. Include Samples of accessories involving color selection.
- D. Samples for Verification: For each type of protective surfacing and exposed finish.
1. Include Samples of accessories to verify color and finish selection.
 2. Unitary, Seamless Surfacing: Minimum 6 by 6 inches (150 by 150 mm).
 3. Loose-Fill Surfacing: Minimum 2 quart (0.95 L).
 4. Stabilizing Mats: Minimum 12 by 12 inches (300 by 300 mm).
 5. Drainage/Separation Geotextile: Minimum 12 by 12 inches (300 by 300 mm).

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Material Certificates: For each type of loose-fill surfacing.
- C. Product Certificates: For each type of unitary surfacing product.
- D. Certified Test Results: ASTM F1292, ASTM F1951, and ASTM 2075.
1. Product Test Reports: Based on evaluation of comprehensive test performed by a qualified testing agency, for each unitary synthetic playground surface system. Product test reports shall be current (within past 5 years) and include descriptions of test samples as specified in applicable ASTM standard specifications.
- E. Field quality-control reports.
- F. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For playground protective surfacing to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Loose Fill: Amount equal to 1 percent of amount installed, but no fewer than 3 units

MANSFIELD ELEMENTARY SCHOOL

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for materials and execution.
 - 1. Build mockups for protective surfacing including accessories.
 - a. Size: 48 inches (1200 mm) by 48 inches (1200 mm).
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Certifications:
 - 1. International Play Equipment Manufacturer's Association (IPEMA) certified.
- D. Standards and Guidelines: Comply with CPSC No. 325, "Public Playground Safety Handbook"; ASTM F1292; ASTM F1487; and ASTM F1951.

1.9 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree to repair or replace components of protective surfacing that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Reduction in impact attenuation as measured by reduction of critical fall height.
 - b. Deterioration of protective surfacing and other materials beyond normal weathering.
 - 2. Warranty Period:
 - a. Engineered Wood Fiber: 15 years from date of Substantial Completion.
 - b. Unitary seamless surfacing: 7 years from date of Substantial Completion.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- B. Store materials protected from exposure to harmful environmental conditions and at a minimum temperature of 40 degrees F and a maximum temperature of 90 degrees F.

MANSFIELD ELEMENTARY SCHOOL

1.11 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit playground surface system installation to be performed according to manufacturer's written instructions and warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain protective surfacing materials, including loose-fill accessories, from single source from single manufacturer.
 - 1. Provide geosynthetic accessories of each type from source recommended by manufacturer of protective surfacing materials.
 - 2. Provide secondary materials including adhesives, primers, and repair materials of type and from source recommended by manufacturer of playground surface system materials.

2.2 PERFORMANCE REQUIREMENTS

- A. Impact Attenuation: Critical fall height tested according to ASTM F1292.
- B. Accessibility Standard: Minimum surfacing performance according to ASTM F1951.
- C. Sieve Analysis, Heavy Metals, Tramp Metals according to ASTM F2075.
- D. IPEMA Certification Requirements.
- E. Consumer Product Safety Commission (CPSC) Guidelines.

2.3 UNITARY, DUAL-DENSITY, SEAMLESS SURFACING

- A. Description: Manufacturer's standard, site-mixed and applied, two-layer material with wearing layer over cushioning layer, with combined, overall thickness as required, tested for impact attenuation according to ASTM F1292 and for accessibility according to ASTM F1951.
 - 1. Wearing Layer: Formulation of recycled EPDM rubber particles, binder, and other organic and inorganic components.
 - a. Thickness: Nominal 1/2 inch, minimum 3/8 inch, maximum 5/8 inch.
 - b. Dry Static Coefficient of Friction (ASTM D2047): 1.0.
 - c. Wet Static Coefficient of Friction (ASTM D2047): 0.9.
 - d. Dry Skid Resistance (ASTM E303): 89.
 - e. Wet Skid Resistance (ASTM E303): 57.
 - 2. Cushioning Layer: Formulation of 100% recycled SBR particles and binder.
 - 3. Binder: Weather-resistant, UV-stabilized, flexible, nonhardening, 100 percent solids polyurethane .
 - 4. Mixes: Required mix proportions by weight.

MANSFIELD ELEMENTARY SCHOOL

- a. Cushioning Layer: 16+% urethane binder (as ratio: 14% urethane divided by 86% rubber. 14% urethane binder, 86% rubber (based on entire rubber and urethane mix).
- b. Wearing Layer: 22% urethane binder (ratio: 18% urethane divided by 82% rubber). 18% urethane binder, 82% rubber (based on entire rubber and urethane mix).
5. Critical Height: As indicated on Drawings.
6. Overall Thickness: Not less than as required for critical height indicated.
7. Primer/Adhesive: Manufacturer's standard primer and weather-resistant, moisture-cured polyurethane adhesive suitable for unit, substrate, and location.
8. Wearing Layer Color(s): As selected by Architect from manufacturer's full range. Colors shall be 50% color, 50% black, speckled mix.
 - a. Design: Where colored pattern is required, provide as indicated on Drawings.
9. Additional Performance Requirements:
 - a. Flammability (ASTM D2859): Pass.
 - b. Tensile Strength (ASTM D412): 60 psi (413 kPA).
 - c. Tear Resistance (ASTM D624): 140%.
 - d. Water Permeability: 0.4 gal/yd²/second.

2.4 ORGANIC LOOSE-FILL SURFACING

- A. Engineered Wood Fiber: ASTM F2075; containing no bark, leaves, twigs, or foreign or toxic materials; tested for accessibility according to ASTM F1951.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Dunning Playground Surfacing manufactured by Dunning Playground Surfacing, 105 Brickyard Road, Farmington, CT 06032, (860) 677-1616, or comparable product acceptable to the Landscape Architect.
 2. Critical Height: As indicated on Drawings.
 3. Uncompressed Material Depth: Not less than as required for critical height indicated.

2.5 LOOSE-FILL ACCESSORIES

- A. Stabilizing Mats: Water-permeable PVC or rubber mats tested for impact attenuation according to ASTM F1292, with anchoring system designed to anchor mat securely to subgrade through loose fill, and rated for use in the following locations:
 1. Under and in Front of Slide Exits: 4 inches below surface of protective surfacing.
 2. Under and Around Swings: 4 inches below surface of protective surfacing.
 3. Around Transfer Stations at Accessible Perimeter: 4 inches below surface of protective surfacing.
 4. At high-traffic areas and playground equipment where indicated on Drawings.
 5. Size: 3 feet by 5 feet.
 6. Color(s): As selected by Landscape Architect from manufacturer's full range.

2.6 GEOSYNTHETIC ACCESSORIES

- A. Drainage/Separation Geotextiles: Comply with Section 312300 "Earthwork", Filter Fabric.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for subgrade elevations, slope, and drainage and for other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and without high spots, ridges, holes, and depressions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Do not proceed with playground surfacing installation until all applicable site work, including substrate preparation, fencing, playground equipment installation and other relevant work, has been completed.

3.2 PREPARATION

- A. Prepare substrates to receive surfacing products according to protective surfacing manufacturer's written instructions.

3.3 INSTALLATION OF SAFETY SURFACING BASE COURSE

- A. Install base course over the prepared subgrade in accordance with the safety surfacing manufacturer's written instructions.
- B. Thoroughly compact base by using a tamper, roller, or combination of both, to a minimum of 95 percent optimum standard density per ASTM D698.
- C. The base course must be a level plane that is smooth and comparable in look to the subsurface of an asphalt road prior to paving. This requires significant attention to accomplish. String lines must be used to ensure an even plane is constructed.

3.4 INSTALLATION OF GEOSYNTHETIC ACCESSORIES

- A. Install geosynthetic accessories according to playground surface system manufacturer's and geosynthetic manufacturer's written instructions and in a manner that cannot become a tripping hazard.
 - 1. Drainage/Separation Geotextile: Completely cover area beneath protective surfacing, overlapping geotextile sides and edges a minimum of 8 inches (200 mm) with manufacturer's standard treatment for overlapping loosely laid seams.
 - a. Place seams parallel to direction of slides and travel of swings whenever possible.

3.5 INSTALLATION OF SEAMLESS SURFACING

- A. Mix and apply components of seamless surfacing according to manufacturer's written instructions to produce uniform, monolithic, and impact-attenuating protective surfacing of required overall thickness.
 - 1. Substrate Primer: Apply over prepared substrate at manufacturer's standard spreading rate for type of substrate.
 - 2. Poured Cushioning Layer: Spread evenly over primed substrate to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation, with a minimum of cold joints. Allow cushioning layer to cure for sufficient time so that indentations are not left in the cushioning layer from applicator foot traffic or equipment. Do not allow foot traffic or use of the base mat surface until it is sufficiently cured.
 - 3. Intercoat Primer: Over cured cushioning layer and any adjacent vertical barriers such as playground equipment support legs, apply primer at manufacturer's standard spreading rate.
 - 4. Wearing Layer: Spread over primed base course to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation and, except where color changes, with no cold joints. Finish surface to produce manufacturer's standard wearing-surface texture.
 - a. Design: Where colored pattern is required, place colored, design material as soon as previously placed material is sufficiently cured, using primer or adhesive if required by manufacturer's written instructions.
 - 5. Edge Treatment: As indicated on Drawings. Fully adhere edges to substrate with full coverage of substrate. Maintain fully cushioned thickness required to comply with performance requirements.

3.6 INSTALLATION OF LOOSE-FILL SURFACING

- A. Apply components of loose-fill surfacing according to manufacturer's written instructions to produce a uniform surface. Transport the loose-fill surfacing using only clean, chemical-free and grease-free wheelbarrows and tools. Use shovels and rakes to spread the loose-fill surfacing material.
- B. Loose Fill: Place loose-fill materials to required depth after installation of playground equipment support posts and foundations, stone base and geotextiles. Protect geotextile fabric and stone base from damage. Do not operate equipment directly on the geotextile fabric. Include manufacturer's recommended amount of additional material to offset mechanical compaction.
- C. Stabilizing Mats: Coordinate installation of mats and mat anchoring system with placing and compacting loose fill.
- D. Grading: Uniformly grade loose fill to an even surface free from irregularities.
- E. Compaction: After initial grading, mechanically compact loose fill before finish grading.
 - 1. Install the loose-fill materials in maximum 6-inch loose layers. Rake, level, wet and mechanically compact each layer twice with a flat surface compactor, changing direction 90-degrees for the second compaction. Repeat until the required depth is achieved.

MANSFIELD ELEMENTARY SCHOOL

- F. Finish Grading: Hand rake to a uniformly smooth finished surface and to required elevations.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests.
- B. Perform the following tests with the assistance of a factory-authorized service representative:
 - 1. Perform "Installed Surface Performance Test" according to ASTM F1292 for each protective surfacing type and thickness in each playground area.
 - 2. Perform installed-surface-performance tests at no less than one series of tests for each 1000 sq. ft. (100 sq. m) of each type and thickness of in-place protective surfacing or part thereof.
- C. Playground protective surfacing will be considered defective if it does not pass tests.

3.8 PROTECTION

- A. Prevent traffic over seamless surfacing for not less than 48 hours after installation.

END OF SECTION 321816.13

MANSFIELD ELEMENTARY SCHOOL

SECTION 321828 - ATHLETIC COURT SURFACING

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. Section Includes:
 - 1. Basketball Synthetic Court Striping
 - 2. Four Square and Hopscotch Court Striping
- B. Related Requirements:
 - 1. Section 32 12 16 "Asphalt Paving"

1.3 QUALITY ASSURANCE

- A. Submit list of similar project experience for Owner's review and approval prior to commencing work. Contractor shall demonstrate minimum 5 years of similar project experience. List shall detail similar type jobs successfully completed. Owner retains the right to disapprove any proposed surfacing installer.

1.4 SUBMITTALS

- A. Manufacturer specifications for components, color chart and installation instructions.
- B. Authorized Applicator certificate from the surface system manufacturer.
- C. Submit fully dimensioned shop drawing confirming dimensions and layout of basketball court, and of four square and hopscotch court.
- D. Current Material Safety Data Sheets (MSDS).
- E. Samples for Initial Selection: For court striping, each surface color used.
 - 1. Four (4) samples shall be labeled with manufacturer and product name.

PART 2 - PRODUCTS

2.1 COURT STRIPING

MANSFIELD ELEMENTARY SCHOOL

- A. Basis-of-Design Product: Plexicolor Line Paint as manufactured by a division of California Products Corporation, 150 Dascomb Road, Andover Massachusetts 0810, Tel: (978)-623-9980, Fax: (978)-623-9960, www.plexipave.com, info@plexipave.com, or approved equal.
 - 1. Plexicolor Line Paint: Shall comply with Specification 10.4 of California Products Corporation.
 - 2. Water: Shall be fresh and potable.
 - 3. Color: to be selected by Landscape Architect from manufacturer's full range of colors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect asphalt pavement to determine the pavement does not contain any deviation exceeding 1/8" along a 10' straight edge and that proper cross pitch is present.
- B. Insure that asphalt pavement has cured a minimum of 14 days prior to installation of surfacing.
- C. Layout all work prior to proceeding with surfacing system.

3.2 SURFACE PREPARATION

- A. Pressure clean the entire surface. Power blowers should be used to remove dust and debris. Pressure washing may be needed to remove stains. Pressure should be less than 2,500 lbs./in².
- B. Cracks should be filled with Court Patch Binder mix or crack-filling products compatible with acrylic finishes.

3.3 PLAYING LINE STRIPING

- A. After the surface has thoroughly dried the designated game lines shall be marked in accordance with the drawings. The markings shall be made using Plexicolor Line Paint on the designated color.

END OF SECTION 321828

MANSFIELD ELEMENTARY SCHOOL

SECTION 321828 - ATHLETIC COURT SURFACING

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. Section Includes:
 - 1. Basketball Synthetic Court Striping
 - 2. Four Square and Hopscotch Court Striping
- B. Related Requirements:
 - 1. Section 32 12 16 "Asphalt Paving"

1.3 QUALITY ASSURANCE

- A. Submit list of similar project experience for Owner's review and approval prior to commencing work. Contractor shall demonstrate minimum 5 years of similar project experience. List shall detail similar type jobs successfully completed. Owner retains the right to disapprove any proposed surfacing installer.

1.4 SUBMITTALS

- A. Manufacturer specifications for components, color chart and installation instructions.
- B. Authorized Applicator certificate from the surface system manufacturer.
- C. Submit fully dimensioned shop drawing confirming dimensions and layout of basketball court, and of four square and hopscotch court.
- D. Current Material Safety Data Sheets (MSDS).
- E. Samples for Initial Selection: For court striping, each surface color used.
 - 1. Four (4) samples shall be labeled with manufacturer and product name.

PART 2 - PRODUCTS

2.1 COURT STRIPING

MANSFIELD ELEMENTARY SCHOOL

- A. Basis-of-Design Product: Plexicolor Line Paint as manufactured by a division of California Products Corporation, 150 Dascomb Road, Andover Massachusetts 0810, Tel: (978)-623-9980, Fax: (978)-623-9960, www.plexipave.com, info@plexipave.com, or approved equal.
 - 1. Plexicolor Line Paint: Shall comply with Specification 10.4 of California Products Corporation.
 - 2. Water: Shall be fresh and potable.
 - 3. Color: to be selected by Landscape Architect from manufacturer's full range of colors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect asphalt pavement to determine the pavement does not contain any deviation exceeding 1/8" along a 10' straight edge and that proper cross pitch is present.
- B. Insure that asphalt pavement has cured a minimum of 14 days prior to installation of surfacing.
- C. Layout all work prior to proceeding with surfacing system.

3.2 SURFACE PREPARATION

- A. Pressure clean the entire surface. Power blowers should be used to remove dust and debris. Pressure washing may be needed to remove stains. Pressure should be less than 2,500 lbs./in².
- B. Cracks should be filled with Court Patch Binder mix or crack-filling products compatible with acrylic finishes.

3.3 PLAYING LINE STRIPING

- A. After the surface has thoroughly dried the designated game lines shall be marked in accordance with the drawings. The markings shall be made using Plexicolor Line Paint on the designated color.

END OF SECTION 321828

SECTION 323113 - CHAIN LINK FENCES AND GATES

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. Section Includes:
 - 1. Chain-link fences and gates.
 - 2. Pedestrian Swing gates with kick-plates and ADA compliant latch.
 - 3. Chain-link fence at basketball court with fabric inside the posts.
 - 4. Pre-engineered fence post anchoring system.
- B. Related Requirements:
 - 1. Section 03 30 00 "Cast-in-Place Concrete" for cast-in-place concrete post footings.
 - 2. Section 32 32 23 "Segmental Retaining Walls" for coordination of fence posts installed behind segmental retaining walls.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Fence and gate posts, rails, and fittings.
 - b. Chain-link fabric, reinforcements, and attachments.
 - c. Gates and hardware.
 - d. Pre-engineered fence post anchoring system.
- B. Shop Drawings: For each type of fence and gate assembly.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include accessories, hardware, gate operation, and operational clearances.
 - 3. Include fence post layout for coordination between pre-engineered fence post anchoring system and segmental retaining wall.
- C. Samples for Initial Selection: For each type of factory-applied finish.
- D. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.

MANSFIELD ELEMENTARY SCHOOL

1.5 QUALITY ASSURANCE

- A. Provide fences and gates as complete units produced by a single manufacturer, including necessary erection accessories, fittings, and fastenings.
- B. Installation shall be performed by the manufacturer or by an experienced chain link fence installer approved by the manufacturer.
- C. Provide a rigid, plumb finished fence structure, with fabric tight and in tension.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.7 COORDINATION

- A. Coordinate installation of pre-engineered fence post anchoring system for fences. Furnish setting drawings and directions for installing sleeves that are to be installed during construction of segmental retaining walls. Deliver such items to Project site in time for segmental retaining wall construction.

1.8 WARRANTY

- A. Special Warranty: Installer 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, the following:
 - a. 15-years: Deterioration of metals, metal finishes, and other materials beyond normal weathering.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined below, to design framework and foundations for chain link fences greater than 7-feet in height.
 - 1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product similar in material, design, and extent to those indicated for this Project.
- B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.
 - 1. Design Wind Load: As required by local Codes.
 - 2. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

MANSFIELD ELEMENTARY SCHOOL

- C. Lightning Protection System for chain link fences and gates directly under electrical utility lines or near electrical equipment: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle according to "CLFMI Product Manual" and requirements indicated below:
 - 1. Fabric Height: As indicated on Drawings.
 - 2. Steel Wire for Fabric: 2-inch mesh by 9-gauge (0.148-inch) core wire size (8-gauge finished wire).
 - 3. Polymer-Coated Fabric: ASTM F668, Class 2b over zinc-coated steel wire.
 - a. Color: To be selected by Landscape Architect from manufacturer's full range of standard and custom colors, according to ASTM F934.
 - 4. Selvage: Knuckled at both selvages.

2.3 FENCE FRAMEWORK

- A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 based on the following:
 - 1. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40.
 - a. Line Post: As indicated on Drawings.
 - b. End, Corner, and Pull Posts: As indicated on Drawings.
 - 2. Horizontal Framework Members: Intermediate top, and bottom rails according to ASTM F1043.
 - a. Top Rail: 1.66 inches in diameter.
 - 3. Brace Rails: ASTM F1043.
 - 4. Kick Plate: 1/8" galvanized steel plate on push side of gate, welded in place. Color to match gate.
 - 5. Metallic Coating for Steel Framework:
 - a. Hot-dipped galvanized with a minimum average 1.8 oz./sq. ft. of coated surface area.
 - 6. Polymer coating over metallic coating.
 - a. Color: Match chain-link fabric, according to ASTM F934.

2.4 SWING GATES

- A. General: ASTM F900 for gate posts and single and double swing gate types.
 - 1. Gate Leaf Width: As indicated.
 - 2. Framework Member Sizes and Strength: Based on gate fabric height as indicated.
- B. Pipe and Tubing:
 - 1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; protective coating and finish to match fence framework.
 - 2. Gate Posts: Round tubular steel.
 - 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded.
- D. Kick-plates for pedestrian gates:
 - 1. 1/8" galvanized steel plate on push side of gate

2. Full width of gate, from bottom of gate to 10" from bottom of gate
3. Weld in place
4. Finish to match gate

E. Hardware:

1. Hinges type:
 - a. Hinges, general: Structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 180 degrees as indicated on the drawings.
2. Latch types:
 - a. Latches, general: Forked type capable of retaining gate in closed position permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Keeper: Provide keeper for each gate leaf. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.
4. Double Gates: Provide drop rod to hold inactive leaf. Provide gate stop pipe to engage center drop rod. Provide locking device and padlock for locking both gate leaves.

2.5 FITTINGS

A. Provide fittings according to ASTM F626.

1. Post Caps: Provide for each post. Caps to be made from formed steel, cast malleable iron, or aluminum alloy to provide weather tight enclosure.
2. Provide dome caps for terminal posts.
3. Provide line post caps with loop to receive top rail.

B. Rail and Brace Ends: For each gate, corner, pull, and end post.

C. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.

D. Tension and Brace Bands: Pressed steel.

E. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

F. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

G. Tie Wires, Clips, and Fasteners: According to ASTM F626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:
 - a. Hot-Dip Galvanized Steel: 0.148-inch- diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

H. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.
 - a. Polymer coating over metallic coating.

MANSFIELD ELEMENTARY SCHOOL

2.6 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with 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.

2.7 PRE-ENGINEERED FENCE POST ANCHORING SYSTEM

- A. Fence Post Anchoring System: Pre-engineered below-grade fence post anchoring system for enhancing fence foundation stability in segmental retaining wall applications. Anchoring system shall integrate stable fence footings into the support structure of a segmental retaining wall with geogrids while it is being constructed. Units shall consist of a tower with perforated lid to support fence post and concrete fill and integral cantilever support base.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Sleeve-It SD-1 Post Foundation System as manufactured by Strata Systems, Inc., (800) 680-7750 or www.geogrid.com, or a comparable product acceptable to Landscape Architect.
 - 2. Composition: 95% post-consumer recycled high density polypropylene.
 - 3. Dimensions:
 - a. Total Unit Weight: 7 pounds.
 - b. Total Unit Height: 23.4 inches.
 - c. Total Unit Width: 15.3 inches.
 - d. Total Unit Depth: 30.6 inches.
 - e. Total Unit Volume: 1.673 cu. ft.
 - f. Base Height: 1.5 inches.
 - g. Perforated Lid Aperture: 9.4 inches x 7.4 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified 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.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 PRE-ENGINEERED FENCE POST ANCHORING SYSTEM

- A. Install pre-engineered fence post anchoring system in accordance with the manufacturer's written instructions when the segmental retaining wall has been constructed to two feet from proposed top, not including capstone.
- B. When installing fencing, posts must be concreted into the sleeve cavity. Posts shall extend a minimum distance of 18 inches into the sleeve to ensure proper engagement with the fence foundation system. All posts must be on the inboard side of vertical portion of cantilever base. Fill cavity completely with concrete. Protect aboveground portion of posts from concrete splatter.
- C. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

3.4 CHAIN-LINK FENCE INSTALLATION

- A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.
 - 1. Install fencing on established boundary lines inside property line.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. 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.
 - a. Concealed Concrete: Place top of concrete 2 inches below grade as indicated on Drawings to allow covering with surface material.
 - b. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
- D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.
- E. Line Posts: Space line posts uniformly at not more than 10 feet o.c., except behind segmental retaining walls. Coordinate line post spacing behind segmental retaining walls with pre-engineered fence post anchoring system spacing requirements.
- F. Post Bracing and Intermediate Rails: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
 - 1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

MANSFIELD ELEMENTARY SCHOOL

- G. Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- H. Intermediate and Bottom Rails: Secure to posts with fittings.
- I. Chain-Link Fabric: Apply fabric to outside of enclosing framework, with the exception of the basketball court, which shall have fabric inside the framework. Leave 1-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.
- K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- L. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 GATE INSTALLATION

- A. 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.

3.6 ADJUSTING

- A. 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.
- B. Lubricate hardware and other moving parts.

END OF SECTION 323113

MANSFIELD ELEMENTARY SCHOOL

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SECTION 323119 - METAL PICKET FENCES AND GATES

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. Section Includes:
 - 1. Metal picket steel fences and gates.
 - 2. Metal picket steel pedestrian gates with kick-plates, self-closing hydraulic hinges and panic bar exit hardware.
- B. Related Requirements:
 - 1. Section 03 30 00 "Cast-in-Place Concrete" for concrete post concrete fill.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fencing and gates.
 - 1. Include plans, elevations, sections, gate locations, post spacing, and mounting attachment details.
- C. Samples: For each fence and gate material for each color and finish specified.
 - 1. Provide samples 12 inches in length for linear materials.

1.4 CLOSEOUT SUBMITTALS

- A. Operating and Maintenance Manuals: Provide manufacturer's operating and maintenance manuals for exit hardware, locking devices and hinges. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representative. The final copies delivered after completion of the installation test to include as built modifications made during installation, checkout and acceptance. Furnish any specialized tools needed for Owner's continued adjustment, maintenance and removal and replacement of gate hardware.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Include 8 foot length of fence complying with requirements.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

MANSFIELD ELEMENTARY SCHOOL

- C. Source Limitations: Obtain each type and variety of hardware from a single source, qualified supplier unless otherwise indicated.

1.6 WARRANTY

- A. Powder-coat finish: 10 years.
- B. Defects in framework materials and workmanship: 10 years.
- C. Exit devices: 10 year mechanical.

PART 2 - PRODUCTS

2.1 METALLIC-COATED-STEEL TUBULAR PICKET FENCES AND GATES

- A. Metallic-Coated-Steel Tubular Picket Fences and Gates: Comply with ASTM F2408 for industrial application (class) unless otherwise indicated.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Ameristar Aegis II Majestic design 3-Rail manufactured by Ameristar Fence Products, Inc. in Tulsa, Oklahoma or comparable product by Master Halco or Merchants Metals.
 - 2. Finish Color: Custom non-standard color to match Architect's sample.

2.2 MATERIAL

- A. Steel material for fence framework (i.e. tubular pickets, rails and posts), shall be galvanized prior to forming in accordance with the requirements of ASTM A653/A653M, with minimum yield strength of 45,000 psi (310 MPa). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft² (276 g/m²), Coating Designation G-90.
- B. Material for pickets shall be 1" square x 14 Ga. tubing. The cross-sectional shape of the rails shall conform to the manufacturer's ForeRunner™ double wall design with outside cross-section dimensions of 1.75" square and a minimum thickness of 14 Ga. Picket holes in the ForeRunner rail shall be spaced 4.715" o.c. Picket retaining rods shall be 0.125" diameter galvanized steel. High quality PVC grommets shall be supplied to seal all picket-to-rail intersections. Fence posts and gateposts for fences up to and including 6-foot height shall meet the minimum size requirements as follows, unless noted otherwise:
 - 1. Fence posts: 2-1/2-inch by 12-gauge.
 - 2. Posts for gate leaves up and including 6-foot wide: 3-inches by 12-gauge.
 - 3. Posts for gate leaves 6-feet to 10-feet wide: 4-inches by 11-gauge.
 - 4. Posts for gate leaves 10-feet to 16-feet wide: 6-inches by 3/16-inch.

2.3 FABRICATION

- A. Pickets, rails and posts shall be precut to specified lengths. ForeRunner rails shall be prepunched to accept pickets. Pickets shall be predrilled to accept retaining rods.
- B. Grommets shall be inserted into the prepunched holes in the rails and pickets shall be inserted through the grommets so that predrilled picket holes align with the internal upper raceway of the ForeRunner rails (Note: This can best be accomplished by making an alignment jig).

MANSFIELD ELEMENTARY SCHOOL

Retaining rods shall be inserted into each ForeRunner rail so that they pass through the predrilled holes in each picket.

- C. The manufactured galvanized framework shall be subjected to the PermaCoat® thermal stratification coating process (high-temperature, in-line, multi-stage, multi-layer) including, as a minimum, a six-stage pretreatment/wash, an electrostatic spray application of an epoxy base, and a separate electrostatic spray application of a polyester finish. The base coat shall be a thermosetting epoxy powder coating (gray in color) with a minimum thickness of 2 mils (0.0508mm). The topcoat shall be a “no-mar” TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508mm). The color shall be a custom non-standard color to match Architect’s sample. The stratification-coated framework shall be capable of meeting the performance requirements for each quality characteristic shown in Table 2.
- D. Completed sections (i.e., panels) shall be capable of supporting a 600 lb. load applied at midspan without permanent deformation. Panels shall be biasable to a 25% change in grade.
- E. Swing gates shall be fabricated using 1.75” x 14ga Forerunner double channel rail, 2” sq. x 11 ga. gate ends, and 1” sq. x 14ga. pickets. Gates that exceed 6’ in width will have a 1.75” sq. x 14ga. intermediate upright. All rail and upright intersections shall be joined by welding. All picket and rail intersections shall also be joined by welding. Gusset plates will be welded at each upright to rail intersection. Cable kits will be provided for additional trussing for all gates leaves over 6’. Finish and color to match adjacent metal picket fence.
- F. Pedestrian swing gates shall be self-closing, having a gate leaf no larger than 48” width.

2.4 SWING GATES

- A. Gate Configuration: As indicated.
- B. Gate Frame Height: As indicated.
- C. Gate Opening Width: As indicated.
- D. Gate Finish and Color: To match adjacent metal picket fence. Custom non-standard color to match Architect’s sample.
- E. Steel Frames and Bracing: Fabricate members from square steel tubing 2 by 2 inches (51 by 51 mm) with 11 gauge wall thickness.
- F. Frame Corner Construction: Welded and 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) wide or wider.
- G. Additional Rails: Provide as indicated, complying with requirements for fence rails.
- H. Infill: Comply with requirements for adjacent fence.
- I. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.
- J. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet (1.52 m) wide. Provide center gate stops and cane bolts for pairs of

gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

- K. Pedestrian Gate Hinge: Integrated hinge-closer set (2 qty) shall be ADA compliant that shall include a variable speed and final snap adjustment with compact design (no greater than 5" x 6" footprint). Hinge-closer set (2 qty) shall be tested to a minimum of 500,000 cycles and capable of self-closing gates up to a maximum gate weight of 260 lbs. and maximum weight load capacity of 1,500 lbs. Hinge-closer device shall be externally mounted with tamper-resistant security fasteners, with full range of adjustability, horizontal (.5" - 1.375") and vertical (0 - .5"). Maintenance free hinge-closer set shall be tested to operate in temperatures of negative 20 F to 200 F degrees, and swings to negative 2 degrees to ensure reliable final lock engagement.
- L. Non-Pedestrian Gate Hinge: Heavy Duty barrel hinge with grease fitting.
- M. Panic Tube: As indicated on Drawings and sized to meet the requirements of exit hardware and trim. Finish and color to match gate.
- N. Exit Hardware: BHMA A156.3, Grade 1, Type 4 (narrow stile rim exit device), with push pad actuating bar, corrosion resistant and suitable for exterior use. Provide exit device rails factory sized for proper gate leaf width application. Mounting rails to be formed from smooth stainless steel no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted steel or aluminum metal rails are not acceptable. Heavy-duty metal end caps shall be formed from the same base metal as the push and mounting rails. Exit device latch shall be stainless steel, pullman-type with deadlock feature. Devices shall be available with matching or similar trim. Provide manufacturer's recommended strike, suitable for exterior use and application.
 - 1. Basis-of-Design: Subject to compliance with requirements, provide Advantex Series as manufactured by Detex Corporation, 302 Detex Drive, New Braunfels, TX (800) 729-3839, or comparable product acceptable to Landscape Architect.
 - a. Rim Device: 40xW Weatherized Narrow Stile Rim Exit Device.
 - b. Device Finish: To be selected by Landscape Architect from manufacturer's full range of standard and non-standard colors.
 - 2. Function: 08 – Entrance by lever. Key locks and unlocks lever.
 - 3. Performance Requirements:
 - a. UL Listed Panic Hardware.
 - b. UL 1034-34 Temperature Section 34 (Temperature Range -31 degrees F to 150 degrees F).
 - c. UL1034-54 Dust Section 54.
 - d. MIL-STD 810F, Method 506.4 (driving rain test).
 - e. MIL-STD 810F, Method 509.4 (salt fog test).
 - 4. Provide all necessary proper fasteners as required by manufacturer.
 - 5. Device must fit flat against mounting channel with no gaps that permit unauthorized dogging of the push bar. The addition of filler strips is not acceptable.
- O. Lever Operating Trim: Furnish and install exit device manufacturer's heavy duty trim suitable for exterior use.
 - 1. Basis-of-Design: Subject to compliance with requirements, provide Advantex Series Trims as manufactured by Detex Corporation, 302 Detex Drive, New Braunfels, TX 78130, (800) 729-3839, or comparable product acceptable to Landscape Architect.
 - a. Trim: DN Narrow Stile Lever Trim.
 - 1) Lever: S Lever.

MANSFIELD ELEMENTARY SCHOOL

- 2) Finish: To be selected by Landscape Architect from manufacturer's full range of standard and non-standard colors.
 - 3) Function: Entrance by Lever. Key locks or unlocks lever.
 - 4) Cylinder: 7-pin IC Core cylinder housing.
- P. Security Plate: Provide security plate as indicated on Drawings to prevent tampering with locking device from outside fence. Finish and color to match gate.
- Q. Kick-plate Tube: As indicated on Drawings to meet ADA requirements. Finish and color to match gate.
- R. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 1/2-inch- (12.7-mm-) diameter, round steel bars, hot-dip galvanized after fabrication. Finish and color to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.
- S. Finish exposed welds to comply with NOMMA Guideline 1, Finish #1.

2.5 MISCELLANEOUS MATERIALS

- A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi , 3-inch slump, and 1-inch maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C387/C387M mixed with potable water according to manufacturer's written instructions.
- B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended by manufacturer for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
 1. Install fencing on established boundary lines inside property line.

MANSFIELD ELEMENTARY SCHOOL

3.3 FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.
- C. 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 and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Concealed Concrete: Top 2 inches below grade to allow covering with surface material. Slope top surface of concrete to drain water away from post.
 - 3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
 - 4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.
 - a. Extend posts at least 5 inches into sleeve.
 - b. After posts have been inserted in sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.
 - 5. Space posts uniformly at 8 feet o.c.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. 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.

3.5 ADJUSTING

- A. 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.
- B. Lubricate hardware and other moving parts.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain gates and hardware.

END OF SECTION 323119

SECTION 323124 - SOLID CELLULAR PVC FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
 - 1. Solid cellular PVC plastic lumber fence and gates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fences and gates.
 - 1. Fence and gate posts, rails, and fittings.
 - 2. Gates and hardware.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
- C. Samples for Verification: Prepared on Samples of size indicated below:
 - 1. Submit samples for verification of PVC color in form of 3-inch lengths of actual product to be used in color selection

1.4 INFORMATIONAL SUBMITTALS

- A. Installer Qualifications: Engage an experienced installer who has at least three years experience and has completed at least five Solid Cellular PVC fence and gate projects with same material and of similar scope to that indicated for this project with a successful construction record of in-service performance.
- B. Product Certificates: For each type of fence, and gate, from manufacturer.
- C. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer is to be qualified by having been in the business of making custom exterior cellular PVC structures for over 5 years.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- C. Allowable Tolerances:

MANSFIELD ELEMENTARY SCHOOL

1. Variation in component length: -0.00 / +1.00"
2. Variation in component width: $\pm 1/16$ "
3. Variation in component thickness: $\pm 1/16$ "
4. Variation in component edge cut: $\pm 2^\circ$
5. Variation in Density -0% + 10%

D. Workmanship, Finish, and Appearance:

1. Free foam cellular PVC that is homogeneous and free of voids, holes, cracks, and foreign inclusions and other defects. Edges must be square and top and bottom surfaces shall be flat with no convex or concave deviation.
2. Uniform surface free from cupping, warping, and twisting.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- B. Trim materials should be stored on a flat and level surface on a full shipping pallet. Handle materials to prevent damage to product edges and corners. Store materials under a protective covering to prevent jobsite dirt and residue from collecting on the boards.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for fences and gates shown on the drawings in relation to the property survey and existing structures. Verify dimensions by field measurements.
- B. Verify locations of underground utilities and irrigation system.

1.8 WARRANTY

- A. Provide manufacturer's standard limited warranty for products, stating that components will be free from defects in material that occur as a direct result of the manufacturing process, occur under normal use and service, occur during the warranty period and result in blistering, peeling, flaking, cracking, splitting, cupping, rotting or structural defects from termites or fungal decay.
 1. Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COMPONENT ASSEMBLIES:

- A. Basis-of-Design Product: Subject to compliance with requirements, provide reinforced cellular PVC fence and gate system assemblies and components fabricated by Walpole Woodworkers, 1079 Farmington Ave., Rt. 4, Farmington, CT 06032, Phone: 860-677-9690 or comparable product by Atlas Outdoor, 30 Northeast Industrial Road, Branford CT or Paragon Fence, LLC, PO Box 93, Southington CT.

2.2 PLASTIC LUMBER:

- A. AZEK Trimboards manufactured by Azek Building Products, Inc., 894 Prairie Ave.; Wilmington, OH 45177; Toll Free Tel: 877-ASK-AZEK; Tel: 570-346-8797.
 - 1. Material: Free foam cellular PVC material with small-cell microstructure.
 - 2. Minimum performance and physical characteristic requirements:
 - a. Density: 0.55 g/cm³ (ASTM D 792)
 - b. Water Absorption: 0.15% (ASTM D 570)
 - c. Tensile Strength: 2256 psi (ASTM D 638)
 - d. Tensile Modulus: 144,000 psi (ASTM D 638)
 - e. Flexural Strength: 3329 psi (ASTM D 790)
 - f. Flexural Modulus psi 144,219 (ASTM D 790)
 - g. Nail Hold: 35 Lbf/in of penetration (ASTM D 1761)
 - h. Screw Hold: 680 Lbf/in of penetration (ASTM D 1761)
 - i. Staple Hold: 180 Lbf/in of penetration (ASTM D 1761)
 - j. Gardner Impact: 103 in-lbs (ASTM D 5420)
 - k. Charpy Impact (@23°C): 4.5 ft-lbs (ASTM D 256)
 - l. Coefficient of Linear Expansion: 3.2 x 10⁻⁵ in/in/°F (ASTM D 696)
 - m. Burning Rate: No burn when flame removed (ASTM D 635)
 - n. Flame Spread Index: 25 (ASTM E 84)
 - o. Heat Deflection Temp 264 psi: 150 °F (ASTM D 648)
 - p. Oil Canning (@140°F): Passed (ASTM D 648)
- B. Structural Framework: Extruded seamless cellular PVC fabrications of sizes as shown on the Drawings. Reinforced with aluminum or steel shapes, and designed for minimal deflection under load.
- C. Boards: Tongue and groove solid extruded seamless cellular PVC.
- D. Finish: All materials to be spray painted and oven dried in custom color with two coats of with Sherwin-Williams vinyl safe paint and carrying a warranty of 25 years.
 - 1. Color: As selected by Architect from manufacturer's full range of colors.

2.3 GATES

- A. Double Gate: Gates shall be internally reinforced solid cellular PVC lumber to match adjacent solid board fence. Comply with 2.2 PLASTIC LUMBER above.
 - 1. Gate Configuration: As indicated.
 - 2. Gate Opening Width: As indicated.
 - 3. Gate Height: As indicated.
 - 4. Gate Color: Match adjacent solid board fence of same material. Comply with 2.2 PLASTIC LUMBER finish above.
 - 5. Gate Frames: Fabricate gate frame from structural steel tubing welded to form rigid one-piece unit. Minimum size: 4" square, per manufacturer's shop drawings.
 - 6. Bracing: Provide diagonal bracing on gates to prevent sag as required, per manufacturer's shop drawings.
 - 7. Hardware materials: Hot dipped galvanized steel or malleable iron shapes to suit gate size. Field coat moveable parts with special coating provided by manufacturer, to match adjacent finishes.
 - 8. Hinges: Heavy Duty hinges structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 180.

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9. Latch: Forked or slide bolt type capable of retaining gate in closed position and have provision for padlock. Latch shall permit operation from either side of gate.
10. Keeper: Provide keeper for each gate leaf. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.
11. Double Gates: Provide drop rods to hold each leaf. Provide gate stop pipes to engage center drop rods. Provide locking device and padlock eyes as an integral part of latch, requiring one padlock for locking both gate leaves.
12. Steel post: Schedule 40 galvanized standard-weight steel pipe complying with ASTM A 53/A 53M, or electric-resistance-welded pipe complying with ASTM A 135/A 135M.
 - a. Pipe OD: Not less than 6-5/8 inches.
 - b. Installation Method: Cast in concrete
 - c. Steel Finish: Galvanized

2.4 ACCESSORIES

- A. Fasteners: Provide fasteners recommended by the manufacturer, of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Use stainless steel unless otherwise indicated.
- B. Adhesives: Cellular PVC cement: AZEK Adhesive.
- C. Sealants: Urethane, polyurethane, or acrylic based sealants without silicone.

2.5 CONCRETE

- A. Concrete: CDOT Form 816, Article M.03.01, Class "C".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify areas to receive fencing are completed to final grades and elevations.
- B. Ensure property lines and legal boundaries are clearly established.

3.2 INSTALLATION

- A. Drill post holes into firm undisturbed or compacted earth as detailed. Align each post for vertical and top alignment. Secure in position and fill with concrete up to within 3" of ground surface. Trowel finish around posts and slope to direct water away from posts.
- B. Gate posts and corner posts on all fences and line posts on taller fences shall be filled with concrete for additional strength.
- C. Set gate posts for gate opening specified in the construction drawings
- D. Install fence in accordance with the manufacturer's installation instructions, accurately to required lines and levels, true, plumb and level.

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- E. Check each post for vertical and top alignment, and maintain in position during placement and finishing operation.
- F. Gate Installation;
 - 1. Install gates plumb, level and secure using bolt-on hardware supplied by the manufacturer.
 - 2. Adjust hardware for smooth operation.

3.3 CLEANING

- A. Clean up during installation and upon completion of fencing work. Remove from site all waste and excess materials, debris, tools, and equipment. Repair any damage resulting from fence installation.

END OF SECTION 323124

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SECTION 323223 - SEGMENTAL RETAINING WALLS

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 single-depth segmental retaining walls with and without soil reinforcement.
- B. Related Requirements:
 - 1. Section 312300 "Earthwork" for excavation for segmental retaining walls.
 - 2. Section 323113 "Chain Link Fences and Gates" for pre-engineered fence post anchoring system units.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each color and texture of concrete unit specified. Submit full-size units.
- C. Delegated-Design Submittal: For segmental retaining walls, to comply with performance requirements and design criteria. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer licensed in the State of Connecticut.
- B. Product Certificates: For each type of segmental retaining wall unit and soil reinforcement from manufacturer.
 - 1. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D6638.
- C. Research/Evaluation Reports: For segmental retaining wall units and soil reinforcement, from ICC-ES.
- D. Preconstruction test reports.
- E. Source quality-control reports.

MANSFIELD ELEMENTARY SCHOOL

1.5 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 D6706.
 - 2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D5321.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.
- B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F (71 deg C) or below 32 deg F (0 deg C), and other conditions that might damage them. Verify identification of geosynthetics before use, and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of another manufacturer are proposed, engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design segmental retaining walls.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer using performance requirements and design criteria indicated.
- C. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.
- D. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."
 - 1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
 - 2. Superimposed loads (surcharge) indicated on Drawings.
- E. Seismic Performance: Engineering design shall be based on the loads and factors due to soil pressures resulting from grades indicated and be according to NMCA's "Segmental Retaining Walls – Seismic Design Manual."

MANSFIELD ELEMENTARY SCHOOL

- F. Design Parameters: As cited in the “Geotechnical Study for New Mansfield Elementary School, 134 Warrenville Road, Mansfield, CT” prepared by Dr. Clarence Welti, P.E., P.C., dated April 27, 2020.

2.2 SEGMENTAL RETAINING WALL UNITS

- A. Concrete Units: ASTM C1372, 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. Basis-of-Design Product: Subject to compliance with requirements, provide “RomanWall” units by Unilock or a comparable product acceptable to Architect.
 - 2. Provide units that comply with requirements in ASTM C1372 for freeze-thaw durability.
 - 3. Provide units that interlock with courses above and below by means of integral lugs, lips, or tongues and grooves.
- B. Color: “Granite”.
- C. Shape and Texture: Provide units with smooth tops and rock face on front and back of all units, and rock face on side of closed-end coping units as indicated.,
 - 1. Face Dimensions: As indicated.
- D. Batter: Provide units that allow vertical installation with no batter.
- E. Cap Units: Provide “Ledgestone” cap units of shapes indicated with smooth, as-cast top surfaces without holes or lugs. Provide fullnose coping, coping and closed-end coping units as indicated on Drawings.
 - 1. Color: Grey.
- F. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face as indicated.

2.3 INSTALLATION MATERIALS

- A. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.
- B. Leveling Base and Drainage Fill: Comply with requirements in Section 312300 "Earthwork" for 3/4-inch crushed stone.
- C. Reinforced-Soil Fill: Comply with requirements in Section 312300 "Earthwork" - and Project geotechnical report for backfill requirements.
- D. Nonreinforced-Soil Fill: Comply with requirements in Section 312300 "Earthwork" for satisfactory soils.
- E. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

MANSFIELD ELEMENTARY SCHOOL

1. Apparent Opening Size: No. 70 to 100 (0.212- to 0.150-mm) sieve, maximum; ASTM D4751.
 2. Minimum Grab Tensile Strength: 110 lb (49.9 kg); ASTM D4632.
 3. Minimum Weight: 4 oz./sq. yd. (132 g/sq. m).
- F. Subdrainage Pipe and Filter Fabric: Comply with requirements in Section 334211 "Stormwater Gravity Piping" and Section 312300 "Earthwork."
- G. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement and as follows:
1. Miragrid 3XT manufactured by TenCate Geosynthetics North America, or comparable product acceptable to delegated design engineer.
 2. Product Type: Knitted or woven geogrid made from polyester yarns with a protective coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.
- B. Do not use units with chips, cracks, or other defects where such defects are exposed in the completed Work.
- C. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D698.
- D. 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.
- E. 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.

1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
3. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.

F. Cap Units: Place cap units and secure with cap adhesive.

3.3 FILL PLACEMENT

- A. General: Comply with requirements in Section 312300 "Earthwork," with NCMA's "Segmental Retaining Wall Installation Guide," and with 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 D698.
 - 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 D698.
 3. Compact nonreinforced-soil fill to comply with Section 312300 "Earthwork."
- D. 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.
- E. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.
- F. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at wall base away from wall. Provide uniform slopes that prevent ponding.
- 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.

MANSFIELD ELEMENTARY SCHOOL

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.

3.4 PRE-ENGINEERED FENCE POST ANCHORING SYSTEM

- A. Install pre-engineered fence post anchoring system behind wall in accordance with manufacturer's written installation instructions.
- B. Prepare level area approximately 24 inches wide by 36 inches deep behind the wall face. The prepared area should be 24 inches below the proposed top of wall (not including capstone).
- C. Place fence post anchoring units on level surface in an upright position with the front edge of the unit flush against the back of the wall. Multiple units should be spaced in accordance with fence specifications.
- D. Encapsulate and stabilize the units by placing and compacting sufficient backfill material layers as required. If geogrid is required, slit the geogrid perpendicular to the wall face just enough to fit around the base of the unit while ensuring that the geogrid remains properly attached to the wall. Continue the backfilling process until the material reaches the top of the tower. Do not remove perforated lid until ready to place fence post. Do not step on perforated lid.
- E. Coordinate with fence installer for installation of fence posts.

3.5 CONSTRUCTION TOLERANCES

- A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet (32 mm in 3 m), 3 inches (75 mm) maximum.
- B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet (32 mm in 3 m).
- C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet (32 mm in 3 m).
- D. Maximum Gap between Units: 1/8 inch (3 mm).

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Comply with requirements in Section 312300 "Earthwork" for field quality control.
 1. In each compacted backfill layer, perform at least one field in-place compaction test for each 24 inches (600 mm) of fill depth and each 50 feet (15 m) or less of segmental retaining wall length.

MANSFIELD ELEMENTARY SCHOOL

3.7 ADJUSTING

- A. Remove and replace segmental retaining wall construction of the following descriptions:
 - 1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Architect approves methods and results.
 - 2. Segmental retaining walls that do not match approved Samples.
 - 3. Segmental retaining walls that do not comply with other requirements indicated.
- B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 323223

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MANSFIELD ELEMENTARY SCHOOL

SECTION 323300 - SITE FURNISHINGS

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. Section Includes:
 - 1. Backed benches.
 - 2. Trash receptacles.
 - 3. Bicycle racks.
 - 4. Concrete-filled pipe bollards and bollard covers.
- B. Related Requirements:
 - 1. Section 03 31 00 "Cast-in-Place Concrete" for cast in place concrete post footings.
 - 2. Section 055213 "Exterior Pipe and Tube Railings" for galvanized steel pipe for bollards.
 - 3. Section 31 23 00 "Earthwork" for excavation for installing concrete footings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.
- C. Samples for Initial Selection: For units with factory-applied finishes.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 BENCH

- A. Basis-of-Design Product: Subject to compliance with the requirements, provide products indicated on the Drawings, "Austin" backed bench by Landscape Forms, Inc., 431 Lawndale Avenue, Kalamazoo, Michigan 49048. Toll Free (800) 521-2546. Phone (269) 381-0396. Fax (269) 381-3455 or "Trio" backed bench by Forms + Surfaces or "800 Series" backed bench MBE-0870-00025 by Maglin Site Furnishings.
- B. "Austin" Backed benches:
 - 1. Benches
 - a. Style: Freestanding/Surface Mount style with end arms both ends.
 - b. Depth: 24 inches.

MANSFIELD ELEMENTARY SCHOOL

- c. Overall Height: 33 inches.
- d. Length: 72 inches.

C. Materials

1. Seat and back panels panels: Exterior wood, Ipe, no finish.
2. Frame, Legs, and Arms: Supports: Cast ductile iron. End caps, back straps and optional arm rests: 319 cast aluminum

D. Accessories

1. For Concrete Substrates: 3/8" stainless steel wedge or epoxy anchors with minimum 2-1/2" embedment in conformance with manufacturer's installation instructions. Provide stainless steel shims or washers to level benches before tightening anchors.
2. For Asphalt Substrates: BoltHold SP10-38S stainless steel asphalt anchors by Asphalt Anchors Corp., www.asphaltanchors.com or comparable product. Adhesive: EPX2 grout provided by the anchor manufacturer or epoxy acceptable to the anchor manufacturer.

E. Recycled Content

1. Recycled Material Content: Minimum 48 percent.
2. Post-Consumer Material Content: Minimum 26 percent.
3. Pre-Consumer Material Content: Minimum 22 percent.
4. Recyclable: 100 percent.

F. Fabrication

1. Assembly: Shop assembled.

G. Finishes

1. Finish on Metal: Landscape Forms, Inc. "Pangard II".
 - a. Primer: Rust inhibitor on ferrous supports.
 - b. Topcoat: Thermosetting TGIC polyester powder coat. UV, chip, and flake resistant.
 - c. Test Results: "Pangard II".
 - 1) Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
 - 2) UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
 - 3) Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
 - 4) Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
 - 5) Erichsen Cupping, ISO 1520: 8 mm.
 - 6) Impression Hardness, Buchholz, ISO 2815: 95.
 - 7) Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
 - 8) Pencil Hardness, ASTM D 3363: 2H minimum.
 - 9) Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max. undercutting 1 mm.
 - 10) Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max. blisters 1 mm.
2. Color: Custom color from full range of standard, premium and metallic colors, to be selected by Architect.

2.2 TRASH AND LITTER RECEPTORS

- A. Basis-of-Design Product: Subject to compliance with the requirements, provide products indicated on the Drawings, "Chase Park" litter receptacle by Landscape Forms, Inc., 431 Lawndale Avenue, Kalamazoo, Michigan 49048. Toll Free (800) 521-2546. Phone (269) 381-

MANSFIELD ELEMENTARY SCHOOL

0396. Fax (269) 381-3455 or “NSDC-45” receptacle by Stanley or “Urban Renaissance” receptacle by Forms + Surfaces.

B. “Chase Park” Litter Receptacles

1. Style:
 - a. Top-Opening Style
 - 1) Top opening, 5-inch diameter for Recycle
 - 2) Top opening, 10-inch diameter for trash
2. Mounting:
 - a. Surface mounted
3. Signage:
 - a. For top-opening recycling litter: To be selected by the Architect.
 - b. For top-opening trash litter: To be selected by the Architect.

C. MATERIALS

1. Base: Rotationally molded linear low density polyethylene. Color is dark gray. Base is filled with concrete for stability.
2. Sides and Door: Cast 319 aluminum.
3. Hinges: Two, carbon steel with silver Magni-coat, connects sides and door.
4. Latch: carbon steel with silver Magni-coat
5. Lock Cam, and Lock Plate: Type 304 Stainless steel.
6. Lid: 0.100-inch thickness, spun 1100-0 aluminum.
7. Lid Bracket: 1-inch by 1-inch by 1/4-inch aluminum angle.
8. Liners: Black, formed polyethylene.
9. Single liner, top opening litter, 40 gallon capacity
10. Fasteners: Stainless steel.
11. Security Cable: 1/16-inch diameter, 24-inch long, nylon-coated stainless steel wire rope with eye fittings.
12. Recycling sign backer plates: Two 8-inch wide by 6-inch tall by 1/8-inch thick, 3003 or 5052 aluminum plates welded to back panel and door.
13. Recycling sign decals: Two 5-inch tall by 7-inch long, exterior-grade vinyl.

D. ACCESSORIES

1. Anchor Bolts: Stainless Steel, provided by the installer.

E. RECYCLED CONTENT

1. Post-Consumer Material Content: Minimum 10 percent.
2. Pre-Consumer Material Content: Minimum 48 percent.
3. Recyclable: 100 percent.

F. FABRICATION

1. Shop assembled litter receptacles.

G. FINISHES

1. Finish on Metal: Landscape Forms, Inc. “Pangard II”.
 - a. Primer: Rust inhibitor.
 - b. Topcoat: Thermosetting polyester powdercoat. UV, chip, and flake resistant.
 - c. Test Results: “Pangard II”.
 - d. Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
 - e. UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
 - f. Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
 - g. Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
 - h. Erichsen Cupping, ISO 1520: 8 mm.

MANSFIELD ELEMENTARY SCHOOL

- i. Impression Hardness, Buchholz, ISO 2815: 95.
 - j. Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
 - k. Pencil Hardness, ASTM D 3363: 2H minimum.
 - l. Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.
 - m. Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.
2. Color: Custom color from full range of standard, premium and metallic colors, to be selected by Architect.

2.3 BICYCLE RACKS

- A. Basis-of-Design Product: Subject to compliance with the requirements, provide products indicated on the Drawings, “Metro40 - Ride” bike rack by Landscape Forms, Inc., 431 Lawndale Avenue, Kalamazoo, Michigan 49048. Toll Free (800) 521-2546. Phone (269) 381-0396. Fax (269) 381-3455 or “1600 Series” bike rack MBE-1600-00007 by Maglin Site Furnishings or “EP 5950” bike rack by Equiparc.
- B. “Metro40 – Ride” Bike Rack
1. Frame: Aluminum Casting – 319 ASTM B26 or 356 ASTM B108 & LFI 7.4.2-A1.
 2. Adjustable Leveler: Stainless steel round bar 303 ASTM A581, A582.
 3. Anchor Cover: Aluminum Casting – 319 ASTM B26 or 356 ASTM B108 & LFI 7.4.2-A1.
 4. Anchor Set Screw: 1/4-20 x 1.50" set screw, cup point, hex drive, magni-coated.
 5. Capacity per rack: 2 bikes.
 6. Surface Mount.
- C. FINISHES
1. Finish on Metal: Landscape Forms, Inc. “Pangard II”.
 - a. Primer: Rust inhibitor.
 - b. Topcoat: Thermosetting polyester powdercoat. UV, chip, and flake resistant.
 - c. Test Results: “Pangard II”.
 - d. Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
 - e. UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
 - f. Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
 - g. Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
 - h. Erichsen Cupping, ISO 1520: 8 mm.
 - i. Impression Hardness, Buchholz, ISO 2815: 95.
 - j. Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
 - k. Pencil Hardness, ASTM D 3363: 2H minimum.
 - l. Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.
 - m. Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.
 2. Color: Custom color from full range of standard, premium and metallic colors, to be selected by Architect.

2.4 CONCRETE FILLED PIPE BOLLARDS

- A. Pipe: Schedule 40 galvanized steel pipe.
- B. Concrete: Connecticut Department of Transportation Standard Specifications Form 816-2004, Article M.03.01, Class ‘C’.
- C. Bollard Covers:

MANSFIELD ELEMENTARY SCHOOL

1. Basis-of-Design Product: Subject to compliance with the requirements, provide product indicated on the Drawings, 1/4-Inch Dome-Top Plastic Bollard Cover manufactured by Ideal Shield, 2525 Clark Street, Detroit MI 48209-1355. Tel: 877-325-0769.
 - a. Dome top low-density polyethylene thermoplastic tubes having ultra-violet resistance and anti-static properties
 - b. Nominal thickness of 0.250 inch.
 - c. Sleeves to shield nominal pipe diameters: 5-inches and 8-inches.
 - d. Sleeve height: as detailed.
 - e. Sleeve color: as selected by the Architect from standard pantone colors.
 - f. Surface of sleeve to be smooth with round top; no ribbed or two-piece systems will be accepted.
 - g. Secure with manufacturer's neoprene adhesive tape; no screws, glue, or clamping will be accepted.

2.5 FABRICATION

- A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- E. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.6 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. ALUMINUM FINISHES
 1. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.
- C. STEEL AND GALVANIZED-STEEL FINISHES
 1. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

MANSFIELD ELEMENTARY SCHOOL

- D. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.
- D. Post and Anchor Setting: Set cast-in support posts and anchor castings in concrete footing with smooth top, shaped to shed water. Protect portion of posts and anchors above footing from concrete splatter. Verify that posts and anchors are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts and anchors in position during placement and finishing operations until concrete is sufficiently cured.
- E. Do not install damaged, cracked, chipped, deformed, or marred furnishings. Field touch up minor imperfections in accordance with manufacturer's instructions. Replace furnishings that cannot be field repaired.
- F. Bollard cover sleeve: install with manufacturer's neoprene adhesive per manufacturer's installation guidelines.

3.3 CLEANING AND PROTECTION

- A. Protect furnishings from damage.
- B. Immediately prior to Substantial Completion, clean furnishings in accordance with manufacturer's instructions to remove dust, dirt, adhesives, and other foreign materials.
- C. Touch up damaged finishes according to manufacturer's instructions..

END OF SECTION 323300

MANSFIELD ELEMENTARY SCHOOL

SECTION 329115 - SOIL PREPARATION (PERFORMANCE SPECIFICATION)

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. Section includes planting soils specified according to performance requirements of the mixes.
- B. Related Requirements:
 - 1. Section 31 10 00 "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Section 32 92 00 "Turf and Grasses" for placing planting soil for turf and grasses.
 - 3. Section 32 93 00 "Plants" for placing planting soil for plantings.

1.3 DEFINITIONS

- 1. AAPFCO: Association of American Plant Food Control Officials.
- 2. CEC: Cation exchange capacity.
- 3. Compacted Soil: Soil having a density greater than the threshold for root limiting. Acceptable compaction is 75-85% Standard Proctor density. Compaction greater than 85% is root limiting, and compaction greater than 90% is excessive.
- 4. Imported Soil: Soil that is transported to Project site for use.
- 5. NAFT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
- 6. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- 7. 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.
- 8. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- 9. SSSA: Soil Science Society of America.
- 10. 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.
- 11. 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.
- 12. 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.
- 13. USCC: U.S. Composting Council.

MANSFIELD ELEMENTARY SCHOOL

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include recommendations for application and use.
 - 2. Include test data substantiating that products comply with requirements.
 - 3. Include sieve analyses for aggregate materials.
 - 4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
 - a. Manufacturer's qualified testing agency's certified analysis of standard products.
 - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
 - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- B. Samples: For each bulk-supplied material, 1-gal. volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.5 INFORMATIONAL SUBMITTALS

- A. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
- B. 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.
- B. The Contractor shall be qualified and experienced in the construction of athletic fields, shall have the necessary specialized equipment and personnel, and shall have successfully completed at least three comparable athletic field projects.
- C. The Contractor shall provide a full-time onsite supervisor experienced in the construction of sports fields.
- D. Only agricultural or landscaping machinery designed for preparing the finished grades and other operations shall be used to complete this phase of work. Laser guided equipment shall be used to complete the finish grading of the Athletic Fields.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.
 - 1. Notify Landscape Architect seven days in advance of the dates and times when laboratory samples will be taken.

MANSFIELD ELEMENTARY SCHOOL

- B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
 - 1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.8 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Landscape Architect under the direction of the testing agency.
 - 1. Number and Location of Samples: Minimum of three representative soil samples for each soil to be used or amended for landscaping purposes. Each representative sample shall consist of not less than 10 soil cores from varied locations; thoroughly mixed.
 - 2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
 - 3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
 - 4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.9 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:
 - 1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
 - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
- C. Chemical Testing:
 - 1. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. Include recommendations for corrective action if RCRA metals exceed the Connecticut DEEP residential requirements for direct exposure criteria.
 - 2. Phytotoxicity: Test for plant-available concentrations of phytotoxic materials using the simple growth test for phytotoxicity performed by the Connecticut Agricultural Experiment Station Soil Testing Laboratory, 123 Huntington Street, P.O. Box 1106, New Haven, CT 06504. Phone: (203) 974-8521. Include recommendations for corrective action.
- D. Fertility Testing: Soil fertility analysis according to standard laboratory protocol of SSSA NAPT NEC-67, including the following:
 - 1. Percentage of organic matter.
 - 2. CEC, calcium percent of CEC, and magnesium percent of CEC.
 - 3. Soil reaction (acidity/alkalinity pH value).
 - 4. Nitrogen ppm.

MANSFIELD ELEMENTARY SCHOOL

5. Phosphorous (P₂O₅) ppm.
6. Potassium ppm.
7. Calcium ppm.
8. Magnesium ppm.
9. Boron ppm.
10. Copper ppm.
11. Iron ppm.
12. Manganese ppm.
13. Manganese-availability ppm.
14. Sulfur ppm.
15. Zinc ppm.
16. Zinc availability ppm.
17. Sodium ppm.
18. Soluble-salts ppm.
19. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
20. Other deleterious materials, including their characteristics and content of each.

- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for adjusting soil pH; and for fertilizing with nitrogen, phosphorous, potassium, and micronutrients.
- G. Infiltration Rate Testing: For rain garden planting mix Type III.
1. To be tested in the field during construction.
 - a. Minimum target infiltration rate is 5 inches per hour.
 2. Test results reviewed by the Architect for determination if Type III mix needs adjustment in the percentage of components.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Do not move or handle materials when they are wet or frozen.
 4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

1.11 PROJECT CONDITIONS

- A. Prevent excessive compaction of soils. Do not handle soils when wet or frozen. Utilize small tracked equipment for grading. Loosen any over-compacted soils prior to finish grading.

MANSFIELD ELEMENTARY SCHOOL

- B. Protect slopes and swales until establishment of permanent vegetative cover. Conform to Erosion and Sedimentation Control requirements.
- C. Blending operations for amending and conditioning topsoil shall be conducted on-site in a dry, orderly and controlled location, as approved by the Architect. Bulk-mixing operations shall produce consistent dry soil blends. Mixing location and operations are subject to the Architect's approval.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED ACCORDING TO PERFORMANCE REQUIREMENTS

- A. Planting-Soil Type I: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Using preconstruction soil analyses and materials specified in other articles of this Section, amend existing, on-site surface soil to become planting soil complying with the following requirements:
 - 1. Percentage of Organic Matter: Minimum 4 to 8 percent by volume.
 - 2. Soil Reaction: pH of 6 to 7 except for acid loving plants the pH shall be 4.5 to 5.5.
 - 3. Soluble-Salt Content: Less than 2.0 mmhos/cm saturation media extract.
 - 4. Fertility: N, P, K, Mg and CA in amounts recommended by the testing laboratory for the turf types and plant groups to be installed.
 - 5. Remove subsoil and nonsoil materials, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, sod, grass, weeds, roots, and other waste materials.
 - 6. Planting soil for the Athletic Fields shall be screened through a 1-inch screen.
 - 7. RCRA Metals: Below maximum limits established by the CT DEEP.
 - 8. Phytotoxicity: Satisfactory soil test for phytotoxicity result.
- B. Planting-Soil Type II: Imported, naturally formed topsoil from off-site sources and consisting of sandy loam soil according to USDA textures; and modified to produce viable planting soil. Amend imported soil with materials specified in other articles of this Section to become planting soil complying with the following requirements:
 - 1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from 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 brome grass.
 - 2. Additional Properties of Imported Soil before Amending:
 - a. Minimum of 2 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
 - b. Soil Reaction: pH of 5.5 to 7.5.
 - c. Moisture Content: 25 percent to 55 percent.
 - d. Soluble salts: Less than 2.5 mmhos/cm saturation media extract.
 - e. Stone and debris: Less than 5 percent by weight.
 - f. Foreign matter: Less than 0.05 percent by weight.
 - g. Particle sizes:
 - 1) 100 percent by volume must pass through a 2 inch sieve.
 - 2) 95 percent or more by volume must pass through a 3/4 inch sieve.
 - 3) Not more than 60 percent of the soil by weight shall be less than 0.05 mm (very fine sand) of which no more than 25 percent by weight shall consist of particles less than 0.002 mm (clay).

MANSFIELD ELEMENTARY SCHOOL

- h. Clean soil to be free of the following:
 - 1) 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.
 - 2) Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the imported soil.
 - 3) Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.
3. Properties of Imported Soil after Amending:
 - a. Percentage of Organic Matter: Minimum 5 to 6 percent by volume.
 - b. Soil Reaction: pH of 6 to 7 except for acid loving plants the pH shall be 4.5 to 5.5.
 - c. Soluble-Salt Content: Less than 2.0 mmhos/cm saturation media extract.
 - d. Moisture Content: 30 percent to 55 percent.
 - e. Foreign matter: Less than 0.5 percent by weight.
 - f. Particle Sizes:
 - 1) 100 percent by volume must pass through a 2 inch screen.
 - 2) 95 percent or more by volume must pass through a 3/4 inch screen.
 - g. Mechanical Analysis:
 - 1) Sand content (0.05 mm to 2.0 mm particle size) shall be 45 to 75 percent of the total weight (average 60 percent).
 - 2) Silt content (0.002 mm to 0.05 mm particle size) shall be 15 to 35 percent of the total weight (average 25 percent).
 - 3) Clay content (less than 0.002 mm particle size) shall be 5 to 20 percent (average 15 percent).
 - h. Fertility: N, P, K, Mg and CA in amounts recommended by the testing laboratory for the turf types and plant groups to be installed.
 - i. RCRA Metals: Below maximum limits established by the CT DEEP.
 - j. Phytotoxicity: Satisfactory soil test for phytotoxicity result.
 - k. Planting soil for Athletic Fields shall be screened through a 1 inch screen.
- C. Planting-Soil Type III: Soil meeting the requirements of Type I or Type II above, and amended to improve storm water quality, for use in rain gardens.
 1. Amended Mix Proportions
 - a. 60-70% sand conforming to paragraph D of Article 2.2 below.
 - b. 15-25% double shredded bark mulch conforming to paragraph A of Article 2.3, Section 329300.
 - c. 15-25% planting soil conforming to Type I or Type II above, except with pH of 5.2 to 7.0.
 2. Amended Mix Soil Reaction: pH of 5.2 to 7.0.

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 90 percent calcium carbonate equivalent and as follows:
 1. Percent by weight passing through square mesh sieves:
 - a. 100 percent passing No. 10 sieve.
 - b. Minimum 90 percent passing No. 20 sieve.
 - c. Minimum 40 percent passing No. 100 sieve.
 2. Form: Provide lime in form of ground dolomitic limestone.

MANSFIELD ELEMENTARY SCHOOL

- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. 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: Yard or leaf waste.
 - 2. Reaction: pH of 5.5 to 7.5.
 - 3. Soluble-Salt Concentration: Less than 2 mmhos/cm saturation media extract.
 - 4. C:N Ratio: 12:1 to 25:1.
 - 5. Moisture Content: 35 to 55 percent by weight.
 - 6. Organic-Matter Content: 20 to 40 percent of dry weight.
 - 7. Maximum Particle Sizes: Smaller than 3/8-inch.
 - 8. Foreign Matter: Less than 0.1 percent dry weight man-made foreign matter.
 - 9. Stability: The maturity of the compost shall be tested and reported using the Solvita Compost Maturity Test and must score 6 or higher to be acceptable.
 - 10. Compost shall be produced by CT DEEP-regulated, permitted, or approved facilities.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.

2.4 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 2.5 Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.

3.2 EXAMINATION

- A. Verify that all subgrades have been shaped and formed to lines and levels needed to achieve the finished grades noted on the Drawings, and to provide for uniform thicknesses of planting soil as scheduled herein.
 - 1. Athletic Fields: Verify that all Athletic Field subgrades are within (+/-) 0.1-percent of the proposed grade.
- 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.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.3 PLACING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply planting 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: Scarify subgrade to a minimum depth of 6 inches with the teeth of a backhoe or loader bucket, tiller or other suitable device. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.
- C. Spread planting soil immediately following the Geotechnical Engineer's approval of the prepared subgrades. Do not leave approved subgrades exposed to weather. Protect loosened shaped subsoil surfaces from disturbance.
- D. Spread planting soil at uniform depths as scheduled using track equipment; starting at the edges of the athletic fields or other areas to receive the planting soil. Work the soil materials out onto the surface to prevent the grading equipment from disturbing the subgrade. Keep grading equipment away from direct contact with the subgrade.
- E. Protect planting soil from over-compaction. Sequence operations to minimize the number of equipment passes required. Use lightest weight equipment practicable. Do not allow rubber-tired equipment on areas where planting soil has been installed. Do not work wet or frozen soil.
 - 1. Final density of planting soil and subsoil shall be a minimum of 75-percent of Standard Proctor Density but not to exceed 85-percent of Standard Proctor Density.
- F. If required by soil test results, apply agricultural limestone, superphosphate, muriate of potash, and other amendments at the rates recommended by the test report. Apply uniformly over the surface and cultivate thoroughly into the top 6-inches of planting soil.
- G. Finish Grading:
 - 1. Grading in athletic field areas shall produce a uniform surface true to the design grades with no deviations greater than 1/2" in 300' when the fine grading is done.
 - 2. Grading in lawns and planting areas shall produce a smooth, uniform surface plane with loose, uniformly fine texture.
 - 3. Roll and rake, remove ridges, and fill depressions to meet finish grades.

MANSFIELD ELEMENTARY SCHOOL

4. All finished planting soil surfaces shall pitch to drains or adjacent curbs or pavements. Leave no areas where standing water can collect.

- H. Manually apply planting soil under the branch spread of trees to remain. Apply by topdressing, to avoid damaging root systems.
- I. Replace planting soil in eroded, settled or damaged areas until all seeded areas are stabilized.

3.4 PLACING AND COMPACTION OF RAIN GARDEN (TYPE III) PLANTING SOIL

- A. Scarify the rain garden subgrade prior to filter media (planting soil) placement.
- B. The rain garden planting soil shall be placed and graded using low ground-contact pressure equipment or by excavators and/or backhoes operating on the ground adjacent to the rain garden.
- C. No heavy equipment shall be used within the perimeter of the bioretention facility before, during, or after the placement of the rain garden planting soil.
- D. The rain garden planting soil shall be placed in horizontal layers not to exceed 12 inches for the entire area of the rain garden.
- E. Saturate the entire area of the rain garden after each lift of soil is placed until water flows from the underdrain. Water for saturation shall be applied by spraying or sprinkling. Saturation of each lift shall be performed in the presence of the Drainage Engineer. An appropriate sediment control device shall be used to treat any sediment-laden water discharged from the underdrain.
- F. Final grading of the rain garden planting soil shall be performed after a 24-hour settling period.
- G. If the rain garden planting soil becomes contaminated during the construction of the basin, the contaminated material shall be removed and replaced with uncontaminated material.
- H. Do not use pesticides, herbicides or fertilizers in the rain garden planting soils.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests:
 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.
 2. Performance Testing: For each amended planting-soil type, demonstrating compliance with specified performance requirements. Perform testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
- C. Soil will be considered defective if it does not pass tests.
- D. Prepare test and inspection reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

MANSFIELD ELEMENTARY SCHOOL

3.6 PROTECTION

- A. Protection Zone: Identify protection zones according to Project Arborist's Tree Preservation drawings.
- 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. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.7 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. 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.

3.8 SCHEDULE OF PLANTING SOILS

- A. New Lawns: 6 inches of Type I or Type II planting soil.
- B. Athletic Fields: 6 inches of Type I or Type II planting soil.
- C. Renovate Existing Lawns: Use Type I or Type II planting soil for minor regrading and other applications as specified in Section 3292 00 "Turf and Grasses".
- D. Tree Planting: Type I or Type II planting soil; depth required based on root ball size.
- E. Continuous Planting Bed for Shrubs: Not less than 18 inches of Type I or Type II planting soil.
- F. Groundcovers/Perennials Continuous Planting Bed: Not less than 12 inches of Type I or Type II planting soil.
- G. Rain Garden : 24 inches of Type III planting soil.
- H. Disturbed Areas not otherwise indicated: 6 inches of Type I or Type II planting soil.

END OF SECTION 329115

MANSFIELD ELEMENTARY SCHOOL

SECTION 329200 - TURF AND GRASSES

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. Section Includes:
 - 1. Installation of athletic fields.
 - a. Athletic field seed mix
 - b. Athletic field sod
 - 2. Seeding and hydroseeding lawns and no-mow fescue lawns.
 - 3. Maintenance and grow-in.
 - 4. Rain garden seed mix.
 - 5. Northeast native wildflower and grass mix.
- B. Related Requirements:
 - 1. Section 32 91 15 "Soil Preparation (Performance Specification)" for planting soil requirements.
 - 2. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- 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 32 91 15 "Soil Preparation (Performance Specification)" and drawing designations for planting soils.
- C. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 ACTION SUBMITTALS

- A. Product data for each type of product.
- B. Submit final field survey or athletic field grades prior to seeding.

MANSFIELD ELEMENTARY SCHOOL

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Qualification Data: For athletic field Installer.
 - 1. Submit for approval a list of at least three comparable athletic field projects successfully completed by the Contractor, which demonstrate the Contractor's experience with athletic field construction.
 - 2. Submit for approval the name and athletic field construction experience of the Contractor's onsite supervisor.
 - 3. Submit for approval a list of equipment intended for use in the construction of athletic fields. List shall demonstrate that the Contractor is adequately equipped to minimize the use of rubber-tired equipment and vehicles, except for agricultural and landscape machinery, to limit compaction to the subgrade, subsoil, and topsoil layers caused by heavy loading.
 - 4. Submit for approval a list of equipment intended for use in maintaining the athletic fields during the three-month Field Maintenance period.
- C. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture for turfgrass seed and sod. Include identification of source and name and telephone number of supplier.
- D. Product Certificates: For fertilizers, from manufacturer.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of lawns, no mow fescue lawns, and rain garden and meadow mixes during the calendar year. Submit before expiration of required maintenance periods.
 - 1. Include written recommendations from the seed producers for maintaining No Mow Fescue Lawns, Rain Garden Seed Mix, and Wildflower and Grass Seed Mix.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Three years' experience in turf installation in addition to requirements in Section 01 40 00 "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
- B. The athletic field installer shall provide a full-time onsite supervisor experienced in the construction of sports fields.

MANSFIELD ELEMENTARY SCHOOL

- C. Field Survey by Contractor: The Contractor shall employ and pay for a licensed independent land surveyor to survey all Athletic Field surfaces on a 25-foot grid to ensure that the topsoil is at the proper elevations prior to the seeding of the fields. Any areas that are off by more than 1/4-inch are to be re-graded to within tolerance prior to seeding.

1.8 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. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Planting soil shall not be delivered or worked in a frozen or muddy condition.

1.9 FIELD CONDITIONS

- A. Provide protection and security as necessary to prevent damage to athletic field and lawn areas by any cause, including vandalism and unauthorized usage, prior to acceptance of seeded areas by the Owner.
- B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting acceptance.
 - 1. Athletic Fields:
 - a. Athletic Field seeding is to be performed between August 15 and September 15, unless otherwise approved by the Architect due to weather or soil conditions.
 - b. Athletic Field work including seeding will not be done if weather or soil conditions will not permit the work to be performed satisfactorily. The permissible final seeding date may be extended for each day that the work is suspended due to weather up until October 16, after which the seeding will be delayed until the following spring.
 - 2. Lawns, and detention basin grasses and wildflowers:
 - a. Spring Planting: April 1 to June 15.
 - b. Fall Planting: August 15 to October 1.
 - 3. No Mow Fescue Lawns:
 - a. Fall planting preferred August 15 to October 1.
 - b. Spring planting: April 1 to **May 15**.
 - 4. Rain garden mix:
 - a. Fall planting August 15 to October 1.
 - b. Spring planting: March 15 to **May 15**.
 - 5. Northeast native wildflower and grass mix:
 - a. Fall planting August 15 to October 1.

MANSFIELD ELEMENTARY SCHOOL

- b. Spring planting: March 15 to **May 15**.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.
- D. Watering: The Contractor shall bear sole responsibility for the furnishing and application of all irrigation water, irrespective of whether or not an irrigation system is installed or operable. The Contractor shall ensure that all irrigation water is applied at the proper frequency, coverage and in the proper amounts to fulfill the plant establishment and maintenance requirements of the Contract. The Contractor's responsibility for all watering shall begin upon delivery of plants to the site, and shall continue through the end of the Warranty period.
 - 1. If no irrigation system is available, or if an available irrigation system is unsatisfactory to the Contractor's needs, then the Contractor shall furnish and apply all irrigation water.
 - 2. If an existing irrigation system is made available for the Contractor's use, and if the Contractor elects to utilize this irrigation system; then the Contractor shall accept total responsibility for ensuring that the system is satisfactorily adjusted and operated while utilized by the Contractor.
 - 3. If an irrigation system is to be provided or design/built under this Contract, and if the Contractor elects to utilize this irrigation system; then the Contractor shall coordinate with the irrigation designer, installer and operator, and shall accept total responsibility for ensuring that the system is satisfactorily adjusted and operated while utilized by the Contractor.

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, with not less than 80 percent germination, not less than 97 percent pure seed, and not more than 0.5 percent weed seed.

2.2 SEED MIXES

- A. Athletic Field Seed Mix:
 - 1. Basis-of-Design Product: Subject to requirements, provide "Hart's Triple Team PLUS Mixture" produced by The Chas. C. Hart Seed Company, Wethersfield CT or a comparable product by Valley Green or NE Seed.
 - 2. Proportioned by weight as follows:
 - a. 32 percent: Amity Tall Fescue.
 - b. 29 percent: Corbett Tall Fescue.
 - c. 29 percent: ZigZag rhizomatous Tall Fescue.
 - d. 10 percent: Tumalo Kentucky Bluegrass.
 - 3. The seed mixture is to have no noxious weeds or other crop seeds. Other cultivars may be substituted for the above listed cultivars with the approval of the Architect, however substitute cultivars must show good traffic tolerance based on the National Turfgrass

MANSFIELD ELEMENTARY SCHOOL

Evaluation Program and must contain the same number of species and cultivars with their percentage by weight in the mixture as specified above.

- B. Lawn Seed Mix:
1. Proportioned by weight as follows:
 - a. 40 percent: equal proportions of 2 or more improved Kentucky bluegrass (*Poa pratensis*) varieties.
 - b. 40 percent: equal proportions of 2 or more improved creeping red fescue (*Festuca rubra*) varieties.
 - c. 20 percent: 1 or more improved variety of perennial ryegrass (*Lolium perenne*).
- C. No Mow Fescue Lawn Seed Mix:
1. Basis-of-Design Product: Subject to requirements, provide “No-Mow Lawn Seed Mix” produced by Prairie Nursery, Inc., Westfield, WI www.prairienursery.com or a comparable product by The Chas. C. Hart Seed Company or Valley Green.
 - a. Proprietary seed mix of fresh, clean, and dry new seed consisting of Hard Fescues (*Festuca brevipila*), Sheep Fescue (*Festuca ovina*), Chewings Fescue (*Festuca rubra* subs. *fallax*), Red Fescue (*Festuca rubra*), and Creeping Red Fescue (*Festuca rubra* var. *rubra*).
 2. Nurse crop: Oats.
- D. RAIN GARDEN MIX
1. Rain Garden Seed Mixes: ERNMX-180 Fresh, clean, and dry new seed, of mixed species produced by Ernst Seeds, 8884 Mercer Pike, Meadville, PA 16335; sales@ernstseed.com (800) 873-3321, or comparable product matching composition below that is acceptable to Landscape Architect.
 2. Mix Composition:
 - a. 33.4% *Schizachyrium scoparium*, 'Itasca', (Little Bluestem, 'Itasca')
 - b. 20.0% *Elymus virginicus*, (Virginia Wildrye)
 - c. 7.0% *Carex vulpinoidea*, (Fox Sedge)
 - d. 5.6% *Chasmanthium latifolium*, (River Oats)
 - e. 5.5% *Echinacea purpurea* (Purple Coneflower)
 - f. 3.0% *Chamaecrista fasciculata*, (Partridge Pea)
 - g. 3.0% *Coreopsis lanceolata* (Lanceleaf Coreopsis)
 - h. 3.0% *Panicum clandestinum*, (Deertongue,)
 - i. 3.0% *Panicum rigidulum*, (Redtop Panicgrass,)
 - j. 3.0% *Rudbeckia hirta*, (Blackeyed Susan)
 - k. 3.0% *Verbena hastata*, (Blue Vervain)
 - l. 2.0% *Heliopsis helianthoides*, (Oxeye Sunflower)
 - m. 1.8% *Asclepias incarnata*, (Swamp Milkweed)
 - n. 1.0% *Carex scoparia*, (Blunt Broom Sedge)
 - o. 1.0% *Senna hebecarpa*, (Wild Senna)
 - p. 0.5% *Aster novae-angliae*, (New England Aster)
 - q. 0.5% *Aster prenanthoides*, (Zigzag Aster)
 - r. 0.5% *Baptisia australis*, (Blue False Indigo,)
 - s. 0.5% *Pycnanthemum tenuifolium* (Narrowleaf Mountainmint)
 - t. 0.5% *Zizia aurea* (Golden Alexanders)
 - u. 0.4% *Monarda fistulosa*, (Wild Bergamot)
 - v. 0.3% *Eupatorium coelestinum*, (Mistflower)
 - w. 0.3% *Eupatorium perfoliatum*, (Boneset)
 - x. 0.3% *Helenium autumnale*, (Common Sneezeweed)

MANSFIELD ELEMENTARY SCHOOL

- y. 0.3% *Juncus tenuis*, (Path Rush)
- z. 0.2% *Juncus effusus* (Soft Rush)
- aa. 0.2% *Solidago nemoralis*, (Gray Goldenrod)
- bb. 0.2% *Solidago rugosa*, (Wrinkleleaf Goldenrod,)

E. NORTHEAST NATIVE WILDFLOWER AND GRASS SEED MIX

1. Showy northeast native wildflower and grass seed mix: ERNMX-153 Fresh, clean, and dry new seed, of mixed species produced by Ernst Seeds, 8884 Mercer Pike, Meadville, PA 16335; sales@ernstseed.com (800) 873-3321, or comparable product matching composition below that is acceptable to Landscape Architect.
2. Mix Composition:
 - a. 30.5% *Schizachyrium scoparium*, 'Camper' (Little Bluestem, 'Camper')
 - b. 30.0% *Bouteloua curtipendula*, (Sideoats Grama)
 - c. 15.0% *Elymus virginicus*, (Virginia Wildrye)
 - d. 4.0% *Echinacea purpurea* (Purple Coneflower)
 - e. 3.5% *Chamaecrista fasciculata*, (Partridge Pea)
 - f. 3.0% *Coreopsis lanceolata* (Lanceleaf Coreopsis)
 - g. 3.0% *Rudbeckia hirta*, (Blackeyed Susan)
 - h. 2.0% *Heliopsis helianthoides*, (Oxeye Sunflower)
 - i. 1.2% *Liatris spicata* (Marsh Blazing Star)
 - j. 1.0% *Tradescantia ohiensis*, (Ohio Spiderwort)
 - k. 0.7% *Pycnanthemum tenuifolium* (Narrowleaf Mountainmint)
 - l. 0.7% *Senna hebecarpa*, (Wild Senna)
 - m. 0.5% *Asclepias tuberosa* (Butterfly Milkweed)
 - n. 0.5% *Baptisia australis*, (Blue False Indigo)
 - o. 0.5% *Zizia aurea* (Golden Alexanders)
 - p. 0.4% *Aster laevis*, (Smooth Blue Aster)
 - q. 0.4% *Aster novae-angliae*, (New England Aster)
 - r. 0.4% *Aster oblongifolius*, (Aromatic Aster)
 - s. 0.4% *Aster prenanthoides*, (Zigzag Aster)
 - t. 0.4% *Eupatorium coelestinum*, (Mistflower)
 - u. 0.4% *Monarda fistulosa*, (Wild Bergamot)
 - v. 0.4% *Solidago nemoralis*, (Gray Goldenrod)
 - w. 0.3% *Penstemon digitalis*, (Tall White Beardtongue)
 - x. 0.2% *Coreopsis tripteris*, (Tall Coreopsis)
 - y. 0.1% *Geum canadense*, (White Avens)
 - z. 0.1% *Oenothera fruticosa* var. *fruticosa* (Sundrops)
 - aa. 0.1% *Penstemon hirsutus* (Hairy Beardtongue)
 - bb. 0.1% *Rudbeckia fulgida* var. *fulgida*, (Orange Coneflower)
 - cc. 0.1% *Senna marilandica* (Maryland Senna)
 - dd. 0.1% *Solidago odora*, (Licorice Scented Goldenrod)

2.3 ATHLETIC FIELD SOD

- A. Athletic field Sod: Certified, 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. Athletic field sod species: match seed mix species from Article 2.2.A above.

MANSFIELD ELEMENTARY SCHOOL

2.4 INORGANIC SOIL AMENDMENTS

- A. Lime: Agricultural liming material containing a minimum of 90 percent calcium carbonate equivalent and as follows:
 - 1. 100 percent passing through No. 10 sieve, a minimum of 90 percent passing through No. 20 sieve, and a minimum of 40 percent passing through No. 100 sieve.
 - 2. Provide lime in form of ground dolomitic limestone.

2.5 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.6 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- D. Straw Blanket: Short-term, single-net erosion control blanket consisting of 100 percent straw matrix with biodegradable natural fiber netting, conforming to Federal Highway Administration Standard Specifications FP-03, Article 713.17(d), Type 2.C.
 - 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. North American Green S75BN Single Net Erosion Control Blanket.

2.7 WATER

- A. Suitable for irrigation, and free from ingredients harmful to plant life.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. 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,

MANSFIELD ELEMENTARY SCHOOL

- paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Verify that seedbed is clean and weed-free.
 - 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
- 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement. Mix and place planting soil according to Section 32 91 15 "Soil Preparation (Performance Specification)."
- B. Placing Planting Soil: Place planting soil in place over exposed subgrade.
- 1. 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 Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 FINISH GRADING AND SEEDBED PREPARATION FOR ATHLETIC FIELDS

- A. Only agricultural or landscaping machinery designed for preparing the finished grades and other operations shall be used to complete this phase of work. Laser guided equipment shall be used to complete the finish grading of all Athletic Fields.
- B. Fine grade to a smooth uniform surface. Grades shall be within specified tolerances. The entire area shall present an even grade with no depressions where water will stand. Planting soil shall be smoothly blended to existing finish grades around trees, erosion control devices and adjacent existing conditions, maintain existing surface drainage patterns. Smoothly round-off all top and toe of slopes. Reinstall erosion control devices and protective fencing as required.

MANSFIELD ELEMENTARY SCHOOL

- C. Finish grade and firm the planting soil with a grading tractor designed for grading areas to be seeded. Correct irregularities in the surface so that all high spots and depressions are eliminated. Final smoothing is to leave a firm and level surface with no soft spots. The grading tractor shall be fitted with automatic hydraulically controlled laser guided grading equipment (land plane or box blade) capable of generating laser control of within 1/4 inch over the entire length of the field and its surrounds.
- D. Final acceptance of the finish grade, including the contractor's field survey, will be approved by the Architect prior to applying the starter fertilizer and sodding or sowing the seed. Any irregularities found on the playfield surface at this time will be corrected by hand raking out the irregularities. The final grade will be checked by an appropriate instrument.
- E. Apply a uniform application of 10-20-10 fertilizer at a rate of 400 lbs. per acre to the seeded areas. A different grade with the same 1-2-1 ratio may be used in place of the 10-20-10 fertilizer and its rate adjusted to apply 88 lbs. P2O5 per acre. Incorporate 10-20-10 fertilizer to a depth of 1 inch with a spike tooth harrow or other suitable means.

3.5 SEEDING

- A. Seeding rates:
 - 1. Athletic Fields: 8 to 10 lb/1000 sq.ft.
 - 2. Lawns: 5 to 8 lb/1000 sq. ft.
 - 3. No-Mow Fescue Lawns: 5 lb/1000 sq. ft. Sow oats as a nurse crop at a total rate of 3 lb/1000 sq. ft. in the fall, or 1-1/2 lb/1000 sq. ft. in the spring.
 - 4. Rain Garden Mix: 1/2 lb./1000 sq.ft. with a cover crop of grain rye at 30 lb/acre (.7 lb./1000 sq. ft.), confirm seeding rate with seed mix company.
 - 5. Northeast Native Wildflower and Grasses Mix: 1/2 lb./1000 sq. ft. with 20 lb/acre of a cover crop (grain oats, Jan 1-Aug 1; grain rye Aug 1-Jan 1), confirm seeding rate with seed mix company.
- B. Athletic Fields: Sow the seed in Athletic Fields at the specified rate using a cultipacker seeder. The total amount of seed is to be divided into two equal parts and applied in two applications with the second application made at approximately a 75° angle to first application. Do not use hydroseeding application methods on the athletic fields.
- C. Lawns: Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 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.
- D. Rake seed lightly into top 1/8 inch to 1/4 inch of soil, roll lightly, and water with fine spray.
- E. Protect seeded areas with slopes exceeding 1:6, and other seeded areas subject to concentrated water runoff, with straw blankets installed and stapled according to manufacturer's written instructions.

MANSFIELD ELEMENTARY SCHOOL

- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
- G. Begin watering immediately.

3.6 HYDROSEEDING

- A. Hydroseeding: May be used for Lawns and for No-Mow Fescue Lawns at the specified rate. Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
 - 2. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.
 - 3. Confine spray to areas being seeded. Prohibit overspray to site improvements and planting beds.
- B. Begin watering immediately.

3.7 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.
- C. Saturate sod with fine water spray within two hours of planting. During first week 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.

3.8 TURF RENOVATION

- A. Renovate existing turf where indicated.
 - 1. Turf renovation work within or near Tree Protection Areas shall be performed in a manner to minimize damage to trees, shrubs, ground cover, soil, and root systems in accordance with the Project Arborist's Tree Preservation drawings.
- B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

MANSFIELD ELEMENTARY SCHOOL

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
 2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- I. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
1. Soil Amendments: Lime and compost according to requirements of Section 32 91 15 "Soil Preparation (Performance Specification)."
 2. Initial Fertilizer: Commercial fertilizer applied according to manufacturer's recommendations.
- J. Apply seed and protect with straw mulch as required for new turf.
1. Use seed drill when overseeding existing turf.
- K. Water newly planted areas and keep moist until new turf is established.

3.9 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.
1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 3. Keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices as acceptable to authorities having jurisdiction.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

MANSFIELD ELEMENTARY SCHOOL

2. Minimum watering requirement: Water for 15 to 30 minutes every other morning for a period of at least 2 weeks during cool weather, or for up to 6 weeks during hot dry weather. Continue watering not less than twice per week for at least 2 months following the date of seeding. Provide additional watering as needed, especially during hot dry weather.
- C. 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. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 1. Mow to a height of to 2 to 3 inches.
- D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.
 1. Lawns: Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.
 2. No-Mow Fescue Lawns: Do not fertilize.

3.10 ATHLETIC FIELD MAINTENANCE

- A. Maintain the field and its surrounds for three months from the date the seeding is complete, following the program outlined below. The three month grow-in period may be discontinuous, and may require maintaining the fields through the following spring, should the seeding schedule be delayed or growth of the grasses cease in the fall, prior to the end of a three month maintenance period.
- B. Maintenance requirements apply equally to the irrigated athletic fields and to all lawn areas without permanent irrigation systems. Provide all irrigation equipment and water as necessary to irrigate all lawn areas in compliance with the following,
- C. Irrigation - Irrigate the seeded areas daily with 1/4 acre inch of water per day using 3 sets to keep the surface moist and to maintain soil moisture at or near field capacity so that the seedbed do not dry out and adequate rooting takes place. The amount of water per day and the number or sets may be adjusted at the request of Owner. The irrigation schedule shall further be adjusted after the seedling plants and sod are rooted. The quantity of water used per day shall be recorded and reported daily to the Owner for the first three weeks from seeding and weekly thereafter.
- D. Mowing - The fields and their surrounds shall be mowed with a reel mower set at a mowing height of 1 1/2" (bench setting) in which the clip of the reel matches the mowing height. The reel blades and bed knife shall be kept sharp and evenly matched to provide a clean cut. The mower shall be operated within the speed range recommended by the manufacturer. The field shall be mowed at 5 day intervals commencing as soon as the seedlings in the seeded areas reach 2 inches high.
- E. Seedling Fertilization - Fertilize the new seedlings with a 15-15-15 fertilizer grade two weeks after seeding. Fertilize at a rate of 293 lbs. per acre to supply 44 lbs. N, P2O5 and K2O per acre. Apply additional fertilizer applications after the 15-15-15 treatment using IBDU(31-0-0) following the schedule below.
 1. Apply 3 applications of 31-0-0 fertilizer at a rate of 142 pounds per acre. Make the applications at 4-weeks, 6-weeks, and 8-weeks after seeding.

MANSFIELD ELEMENTARY SCHOOL

- F. Weed Control - The Contractor will be responsible for the control of weeds that ingress into the seeded areas during the three-month maintenance period. The need to treat will be determined by the Owner. The herbicide or method of control will be based on the weed species present. Herbicide treatments must be applied by an applicator with a pesticide license issued by the State of Connecticut, Department of Environmental Protection.
- G. Contractor shall anticipate that the three-month maintenance schedule may have to be carried into the following spring, with the fall scheduled maintenance ending with the last mowing, the date depending when there is a cessation of aerial growth (leaf growth). This is approximately around the first or second week of November. The Architect will determine the end date of the fall Maintenance period.
- H. The Contractor shall maintain a maintenance log showing water used as specified above, dates of each mowing, dates at which fertilizer treatments were applied and any weed control treatments. The log shall be submitted to the Owner weekly except for the daily report of water use for the first three weeks after seeding in which water amounts are submitted daily.
- I. Protect all athletic fields with barricades, if necessary, to keep all traffic off the area. Repair all damage to turf areas including topsoil replacement, at no additional cost to Owner.

3.11 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Landscape 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. and bare spots not exceeding 5 by 5 inches.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.12 RAIN GARDEN GRASSES AND WILDFLOWERS

- A. Prepare planting areas for soil placement. Mix and place planting soil according to Section 32 91 15 "Soil Preparation (Performance Specification)." Do not proceed with rain garden seeding until Drainage Engineer has approved rain garden soil mix placement.
- B. Maintain a loose friable seed bed. At no time will rubber tired loaders or graders having greater compaction than a small farm tractor be allowed on planting soil. Keep all heavy equipment and trucks off prepared planting soil. Do not prepare while ground is wet or frozen.
- C. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Before sowing, mix seed with seed carrier.
 - 2. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 3. Do not use wet seed or seed that is moldy or otherwise damaged.
- D. Seed detention basins when a minimum of 1/4 inch of natural rainfall is expected, or when a minimum of 1/4 inch of irrigation will be received within 10 days after seeding. If sufficient

MANSFIELD ELEMENTARY SCHOOL

natural rainfall is not received within 10 days, the new seeding shall be irrigated with a minimum of 1/4 inch of water, or so that water penetrates the soil to a uniform minimum depth of 4.0 inches.

- E. Sow seed at a total rate according to “Seeding” Article and as confirmed by seed mix supplier.
- F. Brush seed into top 1/4 inch of soil, roll lightly, and water with fine spray.
- G. Protect seeded areas with slopes exceeding 1:6, and other areas subject to concentrated water run-off, with straw blankets installed and stapled according to manufacturer's written instructions.
- H. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
 - 2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- I. Water newly planted areas and keep moist until meadow is established.

3.13 RAIN GARDEN, GRASSES AND WILDFLOWERS MAINTENANCE

- A. Maintain and establish rain gardens and wildflower meadows by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable stand of grasses and wildflower plants. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply approved treatments as required to keep detention basin and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep detention basin grasses and wildflowers uniformly moist.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
- C. Mow weeds when they reach a height of 8 to 12 inches or whenever the weeds become 2 to 3 times taller than the meadow seedlings. Mow back to the height of the new seedlings. With each successive mowing, raise the blade height so as not to clip the seedlings. To reduce future weeds, mow before weeds set seeds. Use flail-type mowers, and do not allow cuttings to cover and smother the seedlings. Mowing frequency will be determined by the height and intensity of weed competition, and type of equipment used.

MANSFIELD ELEMENTARY SCHOOL

3.14 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove non-degradable erosion-control measures after grass establishment period.
- E. Remove temporary irrigation system for plant establishment within 18 months of installation.

3.15 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" and "Athletic Field Maintenance" Articles. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
 - 1. Athletic Fields: 3-months from completion of seeding, or upon Owner's assumption of maintenance, whichever occurs later. This applies to both seeded and sodded athletic fields. Maintenance Service for seeded turf shall include a minimum of 7 mowings.
 - 2. Seeded Turf including No-Mow Fescue Lawn: 60 days from date of planting acceptance, or upon Substantial Completion of the Contract, whichever occurs later. Maintenance Service for seeded turf shall include a minimum of 5 mowings.
 - 3. Provide Maintenance Service until acceptable turf is established throughout all turf areas. Turf areas will not be accepted individually.
 - 4. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
- B. Rain Garden and Wildflower Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Rain Garden, Grasses and Wildflowers Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable stand of grasses and wildflowers is established, but for not less than maintenance period below.
 - 1. Maintenance Period: 180 days from date of planting completion.

END OF SECTION 329200

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MANSFIELD ELEMENTARY SCHOOL

SECTION 329300 - PLANTS

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. Section Includes:
 - 1. Plants.
 - 2. Tree stabilization.
 - 3. Tree-watering devices.
- B. Related Requirements:
 - 1. Section 31 91 15 "Soil Preparation (Performance Specification)" for planting soil requirements.
 - 2. Section 321500 "Aggregate Surfacing" for landscape edging.
 - 3. Section 32 92 00 "Turf and Grasses" for turf (lawn) planting, hydroseeding, and sodding.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Central Leader: A continuation of the main trunk located more or less in the center of the crown, beginning at the lowest main branch (scaffold) and extending to the top of the tree. Also referred to as the Dominant Leader.
- D. Codominant: Two or more vigorous, upright branches or stems of relatively equal size that originate from a common point, usually where the leader was lost or removed.
- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- F. Crown: The portion of a tree beginning at the lowest main (scaffold) branch extending to the top of the tree.
- G. Finish Grade: Elevation of finished surface of planting soil.
- H. Included Bark: Bark embedded in the union between a branch and the trunk or between two or more stems that prevents the formation of a normal branch bark ridge.

MANSFIELD ELEMENTARY SCHOOL

- I. Nursery: A place where young trees and plants are grown commercially for sale. Not included in this definition are horticultural distribution centers and plant re-wholesalers.
- J. Planting Area: Areas to be planted.
- K. 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 32 91 15 "Soil Preparation (Performance Specification)" for drawing designations for planting soils.
- L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- M. 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.
- N. Scaffold Branches: Large main branches that form the main structure of the crown.
- O. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- P. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- Q. Trunk: The main stem of a tree, beginning at the root collar and ending at the lowest main scaffold branch.

1.4 REFERENCE STANDARDS

- A. American Horticulture Industry Association d/b/a AmericanHort. Ph. (614) 487-1117.
www.AmericanHort.org.
 - 1. ANSI Z60.1: American Standard for Nursery Stock (2014).

1.5 COORDINATION

- A. Coordination with Landscape Architect's Site Visits: The Landscape Architect may elect to be present to observe the execution of the following work. Provide not less than 2 full working days advance notice prior to performing these activities. It will be assumed that any work performed without notifying the Landscape Architect of the date and time in advance was performed incompletely or incorrectly.
 - 1. Deliveries of plant materials.
 - 2. Layout of plant locations.
 - 3. Preparation of planting area subgrades and placement of planting soil.
 - 4. Installation of plants.
- B. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

MANSFIELD ELEMENTARY SCHOOL

1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1.7 Participants: including but not limited to Landscape Architect and Installer.

1.8 ACTION SUBMITTALS

- A. Nursery Source Tagging Submittals
 - 1. Nursery Sources: Within 30-days of the Contract start, submit a list of all proposed nursery sources for approval, confirming the availability of plant varieties, sizes, forms, and quantities indicated in the Contract Documents. For field-grown trees and plants, specified as “balled and burlapped”, include photographs of the available plant blocks to confirm that the nurseries have a sufficient selection of satisfactory plants available for tagging. Provide the names and telephone numbers for the nurseries’ representatives.
 - a. Substitutions: Substitutions of plant material will not be permitted unless approved in writing by the Landscape Architect. If any specified plants are not available at the time when needed to meet the project schedule, submit a statement documenting the nursery sources investigated and providing proposals for equivalent plants of the nearest available size or similar variety. Substitutions will not be allowed if the Landscape Architect identifies alternate nursery sources within a 600 mile radius of the project site.
 - b. Container grown plants shall not be substituted for plants designated “B&B” on the Plant Schedule, unless approved in writing by the Landscape Architect.
 - c. Quantities: Quantities shown on the Plant Schedule are for information only. Provide every plant shown on the Drawings. In the event of a discrepancy between the Planting Plans and the written quantities in the Plant Schedule, the Planting Plan shall govern.
 - 2. Planting Schedule: Submit the projected planting schedule, including nursery visits, digging, delivery, storage and installation dates for review and approval. Schedule the dates for each type of landscape work during normal seasons for such work in each area of the site. Correlate with specified maintenance periods to provide maintenance until conclusion of the planting establishment and maintenance period. Revise schedule to keep current, subject to the Landscape Architect’s approval.
 - 3. Nursery Visit Schedule: Coordinate with the Landscape Architect and the proposed nurseries to arrange nursery visits. The final schedule for nursery visits shall be submitted not later than the November 30 preceding the scheduled installation of the plants.
- B. Product Data: For each type of product.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from multiple angles depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 10 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name and horticultural variety of the plant, plant size, and name of the growing nursery.
 - a. Field-grown trees and shrubs:
 - 1) Specimen trees: Three photographs of every individual specimen tree, taken from multiple angles.

MANSFIELD ELEMENTARY SCHOOL

- 2) Trees and shrubs to be furnished in quantities of 10 or less: At least three photographs of a typical plant taken from multiple angles, plus photographs showing overall views of the blocks from which the plants are to be obtained.
 - 3) Trees and shrubs to be furnished in quantities greater than 10: Photographs of the average plant, the best quality plant, and the worst quality plant; plus photographs showing overall views of the blocks from which the trees are to be obtained.
 - b. Container-grown trees: Three photographs of each individual tree.
 - c. Container-grown shrubs and vines: One photograph of one typical plant.
 - d. Perennials and grasses: Photographs are not required.
- C. Samples for Verification: For each of the following:
1. Organic Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

1.9 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 1. Manufacturer's certified analysis of standard products.
 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Sample Warranty: For special warranty.

1.10 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
 1. Experience: Five years' experience in landscape installation in addition to requirements in Section 01 40 00 "Quality Requirements."
 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

MANSFIELD ELEMENTARY SCHOOL

- D. Plant Material Inspection and Tagging: It is the prerogative of the Architect to inspect and select all plant material at the grower's nursery prior to digging and upon delivery to the project site, for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
1. Plants are subject to inspection and selection for overall form, vigor, and condition by the Architect with the Installer at the nursery source or place of growth. Plants designated as "balled and burlapped" shall be field-grown, and shall not be dug until inspected, approved and sealed by the Architect.
 2. The Installer shall accompany the Architect on all source inspections, and shall make all necessary arrangements, provide transportation, and pay all expenses including travel, food, and lodging.
 3. Coordinate with approved nurseries and with the Architect to schedule the Architect's nursery visits, to secure approved plants, and to confirm digging and shipping dates in conformance with the approved planting schedule. Arrange nursery visits as far in advance of the scheduled installation as possible, which will typically occur during the period running from September through February preceding the installation. In northern and snow-belt nurseries that are expected to become inaccessible during the winter, tagging shall be scheduled for completion prior to the onset of winter conditions. All tagging shall be completed by February 28. Summer and fall digging of deciduous plants will not be permitted without the Architect's approval.
 4. All plants shall be delivered to the site with the Architect's permanent seals intact.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. 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 if applicable.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. All plants shall be prepared and packed, and protected to ensure arrival at the site in good condition. They shall arrived fresh and properly dug, in sound, healthy, vigorous condition with healthy and well-developed tops and root systems, and with all parts moist and showing active green cambium when cut.
- D. 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.
- E. Handle planting stock by root ball.
- F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

MANSFIELD ELEMENTARY SCHOOL

- G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation. Remove all wrapping materials upon delivery to the site or while kept in the holding yard.
- H. Deliveries shall correspond to the planting schedule to ensure immediate planting. 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. Set balled stock on ground and cover ball with mulch or other acceptable material.
 - 2. Do not remove container-grown stock from containers before time of planting.
 - 3. Water root systems of plants stored on-site deeply and thoroughly with a drip irrigation system. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.12 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Preliminary Acceptance. Planting shall progress only under favorable weather conditions and will not be permitted when the ground is frozen or excessively moist.
 - 1. Plant within the following recommended periods to provide optimal conditions for successful recovery from transplanting stresses.
 - a. Plant deciduous plants: April 1 to May 30, and August 15 until the ground freezes.
 - b. Spring planting may be extended until June 15 if a well-monitored irrigation system is in use.
 - c. Plant evergreen plants: April 1 to June 15, and August 15 to October 15.
 - d. Perennials and ornamental grasses: April 1 to May 30, and September 1 to September 15.
 - e. Bulbs: From September 1 until the ground freezes.
 - 2. If special conditions exist to justify a variance in the above planting dates, submit a written request to the Landscape Architect stating the special conditions and the proposed variance. Describe techniques in addition to those specified herein that will be employed to prevent dieback and mortality. No waiver of the plant guaranty will be granted for planting performed out-of-season.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- D. Watering: The Installer shall bear sole responsibility for furnishing and applying all irrigation water, irrespective of whether or not an irrigation system is installed or operable. The Installer shall ensure that all irrigation water is applied at the proper frequency, coverage, and in proper amounts to fulfill the plant establishment and maintenance requirements of the Contract. The Installer's responsibility for all watering shall begin upon delivery of plants the site, and shall continue through the end of the Warranty Period.
 - 1. If not irrigation system is available, or if an available irrigation system is unsatisfactory to the Installer's needs, then the Installer shall furnish and apply all irrigation water.

MANSFIELD ELEMENTARY SCHOOL

2. If an irrigation system is made available for the Installer's use, and if the Installer elects to utilize this irrigation system; then the Installer shall accept total responsibility for ensuring that the system is satisfactorily adjusted and operated while utilized by the Installer.
3. If an irrigation system is to be provided or design/built under this Contract, and if the Installer elects to utilize this irrigation system; then the Installer shall coordinate with the irrigation designer, installer, and operator, and shall accept total responsibility for ensuring that the system is satisfactorily adjusted and operated while utilized by the Installer.

1.13 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.
 - b. Structural failures including plantings falling or blowing over.
 - c. Faulty performance of tree stabilization.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Periods: From date of Preliminary Acceptance of planting or upon Substantial Completion of the contract, whichever occurs later.
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months, except that deciduous plants in a dormant condition on the date the warranty commences will be warranted for an additional period extending through June 1 of the next following spring
 - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
 - c. Annuals: Three months.
 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period. Replace plants that have bark scald; foliage of abnormal density, size, and color; or that have more than 25 percent dead or dying branches and branch tips.
 - c. Provide extended warranty for period equal to original warranty period, for replaced plant material.

1.14 ACCEPTANCE

- A. The Landscape Architect will inspect all plant material for acceptance upon written request of the Installer. The request shall be received at least 10 calendar days before the anticipated date of inspection.
- B. Acceptance of plant material will be granted for general conformance to the specified size, character, and quality, but will not relieve the Installer of responsibility for full conformance to the Contract Documents, including correct species.
- C. Upon completion and re-inspection of all repairs or renewals necessary in the judgment of the Landscape Architect, the Landscape Architect will certify in writing that the plant material has been preliminarily accepted.

MANSFIELD ELEMENTARY SCHOOL

1.15 FINAL INSPECTION AND FINAL ACCEPTANCE

- A. At the end of the Maintenance Period and upon written request of the Installer, the Landscape Architect will inspect all plant material for final acceptance. The request shall be received at least 10 calendar days before the anticipated date of inspection. Upon completion and re-inspection of all repairs and renewals necessary in the judgment of the Landscape Architect at that time, the Landscape Architect will certify in writing that the plant material has received final acceptance.

PART 2 - PRODUCTS

2.1 General:

- A. Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning within the last 2 years. 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.
 - 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
 - 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
 - 3. Plants shall have been grown under climatic conditions similar to those of the project site.
 - 4. Balled and burlapped plants shall be moved as solid units having firm natural balls of soil of sufficient size to encompass the fibrous and feeding root system to ensure full and prompt plant recovery. Plants with loose, manufactured, cracked, broken, or undersized balls will be rejected.
- B. Form and Structure: Unless indicated otherwise in Plant List shown on Drawings, deciduous and evergreen trees shall comply with the following:
 - 1. Habit of growth shall be typical of the species or variety; heavy, symmetrical, well branched and proportioned, and densely foliated when in leaf.
 - 2. Trees shall have a single, relatively straight vertical trunk and central leader. Deciduous shade trees shall be free of major branches up to a height of at least 6-feet unless otherwise specified. Evergreen and clump-form trees shall have dense compact growth branched to the ground unless otherwise specified.
 - 3. Trees shall be free of codominant stems and vigorous, upright branches that compete with the central leader. If the original leader has been headed, a new leader at least one-half of the diameter of the original leader shall be present.
 - 4. Main branches shall be well-distributed along the central leader, and not clustered together. They shall form a balanced crown appropriate for the cultivar or species.
 - 5. Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch.
 - 6. The attachment of the largest branches (scaffold branches) shall be free of included bark.
- C. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

MANSFIELD ELEMENTARY SCHOOL

- D. 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.
- E. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
- F. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

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. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
 - 1. Type: Double-shredded softwood bark composed primarily of pine and spruce bark. Aged not less than 9 months. Sample to be approved.
 - 2. Color: Natural, un-dyed.

2.4 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
 - 1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch actual dimensions by length indicated, pointed at one end.
 - 2. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
 - 3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
 - 4. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
 - 5. Proprietary Staking-and-Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and according to manufacturer's written recommendations.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Foresight Products, LLC; Duckbill Professional Tree Guy System

2.5 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.

MANSFIELD ELEMENTARY SCHOOL

1. Products: Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Spectrum Products, Inc.: Treegator.

2.6 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.
- C. Free-Draining Material: Sand, gravel, stone or mixtures thereof, with not more than 70 percent by weight passing the No. 40 mesh sieve and not more than 10 percent by weight passing the No. 200 sieve.
- D. Deer Repellant: Commercial product with documented deer-deterrent properties.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
 1. 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 soil within a planting area.
 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

MANSFIELD ELEMENTARY SCHOOL

- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make adjustments as directed.
 - 1. Plant locations on the Drawings are approximate and are to be used only as a guide. Installer shall accurately stakeout plant locations and bed outlines. Do not begin planting excavations until the Landscape Architect has approved or adjusted the stakeouts. Prior to installation, modify plant locations within the project area as directed by the Architect without additional cost to the Owner.
 - 2. Unless otherwise indicated, massed plantings and rows of shrubs, perennials, and grasses are to be installed in a staggered triangular or diagonal configuration. Straight, square rows will not be accepted.

3.3 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 15 "Soil Preparation (Performance Specification)."
- B. Placing Planting Soil: Place prepared planting soil over exposed subgrade.
- C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- D. Application of Mycorrhizal Fungi: Broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

3.4 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 for balled and burlapped and container-grown stock.
 - 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 - 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 - 5. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 - 6. Maintain supervision of excavations during working hours.
 - 7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
- B. Continuous Planting Beds for Shrubs:
 - 1. Excavate shrub beds to a minimum depth of 18" with sides sloping inward at a 45-degree angle. Loosen subgrade by dragging with teeth of bucket 3" to 6" deep. Install first lift of planting soil immediately and do not allow loosened subgrade to become compacted.

MANSFIELD ELEMENTARY SCHOOL

2. Install planting soil in 2 equal lifts. Compact each lift to a minimum of 75 percent and a maximum of 82 percent of Standard Proctor Density. Scarify between lifts by dragging with the teeth of bucket.
 3. Excavate circular planting pits in continuous beds aft the planting soil has been installed in continuous beds.
- C. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.
- D. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.
- E. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

3.5 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. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.
1. Backfill: Planting mixture Type 1 or 2.
 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 3. 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.
 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 - a. Quantity: According to manufacturer's written recommendations.
 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.
1. Backfill: Planting mixture Type 1 or 2.
 2. Carefully remove root ball from container without damaging root ball or plant.
 3. 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.
 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 - a. Quantity: According to manufacturer's written recommendations..

MANSFIELD ELEMENTARY SCHOOL

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

- E. 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.

3.6 TREE, SHRUB, AND VINE PRUNING

- A. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.
1. Remove only dead, dying, or broken branches. Do not prune for shape unless otherwise directed by Landscape Architect. Make clean cuts as close as possible to the trunk or parent branch without cutting into the branch collar or leaving a stub.
- B. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated on Drawings:
1. Upright Staking and Tying: Stake trees of up to 5-inch caliper. Use a minimum length required to penetrate at least 12 inches below bottom of backfilled excavation and to extend to the dimension indicated on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
 2. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
- B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings.
1. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.8 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 Type 1 or 2 for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING AREA MULCHING

- A. 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 average thickness. Do not place mulch within 6 inches of trunks or stems.
 - 2. Organic Mulch in Planting Areas: Apply 2-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 6 inches of trunks or stems.

3.10 EDGING INSTALLATION

- A. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4- to 6-inch- deep, shovel-cut edge.

3.11 INSTALLING SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.12 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, 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. Keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices acceptable to authorities having jurisdiction. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- D. Heavily water woody plants in late fall, after leaf drop and before the ground freezes.
- E. Provide early spring clean-up of perennial and ornamental grass beds before new growth starts. Cut back and remove dead top growth, repair damage, remove weeds, refresh mulch, and re-edge beds.
- F. Protect plants from deer damage, including regularly monitoring deer activity and timely applications of deer repellants and barriers.
- G. Upon Final Acceptance at end of Maintenance Period, remove tree-stabilization devices and planting saucers. Dress with mulch.

MANSFIELD ELEMENTARY SCHOOL

3.13 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

3.14 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. 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.
- D. After installation and before Preliminary Acceptance, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
 - 1. Do not remove Landscape Architect's seals. The Landscape Architect will remove the seals during the Final Inspection at the end of the Maintenance Period.
- E. Remove any temporary irrigation systems for plant establishment within 18 months of the start of the Maintenance Period.

3.15 MAINTENANCE SERVICE

- A. Maintenance Service for Trees and Shrubs: 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: 12 months from date of Preliminary Acceptance or upon Substantial Completion of the contract, whichever occurs later.
- B. Maintenance Service for Ground Cover and Other Plants: 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: 12 months from date of Preliminary Acceptance or upon Substantial Completion of the contract, whichever occurs later.

END OF SECTION 329300

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SECTION 333400 – SEPTIC SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes sewage disposal systems including the following:
 - 1. Distribution piping
 - 2. Leaching chambers
 - 3. Washed Screened Gravel Aggregate
 - 4. Septic System Fill
 - 5. Approved Fill

1.2 DEFINITIONS

- A. Leaching Galley: Precast concrete structures installed horizontally in the wastewater absorption field.
- B. Distribution Piping: Piping and pipe fittings installed with tight joints between the effluent pump station and the leaching chambers.
 - 1. Force Main Piping: Non-perforated pipe and pipe fittings installed with tight joints connecting the effluent pump station with the absorption field.
 - 2. Gravity Distribution Piping: Pipe and pipe fittings which discharge the effluent uniformly in the absorption field.
- C. PVC: Polyvinyl chloride.
- D. Gravel Aggregate: Broken stone or screened gravel free of fine particles suitable for use in a subsurface wastewater absorption system.

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - 1. Leaching galleys
 - 2. Leaching field material
 - 3. Clean crushed stone aggregate
- B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated. Prepare separate reports for each type and application of borrow material.

MANSFIELD ELEMENTARY SCHOOL

1.4 QUALITY ASSURANCE

- A. Form 816: State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction.

PART 2 - PRODUCTS

2.1 LEACHING CHAMBERS

- A. Description: Precast concrete structures, with solid top, perforated sides, and open bottom. For each row, include solid end piece with pipe opening.

2.2 LEACHING FIELD MATERIALS

- A. Filter Fabric: ConnDOT Form 816, Article M.08.01-26
- B. Approved Engineered Fill Material:
 - 1. Free of debris, waste, frozen materials, vegetation, clay and other deleterious matter; adequately graded for satisfactory compaction.
 - 2. Borrow: Free of rock or gravel larger than 3 inches in any dimension; Form 816, Section M.02.01, Grading A.
- C. Approved Stone Aggregate: ¾-inch clean crushed stone

2.3 CRUSHED STONE AGGREGATE

- A. Shall be of uniform consistency and only contain clean, hard, tough, durable fragments with a fines standard of a maximum of 1% passing the No. 200 sieve at the pit/quarry source.
- B. This standard should also be met at the SSDS installation site; however in no case shall the fines exceed 1.5%.
- C. Graduation Requirements:

	No. 6 Stone Aggregate (¾" Stone)
Sieve Size	Percent Passing
2-inch	N/A
1.5-inch	N/A
1-inch	100
¾-inch	90 - 100
½-inch	20 - 55
⅜-inch	0 - 15
#4	0 - 5

- D. Aggregate shall be free from silt, dirt, soft, thin, elongated, friable, laminated, micaceous, or disintegrated pieces

MANSFIELD ELEMENTARY SCHOOL

- E. No aggregate fill shall be placed on the bottom area of the subsurface disposal system within the limits of the inside bottom dimensions of the chambers.

2.4 NATIVE ON-SITE SOIL MATERIAL

- A. May be used for general site grading in the vicinity of the leaching field
- B. Native topsoil may be stockpiled and reused
- C. Native soils with a permeability rate of less than 10 feet per day may be used to construct the containment berm over the engineered fill downgradient of the leaching field.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Survey the area for septic system installation. Locate and mark existing utilities, underground structures, and aboveground obstructions before beginning and avoid disruption of and damage to services.
- B. Examine soil structure, materials, and conditions.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean exposed surfaces of tanks and other structures and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

3.3 IDENTIFICATION

- A. Identification materials and their installation are specified in Division 31 Section "Earthwork." Arrange for installation of green warning tape directly over piping (including absorption field piping), at outside edges of underground structures, and at outside edges of absorption fields.
- B. Use detectable warning tape over piping, over edges of underground structures and leaching chambers.

3.4 EARTHWORK

- A. Excavating, trenching, and backfilling for distribution pipe and fittings are specified in Division 31 Section "Earthwork."
 - 1. Stockpile topsoil for reuse in finish grading without intermixing with other excavated material. Stockpile materials away from edge of excavation and do not store within drip line of remaining trees.
 - 2. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

MANSFIELD ELEMENTARY SCHOOL

- B. Construction of the leaching trenches shall not be undertaken when the ground is frozen or when the ambient temperature is below freezing, or during and immediately following a precipitation event.
- C. The leaching trench area and the area down-gradient of the system shall be protected from compaction by the contractor's equipment.
 - 1. The use of rubber-tired equipment such as trucks, compactors, backhoes, bucket loaders, etc shall not be allowed in these areas.
 - 2. The use of tracked equipment shall be allowed in these areas.
- D. Care shall be taken to avoid clogging the infiltrative surfaces during construction by smearing the surface with excavation equipment.
 - 1. If surfaces are smeared, they shall be properly scarified to remove the smeared soils.
 - 2. Loose materials caused by scarification shall be removed.
- E. The bottom of the areas excavated for installation of leaching units shall conform to the lines and grades shown on the approved construction drawings, and any deviation shall be corrected.
- F. Backfill shall be carefully placed and over-compaction of this material shall be avoided. The top six inches of earth cover material over the leaching bed shall be suitable for establishing a healthy turf.

3.5 PIPE JOINT CONSTRUCTION AND PIPING INSTALLATION

- A. Install distribution PVC piping according to ASTM D2321 and ASTM F481.

3.6 LEACHING FIELD INSTALLATION

- A. Excavate for leaching trenches .
- B. Install leaching galleys, distribution boxes, and distribution piping.
- C. Install clean crushed stone on each side of leaching chambers.
- D. Place filter fabric and native fill over leaching trench. Adjacent pieces of filter fabric shall have 6-inches of overlapping edges.
- E. After the leaching facilities and associated effluent distribution system are installed, the top of aggregate fill shall be protected by geotextile fabric.
- F. The geotextile fabric shall extend horizontally to at least 1 foot beyond the top edge of the aggregate fill in each lateral direction.

3.7 CLEANING OF DISTRIBUTION PIPING

- A. Clear interior of piping and structures of dirt and other superfluous material as work progresses.
- B. During construction, the ends of all piping that have not been sealed with clean-out plugs, should be protected to keep rodents, insects, dirt and other debris out of the piping.

MANSFIELD ELEMENTARY SCHOOL

3.8 FIELD QUALITY CONTROL

- A. System Tests: Perform testing of completed piping and structures according to authorities having jurisdiction.

END OF SECTION

MANSFIELD ELEMENTARY SCHOOL

MANSFIELD ELEMENTARY SCHOOL

SECTION 334211 - STORMWATER GRAVITY PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Storm drainage piping, fittings, and accessories.
- B. Site surface drainage, manholes, yard drains, hydrodynamic separators, catch basins, paved area drainage, site surface drainage, and subsurface infiltration chambers.

1.02 RELATED REQUIREMENTS

- A. Section 329115 - Soil Preparation
- B. Section 329200 - Turf and Grasses

1.03 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.
- B. HDPE: High-density polyethylene plastic.

1.04 REFERENCE STANDARDS

- A. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Drainage Pipe; 2009 (Reapproved 2017).
- B. AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-MM (12- to 60-in.) Diameter; 2017.
- C. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2014.
- D. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Material; 2014.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of storm utility drainage piping with size, location and installation of other service utilities. Coordinate the installation of storm subsurface infiltration systems with demolition of existing building.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.06 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe, pipe accessories, manhole covers, and drain structure component construction, features, configuration, and dimensions.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
 - 1. Signed and Sealed Shop Drawings: When required by a product manufacturer, shop drawings signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Manufacturer's Installation Instructions: Indicate special procedures required to install products specified.
- E. Field Quality Control Submittals: Document results of field quality control testing.
- F. Project Record Documents:
 - 1. Record location of pipe runs, connections, storm drain system structures, top of frames, and invert elevations.

MANSFIELD ELEMENTARY SCHOOL

2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.07 QUALITY ASSURANCE

- A. All storm sewer piping materials and methods of installation shall comply with the Town of Mansfield requirements and those indicated on the plans.

PART 2 PRODUCTS

2.01 STORM SEWER PIPE MATERIALS

- A. Provide products that comply with requirements indicated and specified on Drawings.
- B. Plastic Pipe: ASTM D3350, High Density Polyethylene (HDPE) corrugated wall pipe with integrally formed smooth liner, meeting the requirements of AASHTO M 252, Type S, for diameters between 3 inches and 10 inches and AASHTO M 294, Type S, for diameters between 12 inches and 60 inches, soil-tight, bell and spigot joints with rubber gaskets, with pipe and fittings manufactured from virgin PE compounds with cell classification 3254420C.

2.02 PIPE ACCESSORIES

- A. Joints and Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
 1. Within 25' of sewage system components: Provide series 35 ADS coupling, o-ring gasket, or WT pipe/joint (gasketed bell/spigot) at storm drainage piping.
- B. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Storm Sewer Service" in large letters.

2.03 MANHOLES AND CATCH BASINS

- A. Normal-Traffic, Precast Concrete Manhole or Catch Basins: Form 818, Section M.08.02-4.
- B. Frames and Grates: Form 818, Section M.08.02-5.
 1. Catch Basins: Type C or C-L.
 2. Manholes: Refer to plans for cover or grate.
 - a. Cover: Include indented top design with lettering cast into cover, using working equivalent to "STORM" or "STORM SEWER".
 - b. Grate: See plans.
- C. Steps: Shall comply with Town of Mansfield specifications and wide enough to allow worked to place both feet on one step and designed to prevent lateral slippage off step. Cast steps into sidewalks at 12-inch intervals.

2.04 YARD DRAIN

- A. Heavy Duty Yard Drain:
 1. Normal Traffic, Precast, Yard Basin: Precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
 - a. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
 - b. Frames and grates shall be ADA compliant and H-20 load rated, and shall be:
 - 1) Ironsmith
 - 2) US Foundry & Mfg. Corporation
 - 3) Campbell Foundry Company
 - 4) Neenah Foundry

2.05 HYDRODYNAMIC SEPARATOR

- A. Barracuda by Advanced Drainage Systems Inc. (Basis of Design)
- B. Contech Engineered Solutions LLC
- C. Rinker Materials Stormceptor STC
- D. Hydro International Downstream Defender

2.06 SUBSURFACE INFILTRATION CHAMBER

- A. StormTech by Advanced Drainage Systems Inc. (Basis of Design)
- B. StormTrap SingleTrap Modular Concrete detention system
- C. Retain-IT Stormwater detention system

2.07 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
 - 1. Concrete shall conform to the requirements of Section M.03, CTDOT Form 818.
 - 2. Cement: ASTM C 150, Type II.
 - 3. Fine Aggregate: ASTM C 33, sand.
 - 4. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 5. Water: Potable.
- B. Portland Cement Design Mix: 3,000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3,000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - 2. Benches: Concrete, sloped to drain into channel.
- D. Ballast and Pipe Supports: Portland cement design mix, 3,000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

2.08 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in [Section 312300].
- B. Cover: As specified in Section 312300.

PART 3 EXECUTION

3.01 TRENCHING

- A. See Section 312300, for additional requirements.
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- C. Lay pipe to slope gradients noted on Drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Connect to building storm drainage system, foundation drainage system, and utility sewer system.
- E. Install continuous trace wire 6 inches above top of pipe; coordinate with Section 312300.

3.03 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, non-pressure drainage piping according to the following:
 - 1. Join corrugated HDPE piping according to ASTM D 3212 for push-on joints.
 - 2. Join dissimilar pipe materials with non-pressure-type flexible couplings.
- B. Provide Series 35 ADS coupling, o-ring gasket, or WT pipe/joint (gasketed bell/spigot) at storm drainage piping within 25 ft of the sanitary sewage system. See plans.

3.04 UNDERDRAIN PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and coupling according to manufacturer's written instructions and other requirements indicated.
 - 1. Lay perforated pipe with perforations down.
 - 2. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope with spigot end entered fully into adjacent bell.

3.05 UNDERDRAIN PIPE JOINT CONSTRUCTION

- A. Join perforated HDPE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push—on joints.
- B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.06 INSTALLATION - MANHOLES, YARD DRAINS AND CATCH BASINS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Level top surface of base pad; sleeve concrete shaft sections to receive storm sewer pipe sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.07 HYDRODYNAMIC SEPARATOR AND SUBSURFACE INFILTRATION SYSTEM INSTALLATIONS

- A. Per manufacturer's specifications.
- B. Set frames and grates to elevations indicated.

MANSFIELD ELEMENTARY SCHOOL

3.08 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 014000 - Quality Requirements.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
 - 1. Infiltration Test: Test in accordance with ASTM D3385-18 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ringed Infiltrometer.

3.09 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

3.10 CLEANING

- A. Clean interior of piping of dirt and superfluous materials.

END OF SECTION 334211

MANSFIELD ELEMENTARY SCHOOL

SECTION 337119 - ELECTRICAL UNDERGROUND DUCTS, DUCTBANKS, AND MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Conduit and duct:
 - 1. Rigid polyvinyl chloride (PVC) conduit.
 - 2. Polyvinyl chloride (PVC) plastic utilities duct.
- B. Accessories:
 - 1. Underground warning tape.

1.02 RELATED REQUIREMENTS

- A. Section 312300 - Earthwork

1.03 REFERENCE STANDARDS

- A. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
- B. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2016.
- C. NEMA TC 6&8 - Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations; 2013.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for nonmetallic conduit.
- C. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of hand holes.

PART 2 PRODUCTS

2.01 CONDUIT AND DUCT

- A. Rigid Polyvinyl Chloride (PVC) Conduit: NFPA 70, Type PVC; comply with NEMA TC 2 and list and label as complying with UL 651; Schedule 40 unless otherwise indicated; rated for use with conductors rated 90 degrees C.
 - 1. Fittings: Comply with NEMA TC 3 and list and label as complying with UL 651.
 - a. Manufacturer: Same as manufacturer of conduit to be connected.

2.02 ACCESSORIES

- A. Underground Warning Tape: Polyethylene tape suitable for direct burial.
 - 1. Legend: Type of service, continuously repeated over full length of tape.
 - 2. Color:
 - a. Tape for Buried Power Lines: Black text on red background.
 - b. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

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PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- B. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.
- C. Hand hole locations are shown in approximate locations unless dimensions are indicated. Locate as required to complete ductbank system.

3.02 DUCT BANK INSTALLATION

- A. Install duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope duct away from building entrances.
- B. Cut duct square using saw or pipe cutter; de-burr cut ends.
- C. Insert duct to shoulder of fittings; fasten securely.
- D. Install no more than equivalent of three 90-degree bends between pull points.
- E. Provide suitable fittings to accommodate expansion and deflection where required.
- F. Stagger duct joints vertically in concrete encasement 6 inches minimum.
- G. Use suitable separators and chairs installed not greater than 4 feet on centers.
- H. Band ducts together before backfilling.
- I. Provide suitable pull string in each empty duct except sleeves and nipples.
- J. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.

END OF SECTION 337119