33 63 10 COMMON WORK RESULTS FOR PIPING

PART 1 – GENERAL

.1 RELATED DOCUMENTS

.1.1 Contract Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

.1.2 Requirements of the following Specification Sections apply to this Section:

.1.2.1 Piping materials and installation methods for each pipe group are specified as subsections of this Section.

.1.2.2 Section 33 63 50 – IDENTIFICATION FOR PIPING AND EQUIPMENT

.1.2.3 Section 33 63 25 - PIPING SPECIALTIES

.1.2.4 Section 33 63 45 – GASKETS

.1.2.5 Section 33 63 20 – METERS AND GAUGES

.1.2.6 Section 33 63 40 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

.1.2.7 Section 33 63 55 - PIPING INSULATION

.2 DESCRIPTION OF WORK

.2.1 This Section specifies piping materials and installation methods common to more than one section of Division 33 and includes basic piping installation instructions. This Section covers piping that falls under the ASME B31.1 Power Piping Code. Refer to Division 33 Drainage System Sections for drainage piping and related work that falls under ASME B31.9 and local codes.

.2.2 Types of pipes and pipe fittings specified in this Section include the following:

.2.2.1 Steel Pipes

.2.2.2 Stainless Steel Pipes

.2.2.3 Copper Pipes

.2.2.4 Miscellaneous Piping Materials/Products

.2.3 Pipes and pipe fittings furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 33 Sections and in general shall comply with the requirements of this Section.

.3 SUBMITTALS

.3.1 Product Data: In accordance with Section 01 33 00 – SUBMITTAL PROCEDURES, submit the following:

.3.1.1 Manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting

.3.1.2 Piping schedule showing manufacturer, ASTM number, ASTM type, ASTM grade, pipe or tube weight, fitting type, and joint type for each piping system

.3.1.3 The piping and accessories submittal shall clearly describe what components are going to be used for each piping group.

.3.1.4 Records and reports required for certain pipe groups as specified in individual piping group specifications

.3.1.5 Provide ISO 9001 and Independent Test Reports if applicable per Quality Assurance paragraph below.

.3.1.6 “Fire Watch” safety procedures

.3.2 Maintenance Data: In accordance with Section 01 78 00 – CLOSEOUT SUBMITTALS submit the following:

.3.2.1 Maintenance data and parts lists for each type of mechanical fitting.

.3.3 Quality Control Submittals: In accordance with Section 01 33 00 – SUBMITTAL PROCEDURES, submit the following:

.3.3.1 Installers Qualification Data:

.3.3.1.1 Welder Qualification Data: Copies of certification; include names, home addresses and identification numbers of welders.

.3.3.1.2 Welding Procedures: Shall include QW-482 "Suggested Format for Welding Procedure Specification (WPS)" and QW-483 "Suggested Format for Procedure Qualification

Record (PQR)" as specified in Welding Quality Assurance below for different weld types.

.3.3.1.3 Welders' Certificates: Shall include QW-484 "Suggested Format for Manufacturer's Record of Welder or Welding Operator Qualification Tests (WPQ)" for all welders for all weld types as specified in Welding Quality Assurance below.

.3.3.1.4 Welder Identification List

.3.3.2 Manufacturer's Data: Copy of mill certificates, laboratory test and manufacturing reports relating to chemical and physical properties of pipe, fittings, and related materials.

.3.3.3 Independent Testing Agency Qualifications: As specified in this Section.

.3.3.4 ISO 9001 and Independent Test Reports: As specified in Quality Assurance below.

.3.4 Piping Tests: In accordance with Section 01 33 00 – SUBMITTAL PROCEDURES, submit the following:

.3.4.1 Hydrostatic Testing Records: The Contractor shall maintain a constantly updated log (as described in this Section) available to the University and A/E at all times. The Contractor shall submit a final log to the A/E for his records.

.3.4.2 Visual Examination Examiner's Qualifications: Provide as specified in this Section.

.3.4.3 Visual Inspection Reports: Provide as specified in this Section.

.3.4.4 Radiography Examination Written Procedure: Provide as specified in this Section.

.3.4.5 Radiography Examination Reports: Provide as specified in this Section.

.3.4.6 Radiography Examination Examiner's Qualifications: Provide as specified in this Section.

.3.4.7 Independent Testing Agency Information: The Contractor and the independent testing agency shall provide a signed statement that

the testing agency has no affiliation with the Contractor and can serve as an independent agency to provide the testing as specified.

.3.4.8 Welder Identification List: Provide as specified in this Section.

.4 QUALITY ASSURANCE

.4.1 Codes and Standards:

.4.1.1 All piping systems with the exception of potable city water, sanitary, and other plumbing systems piping shall be designed, fabricated, erected, and tested in accordance with ASME B31.1.

.4.1.2 All welders performing welding to this procedure shall be qualified to this procedure in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

.4.1.3 Conform to ASME Boiler and Pressure Vessel Code and ASME B31.1 Power Piping Code for administrative and technical requirements for Boiler External Piping and Non-boiler External Piping.

.4.1.4 Comply with the latest editions of the publications of the following Agencies to the extent referenced in this Section:

- ANSI - American National Standards Institute
- API - American Petroleum Institute
- ASME - American Society of Mechanical Engineers
- ASTM - American Society for Testing and Materials
- AWS - American Welding Society
- AWWA - American Water Works Association
- CISPI - Cast Iron Soil Pipe Institute Association
- FM - Factory Mutual
- NFPA - National Fire Protection Association
- PFI - Pipe Fabrication Institute
- UL - Underwriter's Laboratories, Inc.

.4.2 Special Precautions

.4.2.1 Torch cutting will be permitted only with the specific written approval of the University. Any cutting method, which may create sparks, must include "Fire Watch". Submit "Fire Watch" procedure for approval. Obtain and use the “Hot Work” forms from OSU; the Hot Work form can be provided by the Office of Environmental Health and Safety (EHS). Make sure the plan contains contact names and phone numbers, end of work plan, posting of emergency contact numbers, fugitive emissions control, ventilation for welding and shutdown of exhaust fans in case of fire, and procedures that are specific to this project.

.4.2.2 Draining operations must not damage building components or endanger human health.

.4.3 Country of Fabrication:

.4.3.1 All piping, fittings, and piping accessories not manufactured, fabricated, and/or assembled in the United States of America or Canada must be manufactured, fabricated, and/or assembled by an ISO 9001 registered corporation.

.4.3.2 Submit ISO 9001 registration certificates for all corporations where the piping, fittings, and piping accessories are not manufactured, fabricated, and/or assembled in the United States or Canada.

.4.3.3 For all piping, fittings, and piping accessories not fabricated in the United States or Canada, submit an independent test report for all materials to be provided.

.4.3.4 No piping, fittings, and piping accessories manufactured, fabricated, and/or assembled in China including Taiwan are permitted to be provided in this Contract.

.5 WELDING QUALITY ASSURANCE

.5.1 Welding Procedures: In the form of a submittal, the Contractor shall record in detail and shall qualify the Welding Procedure Specifications for every welding procedure that he proposes. Procedures shall be developed for all metals included in the work. The procedures for making transition welds between different materials or between plates or pipes of different wall thickness shall be qualified. Qualification for each welding procedure shall conform to the requirements of ASME B31.1, and to this specification. The method for each

system shall be fully described including the number of beads, the volts, the amperes, and the welding rod for various pipe thicknesses and materials. The welding procedures shall specify end preparation for butt welds including cleaning, alignment, and root openings. Preheat, interpass temperature control, and post-heat treatment of welds shall be as required by approved welding procedures, unless otherwise indicated or specified. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds. Welding procedures shall be identified individually and shall be clearly referenced to the type of welding required for this project. These procedures shall be the same as those used for all pipe welder qualification tests, all shop welds, and all field welds. The Contractor shall provide Procedure Qualification Records for all proposed Welding Procedure Specifications (WPS).

.5.2 Welding Procedure Submittals: Submit the following:

.5.2.1 Welding Procedure Specifications: Provide for each weld type. It is highly recommended that the Contractor use ASME Form E00006, QW-482 "Suggested Format for Welding Procedure Specification (WPS)".

.5.2.2 Procedure Qualification Records: Provide for each weld type. It is highly recommended that the Contractor use ASME Form E00007, QW-483 "Suggested Format for Procedure Qualification Record (PQR)".

.5.3 Welder Qualification:

.5.3.1 WPQs: Provide welder qualifications for each welder for each weld type. It is highly recommended that the Contractor use ASME Form E00008, QW-484 "Suggested Format for Manufacturer's Record of Welder or Welding Operation Qualification Tests (WPQ)." The WPQs shall be performed under the witness of an independent agency. The witness shall be a representative of an independent testing agency, Authorized Inspector, or consultant, any of which must be approved by the National Certified Pipe Welding Bureau. The qualifying test segment must be a 2-inch nominal pipe size with wall thickness within range of the WPS. Tests position shall be "6G" per ASME Section IX.

.5.3.2 Evidence of Continuity: Welder qualifications must be current. If the qualification test is more than 6 months old, provide record of welding continuity for each welder. Record of welding continuity

shall show that the welder in question has performed welding to the procedure in question without a 6-month continuous span of inactivity since the date that the welder qualification test was passed for the submitted welding procedure. Record of welding continuity shall include, at a minimum, the welder's employer name and address, the date the welder qualification test was passed, and the dates indicating welding continuity including welding procedure for each date.

.5.4 Weld Records:

.5.4.1 For all welding within the scope of ASME B31.1, the Contractor shall submit for approval an administrative procedure for recording, locating, monitoring, and maintaining the quality of all welds to be performed on the project. This quality control document record shall include but not be limited to drawings and schedules identifying location of each weld by individual number, identification of welder who performed each weld by individual welder's name, stamp number, date and WPS used.

.5.4.2 After achieving qualification, but before being assigned work, each qualified person shall be assigned an identifying number by the Contractor that shall be used to identify all of his welds. A list of qualified persons with their respective numbers shall be submitted by the Contractor and shall be maintained accurately with deletions and additions reported promptly.

.5.4.3 Upon completing a joint, the welder shall mark the pipe not more than 6 inches from the weld with the identifying number and the last two digits of the year in which the work was performed. Identification marks shall be made by using a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the A/E that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3-foot intervals. Identification by die stamps or electric etchers will not be allowed. The markers are to be provided by the Contractor. Substituting a map of welds with welders' names shall not be acceptable.

.5.5 Welder Pre-Qualification

.5.5.1 All welders shall be pre-qualified for this project by having the first weld tested via radiographic (RT) method by the independent testing agency (ITA), whose services shall be paid for by the Contractor. Acceptance standards shall be in accordance with Paragraph 136.4.5 of ASME B31.1. The procedure shall be in accordance with Article 2 of Section V of the ASME Boiler and Pressure Vessel Code. The ITA shall submit the written procedure as described in Paragraph T-221 of Article 2 of Section V of the ASME Boiler and Pressure Vessel Code. The ITA shall provide a report in accordance with Paragraph T-291 of Article 2 of Section V of the ASME Boiler and Pressure Vessel Code. All persons performing and evaluating radiographic examinations shall be certified for NDT Level II RT as recognized by the ANST. A nationally certified Level III RT technician per ANST shall be on staff at the testing laboratory. A Corporate Level III RT without National Certification is not acceptable. Welders shall do one weld and then have that weld tested and approved via RT before doing any more welding work. Maintain an active approved list with the University.

.6 DELIVERY, STORAGE, AND HANDLING

.6.1 Piping material shall be packaged in accordance with ASTM A 700 and as specified herein.

.6.2 Pipe Storage: Upon the receipt of each shipment of pipe on the job, the Contractor is responsible for maintaining the marking and for the storage of all pipe in such a manner that the ASTM material specifications and method of manufacture (seamless, etc.) of each piece of pipe will be clearly discernible at the time of its installation in the system. If at the time of its installation any piece of pipe is not readily identifiable, it will be subject to rejection, or arbitrary downgrading by the A/E to the lowest grade which has been received on the job to that date.

.6.3 Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, and clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

.6.4 Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

.6.5 Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

.6.6 Austenitic Stainless Steel Material: The following shall apply to handling, fabrication, and storage of austenitic stainless steel piping, tubing, and material to prevent surface contamination:

.6.6.1 Care shall be taken when handling stainless steel piping and tubing to minimize contact with carbon steel.

.6.6.2 Stainless steel material shall be protected against contact with lead, zinc, copper, and other low melting point materials.

.6.6.3 Tube cutters, grinding wheels, brushes, and files used to work on stainless steel material shall not have been previously used on other material.

.6.6.4 Brushes used on stainless steel shall have stainless steel bristles.

.6.6.5 Grinding wheels used on stainless steel shall be resin-bonded aluminum oxide or silicon carbide.

.6.6.6 Cutoff saws may be used on stainless steel material without special precautions, where followed by a grinding or machining operation.

.6.6.7 Carbon steel packing bands shall not be used in direct contact with stainless steel piping and tubing.

.6.6.8 Nylon slings shall be used in handling stainless steel material.

.6.7 External machined surfaces, flange facings, and bolt holes shall be protected against corrosion during shipment, storage, and installation with the application of one coat of water-soluble, rust-inhibiting coating.

.6.8 All edges prepared for field welding shall be protected against corrosion during shipment, storage, and installation with one coat of rust-inhibiting coating (deoxaluminate or University-approved equivalent) applied after inspection and cleaning.

PART 2 - PRODUCTS

.1 GENERAL

.1.1 Code: The fabrication and erection of all applicable piping shall conform to the latest edition and all current revisions of ASME Code for Power Piping

B31.1. In addition, the fabrication and erection of all piping shall conform to all applicable Federal, State, and Local laws.

.1.2 Piping Materials: Provide all pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by the intended service use, comply with governing regulations and industry standards, and obtain approval from the A/E prior to any work.

.1.3 Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections as determined by the intended service use and install in accordance with pipe manufacturer's recommendations. In addition, obtain approval from the A/E before performing any work.

.1.4 All materials shall be submitted for review prior to being incorporated in the Work. Material for pipes, fittings, and accessories shall be new and in accordance with ASTM specifications. Welded attachments shall be made of material compatible with the piping. Where the material for a specific component is not specified, it shall be selected by the Contractor for review by the A/E. Material and equipment specified by brand or manufacturer are typical and designate the type, quality, and purpose of the items. Similar and equivalent items of equal standards may be accepted if, in the opinion of the A/E, they are equivalent in all important respects and are equally suitable for the purpose intended. The Contractor shall submit descriptive literature and secure the A/E's written approval for any substitutions before orders are placed.

.2 PIPE IDENTIFICATION SYSTEM

.2.1 General: A system has been established which identifies the specific piping materials and, insulation, gaskets, and other components for each type of pipe identified in the Contract Drawings. The specific pipe specification is linked by the service number as listed in the "Piping, Gasket, Insulation, and Service Group Index", which appears in this Section.

.2.2 Pipe Identification System Description: The system used on the Contract Drawings to indicate the specific materials and construction required for each pipe line is illustrated by the following example.

.2.2.1 A typical pipe line may be called out as:

10" HPS, where:

- 10": Indicates nominal pipe size of line
- HPS: Is the abbreviation for the piping system contents and is the service group as depicted in the "Piping, Gasket, Insulation and Service Group Index". In this example the abbreviation is for Steam, High Pressure. In this example, the service group "HPS" requires Pipe Group 3, and Gasket Group "HP."
- Gasket groups are specified in detail in Section 33 63 45 - GASKETS.
- Pipe material and erection specification groups appear as subsections of this Section. For example, in the above example the service group is "HPS" which according to the index corresponds to Pipe Group 3; refer to Section 33 63 10.20 PIPING GROUP 3 - CARBON STEEL - HIGH PRESSURE STEAM PIPE-HPS for the material and erection specification of this pipe line.
- Valve groups are identified and specified in Section 33 63 35 – VALVES.
- Insulation groups are specified in detail in Section 33 63 55 - PIPING INSULATION.

.3 PIPING, GASKET, INSULATION, AND SERVICE GROUP INDEX: THE FOLLOWING PAGES CONTAIN THE "PIPING, GASKET, INSULATION, AND SERVICE GROUP INDEX".

PIPING, GASKET, INSULATION, AND SERVICE GROUP INDEX

SERVICE	LINE DESCRIPTION & DESIGN CONDITIONS	PIPE GROUP	GASKET GROUP	SERV GROUP ON DWGS
EQUIPMENT DRAIN, PUMPED	50 PSIG at 212°F Max, from Sump Pump Discharge in Trenches	90	HP	PED
CONDENSATE, HIGH PRESSURE	200 PSIG at 600°F Max., from HPS to PC System	94	HP	HPR

CONDENSATE, PUMPED	200 PSIG at 388°F Max., Returned Condensate from Campus and Manhole Pumps to Plant	94	HP	PCR
STEAM, HIGH PRESSURE	200 PSIG at 600°F Max., HPS Campus Distribution	3	HP	HPS
CHILLED WATER SUPPLY AND RETURN	100 PSIG at 140°F Max, chilled water return from/to chiller plants and buildings	2	HPB	CWS & CWR

.4 IMPULSE LINES

.4.1 Impulse lines for pressure gauges shall be per Piping System Specification of the PIPE GROUP as identified in the table shown in .3 PIPING, GASKET, INSULATION, AND SERVICE GROUP INDEX. However, regardless what is specified, impulse line for steam systems shall be socket-welded Schedule 80 ASTM A106 Seamless Carbon Steel.

PART 3 – EXECUTION

.1 GENERAL

.1.1 Inspection by the A/E and OSEP: Material, equipment, design, and workmanship shall at all times be subject to the inspection of the A/E and OSEP and, upon being notified in writing by the A/E, any material, equipment, or workmanship not meeting the specified requirements shall be replaced or reworked immediately without additional cost to the University. Inspection by the A/E and/or OSEP shall not relieve the Contractor from the responsibility for full compliance with the specified requirements.

.1.2 University-Furnished Drawings: The Drawings supplied by the University including the Contract Drawings are not intended to be fabrication drawings. Dimensions for pipe fabrication shall be field checked prior to fabrication.

.1.3 Do not interrupt utility services unless permitted in writing by the accountable University representative. Outages to existing utility systems must be planned and scheduled at least two weeks in advance. See outage procedure:

https://ap.osu.edu/sites/default/files/utility_outage_procedures.docx

.2 PREPARATION

.2.1 Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

.2.2 Conformance: The Contractor shall be responsible for checking and conforming to size, location, and flange drilling of all piping, valves, flow nozzles, and material furnished by the University for this piping installation.

.2.3 Measurement Verification by the Contractor: Before fabrication, the Contractor shall verify all measurements at the site and obtain all necessary additional information for completion of the Work, including the following:

.2.3.1 Actual location of weld nozzles, flanges, or other type of terminal connections and verification of weld nozzle ends and flange facings that are existing, to which the Contractor's Work must connect.

.2.3.2 Exact location of existing piping with supports and hangers in place

.2.3.3 Exact location of new and existing structures and equipment

.2.3.4 Interferences and difficulties that may exist

.2.3.5 The Contractor shall take such field measurements and allow for such makeup lengths or closures necessary for accurate alignment and assembly.

.3 INSTALLATIONS

.3.1 General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leak-proof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 0.05 inches misalignment tolerance.

.3.2 Piping Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location arrangement and restrictions of the piping systems. Location and arrangement of piping layout shall take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

.3.3 Piping Alignment:

.3.3.1 For piping systems between anchors that contain externally pressurized or slip-type (packed) expansion joints, use a laser to align the piping so that it is straight and that there will be no binding when the pipe thermally expands into the expansion joint. Use the laser alignment during fabrication of the piping system and when adjusting pipe support, guide, expansion joint, and anchor vertical elevations. Laser alignment equipment shall remain attached to the piping system until approved to be removed by the A/E after the A/E has witnessed the alignment.

.3.3.2 Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

.3.3.3 Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Contract Drawings.

.3.3.4 Locate groups of pipes parallel to each other, spaced to permit applying full insulation, servicing of valves, and thermal expansion of piping systems.

.3.4 Install drains at low points in mains, risers, and branch lines consisting of a tee, reducing tee, weld-o-let, or soc-o-let fitting, applicable 3/4-inch shut-off valve, 3/4-inch nipple, and cap for pipe sizes 6 inches and smaller; provide 2-inch shut off valve, nipple, and cap for pipe sizes 8 inches and larger. All components shall conform to the piping systems described in this Section and to Section 33 63 35 –VALVES. The location of the high point vents and low point drains shall be approved by the A/E.

.3.5 Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical rooms or electronic equipment spaces and enclosures. In no instance shall piping be routed above electrical equipment.

.3.6 Interferences: Do not run piping or conduits through ducts or equipment cabinets.

.3.7 Shop Prefabrication:

.3.7.1 Where shop prefabrication is not specified but is done as the Contractor's choice, any adjustments necessary due to inaccuracies in equipment setting and dimensions or location of existing obstructions shall be done at no additional cost. No shop fabrication sketches will be checked by the A/E, but Contractor shall submit drawings to the A/E for information.

.3.7.2 All shop fabrication shall be fabricated to dimensional tolerances in accordance with Pipe Fabrication Institute Standard ES-3. Accumulated tolerances between fixed points shall not exceed plus or minus 3/8 inch.

.3.8 Connections Equipment and Piping Specialties:

.3.8.1 Contractor shall erect and support piping in manner that shall not put undue strain on the equipment or piping specialty

.3.8.2 The procedure for connection of piping to equipment or piping specialty shall be as follows:

.3.8.2.1 After the equipment piping specialty has been set and grouted, the Contractor shall run the pipe from the equipment.

.3.8.2.2 Flat faced flanges and full-face gaskets shall be used on piping connecting to equipment with flat faced flanges. Raised faces of standard flanges may be machined off flat to accomplish this. Bolting for these joints shall be per ASME B31.1.

.3.8.2.3 Flanges shall be checked by the A/E to assure that no strain is placed on the equipment. If pipe is not in correct alignment, the Contractor shall remove piping and correct. The correction in alignment shall not be made while the pipe is connected to the equipment.

.3.8.3 After alignment is found correct by the A/E, the Contractor shall bolt up the flanges.

.3.8.4 When required by the A/E after the equipment has been in service, tested at operating temperatures, and with the lines and equipment still hot, the Contractor shall loosen flange connections to pumps, tanks, and equipment, and check for alignment, position, expansion, and strain applied to the equipment; make any adjustments necessary, and obtain approval of the A/E before reconnecting.

.3.8.5 Provide temporary strainers as directed per Section 33 63 25-PIPING SPECIALTIES.

.3.9 Thermal Cutting: When thermal cutting is required, the material shall be in accordance with ASME B31.1 welding preheat requirements. Thermal cut surfaces shall be ground to remove all slag, oxide, and surface irregularities to 1/16 inch. Austenitic stainless steel pipe shall be cut by mechanical means only.

.3.10 Welded Attachments:

.3.10.1 Welded attachments shall include lugs, brackets, and similar devices welded to pipe for hangers, supports, and guides. Weld procedures used to attach such devices shall be compatible with the base material. Preheating shall be in accordance with ASME B31.1 requirements for piping material.

.3.10.2 All areas where lugs or attachments are removed or repaired shall be tested hydrostatically to meet accepted standards stated in ASME B31.1. Any linear indications shall be removed and the area retested. The procedure shall be repeated until no indications are noted.

.4 FITTINGS AND SPECIALTIES

.4.1 Use fittings for all changes in direction and all branch connections. For piping greater than 2-inch NPS, if the change in direction is less than 5 degrees, a miter is acceptable and must be provided in accordance with ASME B31.1. No miters are acceptable for angles greater than 5 degrees. For changes in direction greater than 5 degrees, cut a forged fitting. For pipe sizes 2 inch NPS and smaller, changes in direction shall be done with standard 45 and 90 degree elbows – no miters or cut fittings acceptable.

.4.2 Pipe Elbows: Provide pipe elbows where depicted on the Contract Drawings. Use long radius elbows except where specifically designated on the Contract Drawings.

.4.3 Branches: Wherever branch pipe is indicated, install type of fitting shown on Contract Drawings, i.e. forged branch connection fitting, regular "T" fitting, or reducing "T" fitting. If the type of fitting is not shown on the Contract Drawings or specified in the piping specifications, the Contractor may choose between the above-mentioned fittings, within the limits of the following:

.4.3.1 Forged branch connection fittings may only be used if the smaller branch pipe is at least two standard nominal pipe sizes smaller than the larger main pipe.

.4.3.2 All fittings and procedures conform to the specific piping group specification as scheduled in this Section.

.4.3.3 The Contractor shall provide taps into existing mains that will remain energized at up to piping system design pressure where a hot tap is specifically indicated on the Contract Drawings. This procedure is also known as wet tapping. Hot or wet tapping shall be performed by experienced personnel with special hot tap fabrication equipment. All hot tapping shall be coordinated with the University. Hot tapping is only allowed where indicated on the Contract Drawings or by written approval from the University.

.4.4 Reducers: Unless explicitly stated on Contract Drawings, use forged fittings. Use concentric fittings except for steam systems, for reducers in horizontal in direction of flow, use eccentric flat on bottom to allow condensate to continue flowing in direction of steam travel.

.4.5 Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air). Unions shall be rated for the design basis working pressure and temperature of the piping system per this specification.

.4.6 Refer to Section 33 63 25 - PIPING SPECIALTIES for specification of pipe specialties including steam traps, strainers, etc.

.5 JOINTS

.5.1 Threaded Joints:

.5.1.1 Thread pipe with tapered pipe threads in accordance with ANSI B1.20.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Immediately before erecting the piping, all threads on pipe and all fittings shall be thoroughly cleaned of cuttings, dirt, oil, or other foreign matter.

.5.1.2 Ordinary or special-type screwed joints shall be kept to a minimum to reduce any possibility of leakage. Continuous runs of piping shall be used, wherever possible. All screwed connections shall have full threads of true taper and shall be accurate to gauge. Only Teflon shall be used on threaded joints that have a design temperature less than 500°F. Pipe compound shall be used on threaded joints that

have a design temperature greater than 500°F. Care shall be taken to prevent obstruction of pipe or tubing when using Teflon tape.

.5.1.3 When screwed connections are specified to be seal welded, the pipe shall be threaded so that not more than one thread remains outside the joint. The pipe to be welded shall be cleaned to bare metal and free of oil, scale, and dirt. The joint shall be made up hand-tight, without tape, and shall be welded with not less than two light beads with the weld cleaned between successive passes. The seal weld shall completely cover the thread with no undercut on the pipe. Plugs to be installed in seal weld fitting shall be installed using Teflon tape, after all welding is complete.

.5.2 Welded Joints:

.5.2.1 General:

.5.2.1.1 Weld pipe joints only when ambient temperature is above 0°F where possible.

.5.2.1.2 Bevel pipe ends at a 37.5-degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.

.5.2.1.3 Use pipe clamps or tack-weld joints with 1-inch long welds; 4 welds for pipe sizes to 10 inches, 8 welds for pipe sizes 12 inches to 20 inches.

.5.2.1.4 Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.

.5.2.1.5 Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.

.5.2.1.6 If piping component ends are bored, such boring shall not result in the finished wall thickness after welding less than the minimum design thickness.

.5.2.1.7 The inside diameters of piping components to be butt-welded shall be aligned as accurately as is practicable within existing commercial tolerances on diameters, wall thickness

and out of roundness. Alignment shall be preserved during welding. The internal misalignment of the ends to be joined shall not exceed 0.05 inch.

.5.2.2 Welding Processes:

.5.2.2.1 All welding on metal piping systems shall be done using qualified welding and qualified welders and welding operators in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.

.5.2.2.2 All welding shall be done by a process that is compatible with the work being welded and the working conditions. Shielded metal-arc welding (SMAW) shall not be used on work less than 3/16 inch thick.

.5.2.2.3 Where a specific welding process is called for in the piping group, it shall govern.

.5.2.2.4 All stainless work shall use 316L electrodes for the filler metal except 304L for the PED piping. All stainless steel work less than 3/16 inch thick shall be welded by the gas tungsten-arc (GTAW) process with the back side purged. Work thicker than 3/16 inch shall have a root pass by the GTAW Process with the back purged and the balance of the weld may be completed by SMAW Process or any other suitable process.

.5.2.2.5 The root pass for all steam piping shall be per the GTAW tungsten inert gas (TIG) method with E6010 and another hot pass with E6010. The E6010 can be substituted with ER-70S-2 or ER70S-3.

.5.2.2.6 Pulse welding in the form of MIG (Metal Inert Gas) is not allowed for welds of this project. No spray welding is allowed.

.5.2.3 Welding Grooves:

.5.2.3.1 The ends of steel pipe and fittings to be erected with butt welded joints shall be beveled to form welding grooves in accordance with ANSI B16.25, except where otherwise noted in these Specifications, or on the Contract Drawings.

.5.2.3.2 Welding grooves for butt welded joints in pipe of unequal wall thickness shall be beveled in accordance with ASME Code for Pressure Piping B31.1 - latest edition, latest revision and section that is applicable.

.5.2.4 Backing Rings: Backing rings or consumable inserts shall not be used and are not allowed.

.5.2.5 Cleaning of Welding: All slag or flux remaining on the bead of welding shall be completely removed before laying down the next successive bead and at the completion of the weld.

.5.2.6 Preheating of Welded Joints: Pipe adjacent to joints before and during welding shall be preheated by any suitable method in accordance with the qualified welding procedure and in all cases shall be in accordance with ASME B31.1, Paragraph 131.

.5.2.7 Weld Quality:

.5.2.7.1 All welds shall have full penetration and complete fusion with a minimum of weld metal protruding on the inside of the pipe.

.5.2.7.2 The finished weld contour shall be uniform, with the toe or edge of the weld merging smoothly into the base material. Butt welds shall have a slight reinforcement build-up gradually from the toe or edge toward the center of the weld. The limitation on butt weld reinforcement shall be in accordance with ASME B31.1, Table 127.4.2 and shall apply separately to both inside and outside surfaces of the joint. Fillet welds may be slightly concave on the furnished surface.

.5.2.8 Identification of Welders: Refer to Quality Assurance paragraph of Part 1 of this Section.

.5.3 Socket Welding Joints: Where socket welding valves or fittings are used, the pipe shall be spaced with a minimum of 1/16-inch clearance between the end of the pipe and the socket so that no stresses will be imparted to the weld due to "bottoming" of the pipe in the socket. The fit between the socket and the pipe shall conform to applicable standards for socket weld fittings and in no

case shall the inside diameter of the socket exceed the outside diameter of the pipe by more than 0.075 inches.

.5.4 Non-ferrous Pipe Joints:

.5.4.1 Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ASME B31.1.

.5.4.2 Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

.5.5 Flanged Joints:

.5.5.1 Joint and flange assembly personnel for the Contractor shall follow the most recent guidelines published for Pressure Boundary Bolted Flange Joint Assembly ASME PCC-1. The Contractor shall submit to the A/E a flange-assembly procedure that includes start-up re-torque procedures and engineering risk analysis as described in 10. d.

.5.5.2 Before assembly is started, the Contractor shall clean and examine flange and fastener contact surfaces. If applicable, remove all indications of the previous gasket installation from the gasket contact surfaces. Use approved solvents and/or soft-wire brushes, if required, for cleaning to prevent surface contamination and damage to existing surface finish. Avoid using carbon steel brushes on stainless steel flanges.

.5.5.3 Match flanges and provide proper alignment of all joint members within the piping system and at connections with valves and equipment where specified. Follow the Flange Joint Alignment Guidelines as specified in Appendix E of ASME PCC-1.

.5.5.4 Place a new gasket in position after determining the absence of unacceptable gasket sealing imperfections and flatness tolerance deviations, as well as joint alignment considerations.

.5.5.5 Protect gasket surfaces from inadvertent application of approved lubricants. Only apply approved lubricants to working surfaces with the bolt/nut/washer. Lubricants shall be chemically compatible with the bolt/nut/washer materials. All bolts shall be well lubricated over the entire thread. Contractor shall use White Hi-Temp Anti-Seize by Loctite or approved equal bolt lubricant on steam system piping.

.5.5.6 Once the flanges are aligned, install the gasket and install bolts and nuts so they are hand-tight with the marked ends of the bolts and nuts located on the same side of the joint and facing outward to facilitate inspections. Tighten the joint using either the torque increment rounds shown in ASME PCC-1 Table 2; and either the companion in ASME PCC-1 Table 4 or Table 4.1 cross-pattern tightening sequences when using a single tool as described in Section 11, or one of the alternative tightening procedures shown in Alternatives #1, #2, and #3 of Appendix F of the ASME PCC-1.

.5.5.7 All bolts in flanged construction shall be uniformly tightened with proper tools only. Hammering and bumping are prohibited. Care shall be taken to secure uniform pressure on the gasket to avoid overstressing of the bolts, dishing of flanges, and compression of the gasket beyond limits.

.5.5.8 All slip-on flanges are to be welded on front and back, no exceptions. Welding neck flanges shall be bored to match the attached pipe.

.5.5.9 Contractor shall be sure to release any aligning devices used to align jointed assemblies.

.5.5.10 Start-up re-torque (also referred to as hot torque) shall be performed to decrease the likelihood of leakage during operation. Start-up re-torque is performed on steam system piping, hot water piping, or when the temperature of the pipe contents is between 300°F and 450°F or within 24 hours of unit start-up if the joint temperature remains below 300°F. The start-up re-torque shall be performed in accordance with the following:

.5.5.10.1 The ambient-temperature assembly Target Torque value should be adjusted to account for any change in nut factor with temperature.

.5.5.10.2 Once the unit is brought online and the metal temperature is between 300°F and 450°F or within 24 hours of unit start-up if the joint temperature remains below 300°F, then contractor shall proceed in a cross pattern and retighten each bolt to the specified torque in ASME PCC-1. The use of multi-tool tightening on opposing bolts is acceptable, but a cross pattern should be used.

.5.5.10.3 Continue tightening in the cross pattern until the nuts no longer turn.

.5.5.10.4 An engineering and risk analysis of the proposed start-up re-torque operation shall be carried out by the installing Contractor to establish that the operation can be performed safely. The Contractor shall take into account

site conditions, staff qualifications & experience, approved submittal data, manufacturer installation requirements & recommendations, and other critical installation factors when completing their analysis. Submit analysis to the A/E.

.6 CLEANING, FLUSHING, INSPECTING

.6.1 General: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings (if any). Inspect each run of each system for completion of joints, supports, and accessory items.

.6.2 Flush out and clean and then treat and refill the chilled water piping systems with a cleaning contractor. Contractor shall provide a cleaning procedure and treatment program for review and approval by the Architect/Engineer and OSEP. Before proceeding, inspect each run of each system for completion of joints, supports, and accessory items.

.6.3 Provide steam blow for steam piping per Section 33 63 15 – STEAM BLOWING.

.6.4 The PCR piping receives no steam blow or flushing.

.7 PIPING TESTS - HYDROSTATIC

.7.1 All non-boiler external piping shall be hydrostatically tested in accordance with Paragraph 137 of the ASME B31.1 Power Piping Code.

.7.2 General:

.7.2.1 Provide temporary equipment for testing, including pump and gauges. The gauge shall be accurate to within 3 PSIG and shall be calibrated within six months of the test as recorded on a sticker on the gauge. Test piping system before insulation is installed. Pressure testing shall be performed following the completion of post-weld heat treatment, nondestructive examinations, and all other fabrication, assembly, and erection activities required to the provide the system or portions thereof subjected to the pressure test with pressure retaining capability. Remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and

time. The Contractor shall provide air vents at all high points in the system to purge air pockets while the system is filling.

.7.2.2 The Contractor shall test each section of pipe before it is insulated and buried. Provide temporary piping including welded caps prior to the termination into existing piping so that new piping can be hydrostatically tested without having cold water against an active hot valve. After successfully hydrostatic testing, remove the temporary piping and caps and provide new piping to tie into existing piping. It is recognized that the final connection pieces to existing piping will not be hydrostatically tested; however, flow (at normal operating pressure) shall be established through the final connection pieces and fittings, with no visual evidence of weeping or leakage, prior to insulation and burial.

.7.2.3 Air or other gas testing is not acceptable.

.7.3 Test Pressure:

.7.3.1 Test all steam, condensate, and pumped condensate at 1-1/2 times the design pressure listed in the table in Section .3 PIPING, GASKET, INSULATION, AND SERVICE GROUP INDEX. For example, for HPR, the design pressure is 200 PSIG. Therefore, the test pressure shall be 300 PSIG.

.7.3.2 The test pressure shall be continuously maintained for a minimum time of 4 hours. During this 4-hour period, no pressure drop shall be measured. After the 4-hour period, if necessary, the pressure may then be reduced to design pressure and held for such time as may be necessary to continue to conduct the examinations for leakage. Examinations for leakage shall be made of all joints and connections. The piping system shall show no visual evidence of weeping or leaking. Hydrostatic testing shall be witnessed by the University or Engineer. After any leaks are found and corrected, the test shall be repeated.

.7.4 Test Blinds:

.7.4.1 If during the field testing of piping it becomes necessary to insert test blinds in any part of this piping, the Contractor shall provide test blinds and all work required including the flanges and welding of flanges.

.7.4.2 Test blinds shall be equipped with a long handle.

.7.4.3 The Contractor shall submit a written description of the location of test blinds before testing.

.7.4.4 The Contractor shall remove all test blinds after testing.

.7.5 Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

.7.6 Records:

.7.6.1 It is the responsibility of the Contractor to keep accurate, updated records of all hydrostatic testing. The Contractor shall submit a final log of all hydrostatic testing for the Owner's records.

.7.6.2 The Contractor shall maintain a constantly updated list of the following for all hydrostatic tests:

.7.6.2.1 Date and time of test

.7.6.2.2 Hydrostatic test pressure

.7.6.2.3 Piping system tested

.7.6.2.4 Extent of piping system tested so that it can be clearly identified up to what point a piping system has been tested

.7.6.2.5 Test results. All failures shall be indicated with the cause explicitly stated.

.7.6.2.6 Signed witnesses of each test which shall be one employee of the Contractor and by the Engineer

.8 PIPING TESTS - VISUAL EXAMINATION

.8.1 General: Visually examine all pipe welds per ASME B31.1. As described below, visual examination of welds shall be performed by the Contractor. This type of testing is required by the code and shall not be paid for by the A/E.

.8.2 Acceptance Standards:

.8.2.1 The acceptance standards for visual examination shall be as defined in ASME B31.1, Paragraph 136.4.2.A, and are repeated here for convenience. The following indications are unacceptable:

- Cracks-external surface
- Undercut on surface which is greater than 1/32-inch deep
- Weld reinforcement greater than that specified in Table 127.4.2. of ASME B31.1
- Lack of fusion on surface
- Incomplete penetration (applies only when inside surface is readily accessible)
- Any other linear indications greater than 3/16 inch long
- Surface porosity with rounded indications having dimensions greater than 3/16 inch or four or more rounded indications separated by 1/16 inch or less edge to edge in any direction. Rounded indications are indications which are circular or elliptical with their length less than three times their width

.8.2.2 In addition, acceptance will also be based on the proper lay-out, materials, and methods, as specified.

.8.3 Failed Welds:

.8.3.1 All welds not passing visual examination shall be repaired or replaced at no expense to the University.

.8.3.2 Visual defects found shall require additional VT as recommended by inspector.

.8.3.3 Do not begin to repair or replace the weld until the weld report has been submitted to the A/E and the A/E gives approval for repairing the weld with the method that the Contractor proposes. Repair shall be performed using the qualified welding procedures applicable to the original weld.

.8.4 Reporting:

.8.4.1 Reports for visual examinations of welds shall be required for all piping larger than 3 inch NPS except for vent and drain services. Reports preformed for visual examinations by the Contractor are not required to be submitted, but shall be kept available for review at any time by the University or A/E.

.8.4.2 Each weld report shall include the following:

.8.4.2.1 Date of weld examination

.8.4.2.2 Type of examination

.8.4.2.3 Examiner's name

.8.4.2.4 Welders' names including all persons who worked on the weld and their work involved

.8.4.2.5 Piping system

.8.4.2.6 Weld location

.8.4.2.7 Weld procedure and materials

.8.4.2.8 Materials and dimensions of items that were welded

.8.4.2.9 Visual examination results

.8.5 Examiners' Qualifications:

.8.5.1 All persons performing visual examinations and evaluating examinations shall be certified according to AWS QC1 or those requirements stated explicitly in ASME B31.1. It is not intended to have a third party inspector perform this service.

.8.5.2 Credentials and certification of all examiners must be submitted and approved prior to an examiner performing the initial examination.

.8.6 Visual Examination Requirements:

.8.6.1 Welds designated for visual examination shall be examined after the weld is completed for cracks, contour and finish, bead reinforcement, undercutting, overlap, size of fillet welds, finished weld appearance, weld size, weld length, dimensional accuracy of weldment, and monitor post weld heat treatment.

.8.6.2 Records of visual examinations must be kept as described in this Section.

.8.6.3 Shop fabricated welds may be examined in the shop prior to arrival at the project site provided all other conditions of this Section are satisfied.

.8.7 Examiner's Scope:

.8.7.1 Visual examinations to be performed by the Contractor may be performed and interpreted by an employee or employees of the Contractor, provided that each individual is certified as specified. As an option, the Contractor may obtain the services of an independent testing agency to perform these examinations.

.8.7.2 If the Contractor elects to utilize the services of an independent testing agency to perform any visual examinations, the following applies:

.8.7.2.1 The qualifications for the personnel of the independent testing agency performing the examinations shall be submitted.

.8.7.2.2 The Contractor shall provide all required access and lighting for the independent testing agency.

.8.7.2.3 The Contractor shall be responsible for all of the independent testing agencies activities, including handling submittals, performing evaluations at the required times, etc.

.8.7.3 A welder who has performed any work with regard to a specific weld shall not perform the visual examination of the same weld.

.9 PIPING TESTS – MAGNETIC PARTICLE (MT)

.9.1 General: The A/E will direct an independent testing agency to examine pipe welds using the magnetic particle method as indicated in the "Nondestructive Testing Requirements Index", located in this Section. Where MT is designated, butt welds, socket welds, and welded branch connections for sizes NPS 2 and less will be examined per the requirements specified herein on the root and

cap passes. Magnetic Particle testing will be paid for by the A/E except for retests for failed welds which shall be paid for by the Contractor.

.9.2 Acceptance Standards: Will be in accordance with Paragraph 136.4.3 of ASME B31.1. The A/E may, at his sole discretion, elect to waive some of the acceptance standards on a case-by-case basis.

.9.3 Procedure:

.9.3.1 Magnetic particle examination will be performed in accordance with Article 7 of Section V of the ASME Boiler and Pressure Vessel Code.

.9.3.2 The procedure will be as described in Paragraph T-721 of Article 7 of Section V of the ASME Boiler and Pressure Vessel Code.

.9.4 Reporting:

.9.4.1 The report of each magnetic particle examination will be submitted to the A/E and the University within 2 working days of the examination by the ITA.

.9.4.2 In addition to the requirements of Paragraph T-761 of Article 7 of Section V of the ASME Boiler and Pressure Vessel Code, each weld report will include the following:

.9.4.2.1 Date of weld examination

.9.4.2.2 Type of examination

.9.4.2.3 Examiner's name

.9.4.2.4 Welders' names including all persons who worked on the weld and their work involved

.9.4.2.5 Pipe system

.9.4.2.6 Weld location

.9.4.2.7 Weld procedure and materials

.9.4.2.8 Materials and dimensions of items that were welded

.9.4.2.9 Magnetic particle examination results

.9.5 Examiner's Qualifications: All persons performing and evaluating magnetic particle examinations will be certified for NDT Level II MT as recognized by the

ANST. A Nationally Certified Level III MT technician per ASNT shall be on staff at the testing laboratory. A Corporate Level III MT without National Certification is not acceptable.

.9.6 Magnetic Particle Examination Requirements:

.9.6.1 The A/E will be responsible for obtaining and paying for the services of the independent testing agency, except for retesting of failed welds which shall be paid by the Contractor. The Contractor is responsible for providing access to the welds for the Independent Testing Agency.

.9.6.2 When a limited number of welds are specified (not 100%), the welds to be examined shall be random. The A/E will designate the specific welds that are to be randomly tested as the job is in progress.

.9.6.3 It is suggested to the Contractor that the Contractor should notify the A/E when welds that require scaffolding are complete so that the Contractor will not have to re-build scaffolding to gain access to the welds.

.9.6.4 Shop fabricated welds will be examined in the field.

.9.7 Failed Welds:

.9.7.1 All welds not passing magnetic particle examination shall be repaired or replaced at no expense to the University or A/E.

.9.7.2 Do not begin to repair or replace the failed weld until the weld report has been submitted to the A/E and University and the A/E gives approval for repairing the weld with the method that the Contractor proposes. Repair shall be performed using the qualified welding procedures applicable to the original weld.

.9.7.3 All failed welds discovered by magnetic particle examination will be re-examined by magnetic particle examination after the weld is repaired or replaced at no additional cost to the University or A/E with the report being submitted to the A/E and the University within 2 working days of the examination which shall reference the repair of the particular weld.

.10 PIPING TESTS - ULTRASONIC EXAMINATION (UT)

.10.1 General: The A/E will direct an independent testing agency to ultrasonically examine pipe welds as indicated in the "Nondestructive Testing Requirements Index", located in this Section. Where Ultrasonic testing (UT) is designated, it will be performed on piping sizes larger than 2-inch NPS. UT will be paid for by the A/E except for retests for failed welds which shall be paid for by the Contractor.

.10.2 Acceptance Standards: Shall be in accordance with Paragraph 136.4.6 of ASME B31.1. The A/E and University may, at their sole discretion, elect to waive some of the acceptance standards on a case by case basis.

.10.3 Procedure:

.10.3.1 Ultrasonic examination will be performed in accordance with Article 5 of Section V of the ASME Boiler and Pressure Vessel Code.

.10.3.2 The procedure will be as described in Paragraph T-593 of Article 5 of Section V of the ASME Boiler and Pressure Vessel Code.

.10.4 Reporting:

.10.4.1 The report of each ultrasonic examination will be submitted to the A/E and University within 2 working days of the examination.

.10.4.2 In addition to the requirements of Paragraph T-593 of Article 5 of Section V of the ASME Boiler and Pressure Vessel Code, each weld report will include the following:

.10.4.2.1 Date of weld examination

.10.4.2.2 Type of examination

.10.4.2.3 Examiner's name

.10.4.2.4 Welders' names including all persons who worked on the weld and their work involved

.10.4.2.5 Pipe system

.10.4.2.6 Weld location

.10.4.2.7 Weld procedure and materials

.10.4.2.8 Materials and dimensions of items that were welded

.10.4.2.9 Ultrasonic examination results

.10.5 Examiner's Qualifications: All persons performing and evaluating ultrasonic examinations will be certified for NDT Level II as recognized by the American Society for Nondestructive Testing (ANST).

.10.6 Ultrasonic Examination Requirements:

.10.6.1 The A/E shall be responsible for obtaining and paying for the services of the independent testing agency, except for retesting of failed welds which shall be paid for by the Contractor. The Contractor is responsible for providing access to the welds for the Independent Testing Agency.

.10.6.2 When a limited number of welds are specified (not 100%), the welds to be examined shall be random. The A/E will designate the specific welds that are to be randomly tested as the job is in progress.

.10.6.3 It is suggested to the Contractor that the Contractor should notify the A/E when welds that require scaffolding are complete so that the Contractor will not have to re-build scaffolding to gain access to the welds.

.10.6.4 Shop fabricated welds will be examined in the field.

.10.7 Failed Welds:

.10.7.1 All welds not passing ultrasonic examination shall be repaired or replaced at no expense to the University or A/E.

.10.7.2 Do not begin to repair or replace the failed weld until the weld report has been submitted to the A/E and the A/E gives approval for repairing the weld with the method that the Contractor proposes.

.10.7.3 All failed welds discovered by ultrasonic examination shall be re-examined by ultrasonic examination after the weld is repaired or replaced at no additional cost to the University with the report being submitted to the A/E and the University within 2 working days of the examination which shall reference the repair of the particular weld.

.11 NONDESTRUCTIVE TESTING REQUIREMENTS INDEX: THE NONDESTRUCTIVE TESTING REQUIREMENTS INDEX IS LISTED BELOW: "NR" MEANS "NOT REQUIRED."

SERVICE	LINE DESCRIPTION & DESIGN CONDITIONS	VISUAL	MT	UT	SERVICE GROUP ON DWGS
EQUIPMENT DRAIN, PUMPED	50 PSIG at 212°F Max., from Sump Pump Discharge in Trenches	NR	NR	NR	PED
CONDENSATE, HIGH PRESSURE	200 PSIG at 600°F Max., from HPS to PC System	100%	NR	NR	HPR
CONDENSATE, PUMPED	200 PSIG at 388°F Max., Returned Condensate from Campus and Manhole Pumps to Plant	100%	NR	NR	PCR
STEAM, HIGH PRESSURE	200 PSIG at 600°F Max., HPS Campus Distribution	100%	100%	100%	HPS
CHILLED WATER SUPPLY AND RETURN	150 PSIG at 140°F Max., Chilled water from/to chiller plants and buildings	100%	100%	100%	CWS & CWR

.12 OPERATING TEST AND FINAL INSPECTION

.12.1 New utility piping systems shall not be placed in service if these Standards are not met or if the design or A/E approved equipment or installation fails these Standards or inspections by the authority having jurisdiction.

.12.2 A structured inspection and review process shall be followed per the Utility Service Connection and Inspection Standards:

https://fod.osu.edu/sites/default/files/utility_service.pdf

Checklists are available from OSEP and FOD, whichever is the applicable operator of the utility service. Pre in-service checks include cleaning, pressure testing, insulation, painting, and identification.

.12.3 Upon completion of pre-service tests, the work shall be tested by an operating test performed by the University under normal service conditions.

.12.4 Upon completion of each operating test, the Contractor shall correct loose or faulty hangers and shall provide required devices to eliminate sway or vibration of piping.

.13 INSULATION, PAINTING, AND IDENTIFICATION

.13.1 Insulate all piping as indicated in Section 33 63 55 - PIPING INSULATION.

.13.2 Piping identifications shall be in accordance with Section 33 63 50 – IDENTIFICATION FOR PIPING AND EQUIPMENT.

.13.3 Paint piping systems in accordance with Section 33 63 50 – IDENTIFICATION FOR PIPING AND EQUIPMENT.

.13.4 Internal Cleaning of Piping: Refer to Part 3-Execution; Section .6 CLEANING, FLUSHING, INSPECTING.

33 63 10.2 PIPING GROUP 2 – CARBON STEEL - CHILLED WATER SUPPLY AND RETURN PIPE – CWS and CWR

.1 DESIGN BASIS

.1.1 Working pressure, 100 psig at 140°F.

.1.2 Piping Group 2 – Carbon Steel.

.2 PIPE

.2.1 All pipes shall be ASTM A 106 or ASTM A 53, Grade B, Type S, seamless Pipe wall thickness shall be as follows:

1" through 24"	Schedule 40

.3 JOINTS

.3.1 Joints 2 inches and smaller shall be screwed.

.3.2 Joints 2-1/2 inches and larger shall be butt welded.

.3.3 All sizes shall be flanged where shown on the Contract Drawings or where required to connect to flanged valves, fittings, or equipment.

.4 STRESS RELIEVING

.4.1 Stress relieving and pre and/or post weld heat treatment is not required.

.5 FABRICATION AND ERECTION

.5.1 Fabrication and erection shall be in accordance with Section 33 63 10 – COMMON WORK RESULTS FOR PIPING.

.6 TESTING

.6.1 Testing shall be in accordance with Section 33 63 10 – COMMON WORK RESULTS FOR PIPING.

.7 FLANGES

.7.1 Flanges 24 inches and smaller shall be Class 150 welding neck type in accordance with ANSI B16.5 and raised faced as required to match the mating flange. Material shall conform to ASTM A 105. Welding neck flanges shall be bored to match the same ID as the attached pipe.

.8 FITTINGS

.8.1 Fittings 2 inches and smaller shall be 150-pound screwed banded malleable iron in accordance with ANSI B16.3. Material shall conform to ASTM A 197.

.8.2 Fittings 2-1/2 inches and larger shall be steel, butt welded type in accordance with ANSI B16.9 and with the same wall thickness as the attached pipe. Material shall conform to ASTM A 234, Grade WPB.

.9 BOLTING MATERIALS

.9.1 Bolting materials shall be mild steel, hexagonal head bolts with heavy hexagonal nuts conforming to ASTM A 307, Grade B.

.10 UNIONS

.10.1 Unions 2 inches and smaller shall be 150-pound malleable iron, brass seat, nut type. Material shall conform to ASTM A 197.

.10.2 Unions 2-1/2 inches and larger shall be made with flanges.

33 63 10.20 PIPING GROUP 3 – CARBON STEEL - HIGH PRESSURE STEAM PIPE - HPS

.1 DESIGN BASIS

.1.1 Design minimum working pressure and temperature: 200 psig and 600°F.

.1.2 Piping Group 3 – Carbon Steel Pipe.

.2 PIPE

.2.1 All pipe through 16 inches shall be seamless carbon steel conforming to ASTM A53 Grade B Type S or ASTM A 106 Grade B Type S. Pipe wall thickness shall be as follows:

1 through 16 inches	Schedule 40 (Hard Schedule 40, not “STD”)

.2.2 All threaded pipe nipples shall be Schedule "XSTG" conforming to ASTM A 106, Grade B.

.3 JOINTS

.3.1 Joints 2 inches and smaller shall be socket welded.

.3.2 Joints 2-1/2 inches and larger shall be butt welded.

.3.3 All sizes shall be flanged where shown on the Contract Drawings or where required to connect to flanged valves, fittings, or equipment.

.4 STRESS RELIEVING

.4.1 Stress relieving and pre and/or post weld heat treatment is not required.

.5 FABRICATION AND ERECTION

.5.1 Fabrication and erection shall be in accordance with Section 33 63 10 – COMMON WORK RESULTS FOR PIPING.

.6 TESTING

.6.1 Testing shall be in accordance with Section 33 63 10 – COMMON WORK RESULTS FOR PIPING.

.7 FLANGES

.7.1 Flanges shall be Class 300 welding neck type in accordance with ANSI B16.5 and raised. Material shall conform to ASTM A 105. Welding neck flanges shall be bored to match the same ID as the attached pipe.

.8 FITTINGS

.8.1 Fittings 2 inches and smaller shall be 3000-pound socket-weld in accordance ANSI B16.11. Material shall conform to ASTM A 105.

.8.2 Fittings 2-1/2 inches and larger shall be seamless forged steel, butt-welding type in accordance with ANSI B16.9 and with the same wall thickness as the attached pipe. Material shall conform to ASTM A 234, Grade WPB.

.9 BOLTING MATERIALS

.9.1 Bolting shall consist of a bolt head which requires one nut on the opposite side on the threaded end in accordance with ANSI B1.1, Class 2A. Material shall conform to ASTM A354 Grade BD. Nuts shall be heat-treated, heavy, hexagonal nuts, semi-finished and in accordance with ANSI B18.2.2 and B1.1, Class 2B. Material shall conform to ASTM A 194, Grade 2H.

.10 UNIONS

.10.1 Unions 2 inches and smaller shall be 3000-pound forged steel socket weld with steel to steel seats. Material shall conform to ASTM A 105.

.10.2 Unions 2-1/2 inches and larger shall be made with flanges.

33 63 10.90 PIPING GROUP 90 – TYPE 304L STAINLESS STEEL PIPE

.1 DESIGN BASIS

.1.1 Working pressure, 408 psig at 600°F

.2 PIPE

.2.1 All pipe shall be seamless stainless steel conforming to ASTM A312 Type TP304L. The wall thickness shall be as follows:

1 through 8 inches	Schedule 10S

.2.2 The supplier or fabricator shall submit mill chemical and physical test reports of material.

.2.3 Any pipe delivered for incorporated in the work which shows any signs of improper welding techniques, signs of rust, or other forms of corrosion will be rejected.

.3 JOINTS

.3.1 Joints 2 inches and smaller shall be socket welded.

.3.2 Joints 2-1/2 inches and larger shall be butt welded.

.3.3 All sizes shall be flanged where shown on the Contract Drawings or where required to connect to flanged valves, fittings, or equipment.

.4 STRESS RELIEVING

.4.1 Stress relieving and pre and/or post weld heat treatment is not required.

.5 FABRICATION AND ERECTION

.5.1 Fabrication and erection shall be in accordance with Section 33 63 10 – COMMON WORK RESULTS FOR PIPING.

.6 TESTING

.6.1 Testing shall be in accordance with Section 33 63 10–COMMON WORK RESULTS FOR PIPING.

.7 FLANGES

.7.1 Flanged joints shall be lap joint style. Material shall conform to ASTM Specification A 182, F304L. Flanges shall be ANSI Class 150, ANSI B16.5.

.8 FITTINGS

.8.1. 2 Inches and Smaller: Fittings shall be socket weld type, Class 3000, in accordance with ANSI B16.11 and of the same thickness as the attached pipe. Material shall conform to ASTM A182, F304L.

.8.2. 2-1/2 Inches and Larger: Fittings shall be stainless steel butt-welded type in accordance with ANSI B16.11 and with the same wall thickness as the attached pipe. Material shall conform to ASTM A 403, Grade WP 304L.

.9 BOLTING MATERIALS

.9.1 Bolting shall consist of a bolt head which requires one nut on the opposite side on the threaded end in accordance with ANSI B1.1, Class 2A. Bolting materials shall be ASTM A193, Grade B7. Nuts shall be heavy series, hexagon, carbon steel, ASTM A194 Grade 2H, dimensional requirements per ANSI B18.2.2.

.10 UNIONS

.10.1 Unions 2 inches and smaller shall be 3,000-pound forged stainless steel socket weld with stainless steel seats.

.10.2 Unions 2-1/2 inches and larger shall be made with flanges.

33 63 10.94 PIPING GROUP 94 – TYPE 316L STAINLESS STEEL - HIGH PRESSURE AND PUMPED CONDENSATE PIPE – HPR AND PCR

.1 DESIGN BASIS

.1.1 Design minimum working pressure and temperature: 200 psig and 600°F.

.1.2 Piping Group 94 – Type 316L Stainless Steel.

.2 PIPE

.2.1 All pipe shall be seamless stainless steel conforming to ASTM A312 Type TP316L. The wall thickness shall be as follows:

1 through 8 inches	Schedule 40S

.2.2 The supplier or fabricator shall submit mill chemical and physical test reports of material.

.2.3 Any pipe delivered for incorporated in the work which shows any signs of improper welding techniques, signs of rust, or other forms of corrosion will be rejected.

.3 JOINTS

.3.1 Joints 2 inches and smaller shall be socket welded.

.3.2 Joints 2-1/2 inches and larger shall be butt welded.

.3.3 All sizes shall be flanged where shown on the Contract Drawings or where required to connect to flanged valves, fittings, or equipment.

.4 STRESS RELIEVING

.4.1 Stress relieving and pre and/or post weld heat treatment is not required.

.5 FABRICATION AND ERECTION

.5.1 Fabrication and erection shall be in accordance with Section 33 63 10 – COMMON WORK RESULTS FOR PIPING.

.6 TESTING

.6.1 Testing shall be in accordance with Section 33 63 10 –COMMON WORK RESULTS FOR PIPING.

.7 FLANGES

.7.1 Flanged joints shall be weld neck joints. Material shall conform to ASTM Specification A 182, F316L. Flanges shall be ANSI Class 300, ANSI B16.5.

.8 FITTINGS

.8.1. 2 Inches and Smaller: Fittings shall be socket weld type, Class 3000, in accordance with ANSI B16.11 and of the same thickness as the attached pipe. Material shall conform to ASTM A182, F316L.

.8.2. 2-1/2 Inches and Larger: Fittings shall be stainless steel butt-welded type in accordance with ANSI B16.11 and with the same wall thickness as the attached pipe. Material shall conform to ASTM A 403, Grade WP 316L.

.9 BOLTING MATERIALS

.9.1 Bolting shall consist of a bolt head which requires one nut on the opposite side on the threaded end in accordance with ANSI B1.1, Class 2A. Bolting materials shall be ASTM A193, Grade B7. Nuts shall be heavy series, hexagon, carbon steel, ASTM A194 Grade 2H, dimensional requirements per ANSI B18.2.2.

.10 UNIONS

.10.1 Unions 2 inches and smaller shall be 3,000-pound forged stainless steel socket weld with stainless steel seats.

.10.2 Unions 2-1/2 inches and larger shall be made with flanges.

33 63 13.94 UNDERGROUND CONDENSATE DISTRIBUTION PIPING

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.2 DESCRIPTION OF WORK

.2.1 All underground condensate lines, as indicated on contract drawings, shall be Class A testable, drainable, and dryable. The system supplier shall have fabricated systems of the composition herein for at least three years. All straight sections, fittings, anchors, and other accessories shall be factory prefabricated to job dimensions and designed to minimize the number of field welds. Each system layout shall be computer analyzed by the piping system manufacturer to determine the stresses on the carrier pipe and anticipated thermal movement of the service pipe. The system design shall be in strict conformance with ASME B31.1, latest edition. Factory trained field technical assistance shall be provided for the critical periods of installation, i.e., unloading, field joint instruction, and testing. The preapproved conduit system shall include all piping and components to a point twelve inches inside the building, or manhole wall.

.2.2 The system suppliers' representative shall be responsible for directing the installation and testing of the conduit system. It shall be certified in writing by the supplier that the representative is technically qualified and experienced in the installation of the systems. The supplier's representative shall be present during the following work phases:

- Inspection and unloading
- Inspection of trench prior to laying of conduit
- Inspection of expansion loops
- Inspection of joining of system
- Air test (conduit)
- Repair of any patchwork
- Back filling of conduit sections

.2.3 The contractor shall not perform any of the above stated work in the absence of the system supplier's representative.

.2.4 The contractor performing the work shall be responsible for the installation of the preapproved system and all other components of the underground condensate conduit systems, including the manholes and the piping equipment in the manholes and buildings. This responsibility shall include all site work and purchase of the preapproved system from the system supplier.

.3 SUBMITTALS

.3.1 Refer to Division 1 and Common Work Results for Mechanical for administrative and procedural requirements for submittals.

.3.2 Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for the type of manufactured piping specialty.

.3.3 Shop Drawings: Submit for fabricated specialties, indicating details of fabrication, materials, and method of support. A complete engineering stress analysis indicating all anchors, fittings, dimensions in three axes, thermal movement calculations, maximum anticipated stresses and maximum allowable stresses must be submitted.

.3.4 Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

.3.5 Quality Control Submittals:

.3.5.1 Submit welders' certificates specified in Quality Assurance below.

.3.5.2 Welding procedures

.3.6 Excavation Support and Protection:

.3.6.1 Prior to starting work, submit for review and approval, calculations, and shop drawings showing each proposed method of supporting adjacent earth and structures; i.e. retention system and other methods of bracing. Include the following:

.3.6.1.1 Lists of material to be used, including design mixes

.3.6.1.2 Sequence of operations

.3.6.1.3 Detailed sections clearly illustrating the scope of work

.3.6.1.4 Relationship of piles, lagging, walls, and bracing to new and existing structures

.3.6.1.5 Location of utilities and details of support when required

.3.6.1.6 Procedures and details of testing

.3.6.2 Shop drawings and calculations: Prepared by qualified Licensed Professional Engineers registered in the State of Ohio and bearing their seals and signatures.

.3.6.3 Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of complete projects with project names and addresses, names and addresses of architects and the owners, and other information specified.

.3.7 Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by excavation support and protection systems.

.4 QUALITY ASSURANCE

.4.1 Welder's Qualifications: All welders shall be certified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing qualifications.

.4.2 Welding procedures and testing shall comply with ASME B31.1-Code Power Piping Code and The American Welding Society, Welding Handbook.

.4.3 Excavation Support and Protection:

.4.3.1 Comply with the Publications of the following agencies to the extent referenced and applicable:

- ASTM - American Society for Testing and Materials.
- AISC - American Institute of Steel Construction.
- OSHA - Occupational Safety and Health Act.

.4.3.2 Installer Qualifications: Engage an experienced installer to assume engineering responsibility and perform work of this Section who has specialized in installing excavation support and protection systems similar to those required for this Project and with a record of successful in-service performance.

.4.3.3 Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Ohio and who is experienced in providing engineering services for designing

excavation support and protection systems that are similar to those indicated for this Project in material, design, and extent.

.4.3.4 Engineering Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of data for the excavation support and protection system including drawings and comprehensive engineering analysis that shows the system's compliance with specified requirements.

.4.3.5 Do not install excavation support and protection system until successfully reviewed by AE.

.5 JOB CONDITIONS

.5.1 Before starting work, check and verify governing dimensions and elevations. Survey condition of adjoining surfaces. Photograph existing conditions to record any prior settlement or cracking of structures, pavements, and other deficiencies. Prepare a list of existing damages, verified by dated photographs and signed by the University.

.5.2 Survey adjacent structures and improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations. Locate datum level used to establish benchmark elevations.

.5.3 Contractor shall schedule a “Direct Buried Underground Condensate Piping Systems” pre-construction meeting with the Project Manager and AE to review installation requirements. The meeting shall take place after all submittals have been approved, but prior to any utility installation/construction.

.6 EXISTING UTILITIES

.6.1 The contract drawings indicate the general location of underground utilities. All utility locations and elevations in the vicinity of work shall be verified by the contractor prior to the start of project work. Test pits shall be conducted in areas where conflicts may occur prior to any excavation, heavy equipment loading, drilling and setting the H-piles is performed so as to avoid damaging or interfering with these existing utilities.

.6.2 Do not interrupt utility services unless permitted in writing by the accountable University representative. Outages to existing utility systems must be planned and scheduled at least two weeks in advance.

.7 DELIVERY, STORAGE, AND HANDLING

.7.1 Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, and clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

.7.2 Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

.7.3 Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

.1 PIPE MATERIALS AND FITTINGS

.1.1 Systems Designs:

.1.1.1 Pumped Condensate: Maximum operating conditions are 200 PSIG at 388°F. Design conditions for the system shall be 200 PSIG at 388°F.

.1.2 Service Pipe: Condensate piping shall be Type TP316L, schedule 40, seamless stainless steel conforming to ASTM A312. All joints shall be butt-welded for sizes 2-1/2 inches or greater. Where possible, straight sections shall be supplied in 40-foot random lengths with 6 inches of piping exposed at each end for field joint fabrication.

.1.3 Fittings: Fittings 2-1/2 inches and larger shall be steel butt-welding type in accordance with ANSI B 16.9 and with the same wall thickness as the attached pipe. Material shall conform to ASTM A403, Grade WP 316L.

.1.4 Sub-Assemblies: Gland seals, end seals, and direct buried anchors shall be designed, and factory prefabricated to prevent the ingress of moisture into the system. All sub-assemblies shall be designed to allow for complete draining and drying of the conduit system.

.1.5 Insulation: Insulation shall be cellular glass for the service pipe and polyurethane for the outer conduit. Insulation of the service pipe at each field welded joint shall be held in place by stainless steel bands with the minimum

of two bands and the maximum spacing of 12 inches. The insulation shall have passed the most recent boiling test and other requirements specified in the Federal Agency Guidelines. All condensate piping shall have a minimum insulation thickness of 3 inches.

.1.6 Outer Conduit: The steel conduit casing shall be airtight, pressure testable, smooth wall welded steel conduit.

.1.7 Outer Conduit Insulation and Jacket: Conduit insulation shall be 1 inch thick factory applied foam, meeting ASTM C591. The outer jacket shall be either:

.1.7.1 Fiberglass (FRP), which filament wound directly onto the urethane foam insulation, with minimum wall thickness of 0.125 inches. Fiberglass field enclosures matching the thickness of the outer jacket shall be used to complete the installation closures. No shrink wrap type will be allowed for closure joints.

.1.7.2 High Density Polyethylene (HDPE) jacket with minimum wall thickness of 0.125 inches. A pressure testable electric-fusion process or heat shrinkable process (recommended by the manufacturer) HDPE field joint closures equal to or greater than in thickness to the outer jacket shall be used to complete the installation closure. No shrink wrap type will be allowed for closure joints.

.1.8 Pipe Supports: All pipes within the inner casing shall be supported continuously around service pipe at not more than 10-foot intervals. These supports shall be designed to allow for continuous airflow and drainage of the conduit in place. The straight supports shall be designed to occupy not more than 10% of the annular air space. Supports shall be of the type where insulation thermally isolates the carrier pipe from the outer conduit. Supports which directly contact both the carrier pipe and the outer casing shall not be allowed. The surface of the insulation shall be protected at the support by a sleeve not less than 12 inches long, fitted with traverse and where required, rotational arresters.

.1.9 Anchors: Prefabricated steel plate anchors shall be factory furnished and installed where shown on plans. A concrete block shall be cast over the plate and conduit and shall be large enough for firm anchorage into undisturbed trench sidewalls and/or bottom. The concrete block is to be at least 30 inches in length and extend a minimum of 9 inches beyond the top and bottom of anchor plate.

.1.10 Expansion Loops, Ells, and Tees: Expansion utilizing prefabricated ELLS without loops is only allowed as defined on the drawings. Expansion loops shall be of proper design in accordance with stress limits indicated by the code for pressure piping ASME B31.1. Loop piping shall be installed in conduit suitable sized to handle indicted pipe movement.

.1.11 Backfill: A 6-inch layer of sand or pea gravel shall be placed and tamped in the trench to provide uniform bedding for the conduit. The entire trench shall be evenly backfilled with a similar material as the bedding in 6-inch compacted layers to a minimum height of 6 inches above the top of the insulated piping system. Bedding and backfill materials shall be as recommended by the manufacturer.

.1.12 Manufacturers: Insul-Tek "Dual-Con", Thermacor Process Inc. “Duo-Therm 505”, Perma-Pipe “Multi-Therm 500”, or approved equal.

.2 SOIL MATERIALS

.2.1 Refer to Section 31 00 00 – EARTHWORK.

.3 BURIED UTILITY WARNING AND IDENTIFICATION TAPE:

.3.1 Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 6 inches minimum width, color; yellow, with warning and identification imprinted in big black letters continuously and repeatedly over entire tape length. Warning and identification shall read “CAUTION BURIED STEAM SYSTEM DISTRIBUTION PIPING BELOW” or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

PART 3 - EXECUTION

.1 EXCAVATION FOR UTILITY TRENCHES

.1.1 Excavate trenches to indicated slopes, lines, depths, and invert elevations.

.1.2 Excavate trenches to uniform widths to provide a working clearance on each side of pipelines. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

.1.3 Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading.

.1.4 Where encountering rock or another unyielding bearing surface, carry trench excavation 6 inches below invert elevation to receive sub-base course material.

.2 INSTALLATION

.2.1 The installing contractor shall handle the system in accordance with the directions furnished by the manufacturer and as approved by the engineer.

.3 OUTER CONDUIT JACKET AIR TEST

.3.1 In cases that a HDPE outer jacket is used, the Contractor shall furnish all necessary equipment and labor to perform the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc. and complete the test to the satisfaction of the engineer. The field closure joint HDPE outer jacket shall be air tested at 8 PSIG. Testing shall occur in the field after fabrication is complete or as specified in the contract documents. The test pressure shall be held for not less than one hour. The test results shall be provided to the University.

.4 OUTER CONDUIT AIR TEST

.4.1 The Contractor shall furnish all necessary equipment and labor to perform the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc. and complete the test to the satisfaction of the engineer. The casing shall be air tested at 8 PSIG. Testing shall occur in the field after fabrication is complete or as specified in the contract documents. The test pressure shall be held for not less than one hour.

.5 SERVICE PIPE FIELD WELD INSPECTION

.5.1 Ultrasonically test one hundred percent (100%) of the full penetration field welds in the steam systems. Testing shall be performed by a qualified independent testing contractor. All fillet and socket welds shall be visual and

dye penetrant examined on the completed weld by an individual qualified to perform the examinations.

.5.2 Provide documentation of each inspection of accepted or rejected welds. Provide report results within three working days for satisfactory results and one working day for unsatisfactory tests.

.5.3 Remove weld defects by grinding or chipping and repair or replace weld joints in accordance with approved procedures. Retest all repaired joints.

.5.4 The Supplier's representative and the University's representative or Engineer shall be present during testing.

.6 FIELD QUALITY CONTROL

.6.1 Piping Tests: Fill pipeline 24 hours prior to testing and apply test pressure to stabilize system. Use only potable water.

.6.2 Do not proceed until test results on subgrade, fill and backfill layers for previously completed work verify compliance with requirements. Coordinate with the Independent Soil Testing Agency (hired by contractor but approved by the University) to perform all tests.

.6.2.1 The Independent Soil Testing Agency will perform field in-place density tests in accordance to ASTM D1556 (sand cone method), ASTM D2167 (rubber balloon method), or ASTM D2937 (drive cylinder method), as applicable.

.6.2.1.1 In-place density field tests may also be performed by the nuclear method according to ASTM D2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D1556. With each density calibration check, check the calibration curves furnished with the moisture gauges according to ASTM D3017.

.6.2.1.2 When in-place density field tests are performed using nuclear methods, make calibration checks of both density and moisture gauges at beginning of work, on each different type of material encountered, and at intervals as directed by the University.

.6.2.2 Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 150 feet or less of trench, but no fewer than two tests per layer.

.6.3 When subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, re-compact and retest until required density is obtained. Contractor shall pay for all retesting by the Independent Soil Testing Agency and corrective actions.

.7 VERIFICATION OF FINAL ELEVATIONS

.7.1 Prior to covering the top of the casing with backfill material, but after all temporary supports have been removed and initial backfilling of the conduit systems have been accomplished, the contractor shall measure and record the elevation of the top of the casings in the trench. This measurement shall be checked against the contract drawings. These measurements shall confirm that the conduit system have been installed to the elevations shown on the contract drawings. These measurements shall be certified correct by the Contractor and provided to the University for review prior to covering the casing with backfill material. The preapproved conduit system shall be installed, inspected, and tested in accordance with the contract drawings and specifications, the system supplier's Approved Brochure and any directions given by the system supplier's representative. All work pertaining to the preapproved system shall be performed in the presence of the system supplier's representative.

.8 UTILITY TRENCH BACKFILL

.8.1 Place and compact base course material on rock and other unyielding bearing surfaces and to fill unauthorized excavations.

.8.2 Concrete backfill trenches that extend below or pass under footings and that are excavated within 18 inches of footings. Place concrete to elevation of bottom of footings.

.8.3 Place and compact initial backfill of satisfactory soil material or sub-base material, free of particles larger than 1 inch, to a height of 6 inches over the utility pipe or conduit.

.8.3.1 Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

.8.3.2 Place backfill and fill materials in layers not more than 6" in loose depth for material compacted by heavy power-operated compaction equipment, and not more than 4" in loose depth for material compacted by hand-operated tampers.

.8.3.3 Compact soil to 95% of its maximum dry density in accordance with ASTM D698.

.8.4 Coordinate backfilling with utilities testing.

.8.5 Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.

.8.6 Use one bag mix to completely backfill all voids of less than one (1) foot between new and existing utilities.

.8.7 Place and compact final backfill of satisfactory soil material to final subgrade.

.8.8 Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

33 63 15 STEAM BLOWING

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.2 DESCRIPTION OF WORK

.2.1 This Section specifies the requirements for the steam blowing of steam piping.

.3 SUBMITTALS

.3.1 Shop Drawings and Product Data: In accordance with Section 01 33 00 – SUBMITTAL PROCEDURES, submit the following:

.3.1.1 Detailed written description of the steam blow procedures. Include the following:

.3.1.1.1 An estimation of how much piping is going to be temporarily installed and what size

.3.1.1.2 Estimated time for each steam blow and how many total blows estimated to be required

.3.1.1.3 Step by step steam blow procedure; Indicate all safety measures and communication and coordination required with the Owner.

.3.1.1.4 Pressure, flow, and velocity calculations; Indicate inlet pressure from the system, reduced pressure from pressure drop device, and pressures through the system including outlet pressure of system. For all these points, indicate corresponding velocity and Cleaning Force Ratio. Include diagram of the flow pattern to reference calculation points.

.3.1.1.5 Acceptance criteria for each type of blow.

.3.2 Drawings of the following:

.3.2.1 Process flow diagrams depicting the steam blow traveling through piping to be blown and through the temporary piping.

.3.2.2 Isometric drawings depicting the piping to be steam blown. Include the temporary piping leading to the outside exhaust noise reduction system for the steam blows.

.3.3 Maximum noise levels that will be emitted by the steam blow process.

.3.4 Steam blow service company's qualifications as described in Paragraph Quality Assurance below.

.4 QUALITY ASSURANCE

.4.1 A steam target blow shall be considered for all new steam piping, 4 inches NPS and above, to remove general construction debris, organic materials, weld slag, rust and mill scale.

.4.2 The risk of equipment damage downstream from newly installed steam pipe shall be assessed to determine if a steam blow is required or other steps shall be specified to protect equipment.

.4.3 Qualifications for Steam Blow Service Company

.4.3.1 Only firms experienced in performing steam blows in noise sensitive areas for projects similar to the requirements specified for this Project shall be considered.

.4.3.2 The proposed service company that will perform the steam blows shall submit a list of projects where they have performed steam blows in noise-sensitive areas for projects of similar size to this project. The list shall include a brief description of the scope of work for each project, including the size of equipment blown, the facility name and location, and a contact name and telephone number for each facility. The name of a Contractor will not be acceptable. For each project, provide a brief description of the noise sensitive issues, what was done to satisfy the requirements, and the general results of the noise sensitive issues. Failure to provide qualifications in this format will result in a total rejection of the proposed service company.

.4.3.3 The qualifications of the proposed steam blow service will be reviewed by the Engineer.

.4.4 Regulatory Requirements: All temporary piping systems and design shall be in accordance with ASME B31.1 Power Piping Code.

PART 2 - PRODUCTS

.1 GENERAL

.1.1 Products provided under this Section are temporary. The Contractor and the service company shall ensure that all products are safe to use for the service and that no harm will be done to equipment which exists or will remain.

.1.2 Temporary products used under this Section can be re-used in this Contract provided items remain properly identified at all times.

PART 3 - EXECUTION

.1 SCOPE OF SERVICE FOR STEAM BLOWS

.1.1 General:

.1.1.1 The Contractor shall obtain and pay for the service of a company to perform the steam blow services.

.1.1.2 All steam blows shall occur before each line is placed in service for the first time.

.1.2 Steam Blow Service Company Responsibilities:

.1.2.1 The steam blow service company shall design a system to perform steam blowing that satisfies the requirements listed, erect and provide temporary piping and mufflers, and oversee the steam blow procedure.

.1.2.2 The steam blow service company shall provide all required temperature and pressure gauges, hoses and valves. They shall also provide any device used to reduce the pressure (if necessary) to obtain a CFR as specified.

.1.2.3 Fully coordinating with University requirements for phasing.

.1.2.4 Clear communication with operating personnel for the operation of the University personnel.

.1.2.5 Submitting a written plan and procedure for performing steam blow operations.

.1.2.6 Conducting steam blow operations in a safe manner.

.1.2.7 Performing and submitting an ASME B31.1 thermal stress analysis of the vent piping system from the last permanent anchor to the vent silencer which shall be anchored.

.1.3 Contractor Responsibilities: The Contractor shall be fully responsible for all other associated support to the steam blow service company including providing manpower and covering the costs of the following:

.1.3.1 Provide temporary services required for steam blowing including service water piping, drain piping, and any other piping or components.

.1.3.2 Craft labor and supervision for system preparation, unloading steam blow service company equipment, installing vent piping and equipment, operating valves, support during steam blow service, and disassembly and reloading of piping and equipment

.1.3.3 Any connections required for vent or drain piping.

.1.3.4 Modifications and repairs to permanent fixtures such as handrails or openings in wall for vent piping if required

.1.3.5 Posting of safety warnings and barriers

.1.3.6 Temporary insulation of vent piping to protect personnel from hot vent piping

.1.3.7 Radio communication with control room operators

.1.3.8 Reviewing all of the steam blow service company's procedures to ensure that the conditions of this specification are satisfied

.1.3.9 Field verification of temporary equipment/piping layout drawings

.1.3.10 Temporary pipe supports of all associated piping systems

.1.3.11 All other support and materials required to perform steam blowing

.1.3.12 Submitting a written plan and procedure for performing steam blow operations

.1.3.13 Ensuring steam blow operations are conducted in a safe manner

.1.3.14 Opening all steam trap drip leg vents prior to steam blow and closing them after steam blow is closed

.2 STEAM TARGET BLOW

.2.1 Perform steam target blow for all new steam piping, 4 inches NPS and above, to remove general construction debris, gross debris, organic materials, weld slag, rust, and mill scale. Scope shall cover all piping in Bid Package 1, Bid Package 2, and Bid Package 3, from McCracken Power Plant to the South Campus Central Chiller Plant.

.2.2 Procedure and Acceptance Criteria:

.2.2.1 Steam blowing may be performed after hydrostatic testing is performed.

.2.2.2 Remove all meters and instrumentation taps into lines prior to steam blowing. If required by the steam blow process, provide other temporary means to measure steam flow during the steam blow.

.2.2.3 The University will only allow the usage of up to 45,000 PPH of steam (approximately 180 PSIG at 580°F with maximum conditions being 200 PSIG at 600°F). Provide an orifice plate or similar flow-restricting device such as a globe valve upstream of the pipe segment to be blown to limit flow as described below. Submit calculations to support this requirement.

.2.2.4 Blow each pipe segment a minimum of three separate times with cool down periods between to allow the inside temperature of the pipe to drop by 150°F (may be as much as 4 hours) to cause thermal cycling of piping. This is to facilitate the release of weld slag and other bonded debris. Thermal cycling may be performed prior to the commencement of steam blowing.

.2.2.5 The mass velocity head developed during these blows must meet a Cleaning Force Ratio (CFR) of 1.0 or greater where CFR = $(Qsb^2 \times Vsb) / (Qco^2 \times Vco)$ where Qsb = steam flow during steam blow (lb/hr), Vsb = specific volume during steam blow (ft^3/lb), Qco = steam flow during maximum continuous operation (lb/hr), and Vco = specific volume during maximum continuous operation. For these calculations, Vco = 3.08 ft^3/lb. For 16" NPS pipe, Qco = 300,000 lb/hr, for 14" NPS pipe, Qco = 225,000 lb/hr, and for 12" NPS pipe, Qco = 185,000 lb/hr. Operating at reduced pressure will use less steam and therefore waste less make-up water so this is preferred. The CFR shall be greater than 1.0 for the beginning of the pipe to the end. Try to limit velocities through the permanent piping at the end of the segments to no more than 1,000 ft/sec.

.2.2.6 The first two blows shall last for 15 minutes after the CFR has achieved 1.0 or greater. During the third blow, insert a polished brass target in the vent steam path, and blow at CFR 1.0 or greater for a minimum of 15 minutes. The cleanliness level is passed and the blow can end when there are no impacts larger than 0.8 mm diameter and fewer than 10 impacts with a diameter of 0.3 mm to 0.8 mm. Turn over brass targets to Owner.

.2.2.7 No permanent valves shall be used to throttle the flow upstream or downstream of the pipe segment being blown.

.2.3 Other:

.2.3.1 The steam blows shall be witnessed by the University and A/E.

.2.3.2 The steam blows shall not be conducted when the ambient air temperature is less than 50°F because of the campus demand for steam. All line steam blow activities shall be scheduled with University personnel. The scheduling of live steam blow activities is dependent on campus steam demand and steam availability.

.2.3.3 The exhaust end of the line(s) being blow shall be muffled and quenched. Providing the piping is the responsibility of the Contractor.

.2.3.4 Steam discharge shall not produce shock waves or air borne particulate which could settle on parked cars, people, buildings, etc. This includes very small particulate which may soil clothing, buildings, cars, etc.

.2.3.5 The arrangement of the temporary piping shall be designed in accordance with ASME B31.1. The piping arrangement and steam blow shall not cause the stress levels in any permanent or temporary piping component to exceed the allowable levels per ASME B31.1.

.2.3.6 Any low points created as a result of the temporary piping arrangement shall have manual drains installed for proper drainage during the blow. If the drains are installed in permanent piping they shall be installed in accordance with the permanent piping standards and shall remain. If they are temporary, to be removed after the steam blow, they may be of suitable temporary construction, such as threaded brass or bronze valves.

.2.3.7 Modifications to any permanent fixtures or systems to accommodate the steam blow shall be repaired and/or replaced at the completion of the event to the satisfaction of the University and Engineer.

.2.3.8 The Contractor shall provide barricades, warning tapes, and signage as necessary to secure the immediate area during the steam blows.

.2.3.9 The Contractor and his cleaning sub-contractor shall provide all necessary temporary piping, valves, mufflers, etc. needed to accomplish the steam blows safely and within the guidelines of this specification.

.3 NOISE ISSUES

.3.1 General: The steam distribution system is located in a noise sensitive campus community. Noise generated from all steam blow procedures shall be in accordance with the criteria listed herein.

.3.2 Noise Criteria: Noise levels due to the steam blow shall not exceed 95 dB at a distance of 50 feet from the steam vent point. Provide a silencer at the end of the steam blow vent. Ensure that it is anchored and will be secure during the steam blows. City water is available for quenching the exhaust flow to minimize noise and reduce the velocity of the flow into the silencer, however, the Contractor has to provide a temporary water meter and backflow preventer and has to provide the hoses needed to get the water where it needs to go. In addition, the Contractor has to coordinate with the University for the availability of water during the steam blow activities to not draw down campus pressure.

.3.3 Hours of Steam Blow: The hours of steam blowing shall be restricted to times approved by the University. No steam blowing shall occur on holidays. Further restrictions may be applied by the University. Coordinate timing of testing with University.

.3.4 The Contractor shall request permission in writing to the University to perform steam blow operations a minimum of 7 days prior to the proposed start of steam blow operations. The request shall include a description of the operations and activities, services and pipe sections affected and the proposed date, time and duration of operations. Steam blow operations shall commence only after the approval of the University.

33 63 20 METERS AND GAUGES

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.1.2 Requirements of the following Specification Sections apply to this Section:

.1.2.1 Section 33 63 10 - COMMON WORK RESULTS FOR PIPING

.1.2.2 Section 33 63 35 – VALVES

.2 DESCRIPTION OF WORK

.2.1 This Section provides the specification for pressure gauges.

.2.2 All devices supplied, whether free-standing or provided as part of a packaged equipment unit, shall satisfy the requirements of this Section.

.3 SUBMITTALS

.3.1 Shop Drawings and Product Data: All submittals of this Section shall also be incorporated into the operations and Maintenance Manual, including ISA forms. In accordance with Section 01 33 00 – SUBMITTAL PROCEDURES, submit the following:

.3.1.1 Pressure Gauges: Provide manufacturer's catalog cut sheets for each type of pressure gauge with range, accuracy, materials, and accessories marked clearly.

.3.2 Operation and Maintenance Manuals: In accordance with Section 01 78 00 – CLOSEOUT SUBMITTALS, submit the following:

.3.2.1 General maintenance data for all devices including calibration and troubleshooting

.4 DELIVERY, STORAGE, AND HANDLING

.4.1 Store thermometers and pressure gauges in a dry location, away from the weather, dust, and debris.

.4.2 Retain shipping flange protective covers and protective coatings during storage.

.4.3 Inspect items immediately upon arrival and report any irregularities or damage immediately to the manufacturer/supplier and A/E.

.5 QUALITY ASSURANCE

.5.1 Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of gauges and meters.

.5.2 Conform to ASME B31.1 for all installations.

.5.3 Certification: Provide gauges whose accuracies are certified by the manufacturer for the specified operating conditions.

.5.4 Single-source Responsibility: Obtain each category of pressure gauges from one source and by a single manufacturer.

PART 2 - PRODUCTS

.1 PRESSURE GAUGES

.1.1 Type: ASME B40.1, Grade A, Type 316 stainless steel, phosphor bronze bourdon-tube pressure gauge, with bottom stem mounted connection.

.1.2 Case: Phenol with glass lens. Diameter shall be 3-1/2".

.1.2.1 Connector: Steel with 1/2-inch male NPT.

.1.3 Scale: White coated aluminum background with permanently marked black etchings.

.1.4 Range: Units shall appear in PSIG units. For HPS service, range shall be 0 to 300 PSIG. For PC service, range shall be 0 to 150 PSIG.

.1.5 Accuracy: Per ASME B40.1, accuracy Grade A.

.2 PRESSURE GAUGE ACCESSORIES

.2.1 Isolation Valves: For all pressure gauges in the HPS system, provide 1/2-inch NPS shutoff valve, Class 800 valves suitable for 200 PSIG, 600°F operating steam conditions. Valves shall have a socket welded connection on one end and a threated connection on the other. Valves shall be located minimum 2 inches outside of insulation. Basis of Design: Velan C032064C-13TY

.2.2 Syphon: On water systems operating above 120° Fahrenheit and for all steam systems, provide fabricated coil syphon or "pig tail" constructed as specified for the specific piping system in Section 33 63 10 – COMMON WORK RESULTS FOR PIPING.

.2.3 Snubbers: Do not provide for this project.

PART 3 - EXECUTION

.1 GENERAL

.1.1 Location and orientation of all temperature and pressure gauges shall be coordinated with the A/E prior to installation.

.2 PRESSURE GAUGE INSTALLATION

.2.1 Install pressure gauges in pipe coupling or tee as required. Provide shutoff valve, snubber, and/or syphon as specified. Locate pressure gauge in most readable position.

.2.2 Install where indicated in the Contract Documents.

.2.3 Isolation valve shall be installed with the threaded end towards the pressure gauge.

.3 ADJUSTING AND CLEANING

.3.1 Calibrate gauge according to manufacturer's written instructions, after installation.

.3.2 Adjusting: Adjust faces of gauges to proper angle for best visibility.

.3.3 Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

.4 PROCESS CONNECTIONS

.4.1 Contractor shall provide all process connections in piping systems to accommodate gauge installation. Process connection type shall be selected by the Contractor to match the actual gauge provided.

33 63 25 PIPING SPECIALTIES

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.1.2 Requirements of the following Specification Sections apply to this Section:

.1.2.1 Section 33 63 05 - GENERAL PIPING PROVISIONS

.1.2.2 Section 33 63 10 - COMMON WORK RESULTS FOR PIPING

.1.2.3 Section 33 63 20 - METERS AND GAUGES

.1.2.4 Section 33 63 35 - VALVES

.1.2.5 Section 33 63 40 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

.1.2.6 Section 33 63 45 - GASKETS

.1.2.7 Section 33 63 50 – IDENTIFICATION FOR PIPING AND EQUIPMENT

.1.2.8 Section 33 63 55 - PIPING INSULATION

.2 DESCRIPTION OF WORK

.2.1 This Section provides the specification for pipe specialties. Specialties include steam traps, dirt pockets/drip legs, strainers, automatic air vents, pipe sleeves, and pipe sleeve seals.

.2.2 Provide pipe sleeves where piping passes through manhole walls (where detailed), vault walls/roofs, tunnel walls/roofs, metal gratings, trench covers, roofs, and concrete floor.

.2.3 Provide steam traps at all low points in the steam piping system where condensate can collect, as designated on the Contract Drawings. The Contractor shall notify the A/E of low points that are created in the piping system so that a steam trap station can be added. The Contractor shall avoid such low points as physical space limits.

.3 SUBMITTALS

.3.1 Shop Drawings and Product Data: In accordance with Section 01 33 00 – SUBMITTAL PROCEDURES, submit the following:

.3.1.1 Steam Traps: Manufacturer's product data including:

.3.1.1.1 Type

.3.1.1.2 Materials of construction with drawing and design rating

.3.1.1.3 Performance based on specified differential pressure and size

.3.1.2 Steam Trap Valve Station: Manufacturer's product data including:

.3.1.2.1 Type

.3.1.2.2 Materials of construction with drawing and design rating

.3.1.3 Strainers: Manufacturer's product data including:

.3.1.3.1 Drawing showing type and dimensions of strainer

.3.1.3.2 Materials of construction for body and mesh

.3.1.3.3 Design rating

.3.1.3.4 Mesh size and pressure drop versus flow curve

.3.1.4 Pipe sleeve schedule indicating system location and size of pipe sleeve.

.3.1.5 Manufacturer's product data for all materials to be used.

.3.2 Operation and Maintenance Manuals: In accordance with Section 01 78 00 – CLOSEOUT SUBMITTALS, submit the following:

.3.2.1 Maintenance data and spare parts list for:

.3.2.1.1 Steam traps

.3.2.1.2 Steam trap valve stations

.3.2.1.3 Strainers

.4 QUALITY ASSURANCE

.4.1 Comply with the following for steam piping and accessories:

.4.1.1 ANSI/ASME B31.1: Power Piping

.4.1.2 ANSI/ASME Boiler and Pressure Vessel Code: Section VIII, Division 1 - Unfired Pressure Vessels

.4.1.3 MSS - Manufacturers Standardization Society

.4.1.4 UL Listed: Provide UL listed fire separation assemblies

.4.1.5 NFPA: National Fire Protection Association Codes and Standards

PART 2 - PRODUCTS

.1 STEAM TRAPS

.1.1 General

.1.1.1 Refer to the Contract Drawings for details of the steam trap stations which include the drip leg, drip leg valve, steam trap, and all steam trap related items.

.1.1.2 Provide steam condensate traps at locations indicated on the Contract Drawings and of type as indicated in the "Steam Trap Schedule" listed in the Contract Drawings. The capacity of the steam trap provided shall satisfy the design flow listed on the "Steam Trap Schedule" for both the operating and maximum conditions of pressure, differential pressure, and steam temperature. Connection sizes of traps are provided as a basis of design; however, actual sizes are dependent upon the actual selection of the steam trap.

.1.1.3 Steam trap sizing selection and location is based on the piping layout as presented in the Contract Drawings. The Contractor is responsible for informing the A/E of any piping layout changes which could affect the sizing, selection, and location of the steam traps.

.1.1.4 Steam traps shall be provided at all low points in the steam piping system where condensate can collect, upstream of isolation valves and a maximum spacing of one per every 500 lineal feet of steam pipe.

.1.2 Steam Main Distribution – HPS

.1.2.1 Service: For HPS steam mains. The normal operating conditions are 185 PSIG at 585°F. The maximum operating conditions are 200 PSIG at 600°F. Traps shall be designed for service where the discharge of the trap is sub-cooled condensate water between 140 to 210°F.

.1.2.2 Performance: Refer to "Steam Trap Schedule" listed in Contract Drawings. The trap shall be rated for maximum back pressure of 99 percent of inlet pressure.

.1.2.3 Construction:

.1.2.3.1 General: Traps shall be thermodynamic style. All components shall be designed for maximum allowable steam pressure of 300 psig, 625°F, with maximum operating pressure of 300 psig.

.1.2.3.2 Body and Cover: Stainless steel

.1.2.3.3 Disc: Stainless steel

.1.2.3.4 Cap: Stainless steel

.1.2.4 Connections: Size of connection shall depend on the flow requirements. Type of connection shall be universal connector.

.1.2.5 Acceptable Manufacturers: Spirax Sarco or Armstrong. The strainer specified below shall be provided by the steam trap manufacturer and must satisfy the specification below.

.1.2.6 Basis of Design: Armstrong CD-3300.

.2 STEAM TRAP VALVE STATIONS

.2.1 Service: For HPS steam mains. The normal operating conditions are 185 PSIG at 585°F. The maximum operating conditions are 200 PSIG at 600°F.

.2.2 Description: Refer to Steam Trap Station with two isolation valves, integral strainer with blowdown valve, test valve, and steam trap connection.

.2.3 Construction:

.2.3.1 General: All components shall be designed for maximum allowable steam pressure of 300 psig, 625°F.

.2.3.2 For valve selection see BDS 33 63 35.3, Valve Group 3

.2.3.3 Strainer Screen: Stainless steel

.2.4 Connections: 3/4-inch socket welded connections for pipe; Universal trap connection for steam trap.

.2.5 Acceptable Manufacturers: Shall be provided by the steam trap manufacturer.

.2.6 Basis of Design: Armstrong TVS Connector.

.3 STRAINERS - STEAM TRAP SERVICE

.3.1 Strainers for steam service shall be "Y" type, unless otherwise indicated on Contract Drawings. Strainers for steam traps stations shall be in accordance with this specification.

.3.2 Provide a screen blowdown valve for each strainer. The valve shall be the full size of the blow-off tap. Provide shut-off valve in accordance with Section 33 63 35 - VALVES. Provide nipple with cap downstream of valve in accordance with the pipe system specification as specified in Section 33 63 10 - COMMON WORK RESULTS FOR PIPING. Select the length of the nipple connecting the blow-off valve to the strainer basket connection so that the blow-off valve is clear of the insulation.

.3.3 Provide strainer screen with a minimum net free area of 2-1/2 times the cross-sectional area of the entering pipe.

.3.4 All strainer screens shall be 1/8-inch-thick Type 304 or 316 stainless steel with 3/64-inch mesh perforations unless otherwise required by the valve or device which it protects.

.4 PIPE SLEEVES

.4.1 For concrete or masonry interior and exterior walls and floors, partitions, and fire-rated walls (Where Detailed)

.4.1.1 Fabricate sleeves or floor from Schedule 40 steel pipe in length to match finished wall or floor thickness. Provide a continuous 2-inch-wide x 1/4 inch thick steel anchor plate and water stop weld to sleeve.

.4.1.2 For pipes 8 inches NPS diameter and smaller, make sleeve inside diameter a minimum of 2 inches larger than the outside diameter of the pipe insulation. For pipes larger than 8-inch NPS, make sleeve inside diameter a minimum of 3 inches larger than the outside diameter of the pipe insulation. Coordinate with the calculations made by the requirements of Section 33 63 40 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT which shall calculate thermal movements of piping. Provide a greater clearance where dictated by these calculations.

.4.1.3 Sleeves shall be hot-dipped galvanized.

.4.1.4 Where the service pipe insulation is combustible the pipe shall be un-insulated where passing through fire-rated walls and partitions.

For service pipes with non-combustible insulation systems the insulation shall extend through the wall.

.4.2 For Metal Grating and Trench Covers Penetrations

.4.2.1 All grating penetrations shall be banded with 1-1/4-inch-wide by 1/4 inch thick steel bands welded to all of the cut grating bars or plate.

.4.2.2 Opening inside the band shall be the diameter of the pipe or the insulation plus a minimum of 2 inches. Coordinate with the calculations made by the requirements of section 33 63 40 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT which shall calculate the thermal movements of piping. Provide a greater clearance where dictated by these calculations.

.4.3 Mechanical Type (Synthetic Rubber) - Watertight Pipe Sleeves

.4.3.1 General: Provide for all piping penetrations through exterior walls to below ground areas.

.4.3.2 Description: The pipe to wall penetration closures shall be "Link-Seal" as manufactured by Thunderline Corporation - Belleville, Michigan or equal. Seals shall be high temperature rated for 400°F. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and wall opening. The seal shall be constructed so as to provide electrical insulation between the pipe and wall, thus reducing cathodic reaction between these two members. Material shall be silicone and shall be rated for sustained temperature of 325°F.

.4.4 Fire Rated Sleeve Seals

.4.4.1 Provide UL listed fire rated pipe sleeve seals and assemblies at fire rated partitions. Install fire rated sleeve seals in accordance with the manufacturer’s instructions and the listing requirements.

.4.4.2 Fire rating shall be as required for partition rating but not less than 1-1/2 Hours.

.4.5 Non-Rated and Non-Watertight Penetration Pipe Sleeves

.4.5.1 Openings and sleeve for piping shall be large enough to allow lateral thermal movement of the piping. The calculations made by the requirements of Section 33 63 40 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT shall indicate the minimum required clearance.

.4.5.2 If it is observed for any new piping system that the pipe insulation (or pipe wall, if there is no insulation) is touching the pipe sleeve when the pipe is heated, the Contractor shall provide a larger pipe sleeve at no additional cost to the University.

PART 3 - EXECUTION

.1 INSTALLATION - GENERAL

.1.1 Install steam specialties in accordance with manufacturer's instructions and as shown on the Contract Drawings.

.2 INSTALLATION - STEAM TRAPS

.2.1 Provide all steam trap accessories in accordance with the details on the Contract Drawings.

.2.2 Provide drip legs with sizes indicated on Contract Drawings.

.2.3 Install steam traps at an elevation with respect to the drip leg in accordance with the manufacturer's instructions to insure hydraulic head during start-up.

.2.4 Install steam traps at all low points in the steam piping system where condensate can collect, upstream of isolation valves and a maximum spacing of one (1) per every 500 lineal feet of steam pipe.

.3 INSTALLATION OF STRAINERS

.3.1 Install strainers where indicated and at places not indicated but where required by a manufacturer's instruction to protect his equipment.

.3.2 Install steam strainers horizontally on their side with screen chamber at the 3 or 9 o'clock position. Install all other strainers horizontally with the screen chamber at the 6 o'clock position. Provide blowdown drain with valve and cap. Install strainers vertically only when required and when the direction of flow is down.

.4 INSULATION, PAINTING AND, IDENTIFICATION OF STEAM SPECIALTIES

.4.1 Insulate all pipe specialties in accordance with Section 33 63 55 - PIPING INSULATION. Do not insulate moving parts unless insulation sleeves are provided. Do not insulate steam traps.

.4.2 Provide steam trap identification tags in accordance with Section 33 63 50 – IDENTIFICATION FOR PIPING AND EQUIPMENT.

.5 INSTALLATION OF PIPE SLEEVES

.5.1 Extend and partition sleeves through and cut flush with each surface, unless otherwise indicated or specified.

.5.2 Locate piping in sleeve to allow for movement. Do not allow steel sleeves to touch copper piping at any time.

.5.3 After piping has been installed (and insulated if required), fill the annular spaces between piping and sleeves with materials as specified in this Section.

.5.4 Sleeves shall be fabricated, and hot dipped galvanized, cold galvanizing coating shall be applied for any field touchup repairs.

.5.5 Fill all voids between the sleeve and the rough wall opening with non-shrinking non-metallic epoxy grout as specified in Section 03 30 00 - CAST-IN-PLACE CONCRETE.

.5.6 Terminate floor and trench cover sleeves at 1/2 inch above the finished floor or cover.

.6 INSTALLATION OF PIPE SLEEVE SEALS

.6.1 For Pipe Sleeves Receiving Non-Fire-Rated Seals (Watertight Pipe Sleeves)

.6.1.1 Provide and install mechanical type rubber link type as detailed and as manufactured by Thunderline Corporation or equivalent.

.6.1.2 Size the link seal as recommended by the manufacturer and as required for the intended service.

.6.1.3 The link seal shall be installed so that tightening bolts are accessible for maintenance.

.6.1.4 For insulated piping systems provide a 6-inch long removable portion in front of the tightening bolts for maintenance. Do not extend insulation through the sleeve.

.6.1.5 Pack the void between the pipe and the sleeve with oakum and caulk on the non-servicing side of the sleeve.

.6.2 Provide UL listed fire rated pipe sleeve seals and assemblies at fire rated partitions. Install fire rated sleeve seals in accordance with the manufacturer's instructions and the listing requirements.

33 63 30 PIPE EXPANSION JOINTS

PART 1 - GENERAL

.1 RELATED DOCUMENTS

.1.1 Contact Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specification Section, apply to this Section.

.1.2 Requirements of the following specification Sections apply to this Section.

.1.2.1 Section 33 63 05 - GENERAL PIPING PROVISIONS

.1.2.2 Section 33 63 10 - COMMON WORK RESULTS FOR PIPING

.1.2.3 Section 33 63 40 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

.1.2.4 Section 33 63 45 - GASKETS

.1.2.5 Section 33 63 50 – IDENTIFICATION FOR PIPING AND EQUIPMENT

.1.2.6 Section 33 63 55 – PIPING INSULATION

.1.2.7 Section 33 63 35 – VALVES

.2 DESCRIPTION OF WORK

.2.1 This Section includes pipe expansion joints and expansion joint insulation blankets for mechanical piping systems.

.3 SUBMITTALS

.3.1 Shop Drawings and Product Data: In accordance with Section 01 33 00 – SUBMITTAL PROCEDURES, submit the following:

.3.1.1 Product data for each type of pipe expansion joint specified. Provide design data and materials description.

.3.1.2 Pipe expansion joint schedule showing manufacturer's figure number, size, location, and features for each required expansion joint. Indicate country of fabrication and ISO 9001 registry, if applicable. Provide calculations of each joint per EJMA 9th edition standard including stresses, cycle life, joint spring rates, etc.

.3.1.3 Assembly - type shop drawings for each pipe expansion joint, indicating dimensions, weights, required clearances, pipe alignment tolerances and methods of component assembly.

.3.1.4 Assembly drawing of insulation blankets

.3.1.5 Individual expansion joint piping configuration diagrams indicating basic piping configuration between anchors, pipe anchor spacing requirements, guide spacing and guide pipe travel requirements.

.3.1.6 Maintenance data for each type pipe expansion joint specified to include in the "Operating and Maintenance Manuals" specified in Section 01 78 00 – CLOSEOUT SUBMITTALS.

.4 QUALITY ASSURANCE

.4.1 All materials provided shall be designed, fabricated, installed, and tested in accordance with ASME B31.1.

.4.2 All expansion joints shall be designed and installed in accordance with the 2008 9th edition of Expansion Joint Manufacturer's Association (EJMA) Standards.

.4.3 Expansion joint shall be fabricated and assembled in the United States or Canada, or the expansion joints must be manufactured by an ISO 9001 registered corporation. No expansion joints shall be provided where materials

are fabricated or assembled in China including Taiwan, regardless of ISO 9001 registry.

.5 DELIVERY, STORAGE, AND HANDLING

.5.1 Handle expansion joints with great care. Adhere to the requirements of the manufacturer.

.5.2 Do not break the shipping tabs off the expansion joint until it is installed and all piping to the adjacent anchors including the anchors are completed.

PART 2 - PRODUCTS

.1 EXTERNALLY PRESSURIZED EXPANSION JOINTS (METAL-BELLOWS, PACKLESS TYPE)

.1.1 Type: Provide packless bellows expansion joints of externally pressurized design where designated for thermal expansion.

.1.2 Steam Service:

.1.2.1 Design: Expansion joints shall be rated for 200 PSIG, 600°F steam service. Joints shall be designed for 1,000 full pressure/temperature cycles to the 200 psig, 600°F steam rating. Provide axial movement as indicated in the table on the drawings. Non-axial movement shall be minimal due to the internal/external guides of the joint itself and the guides of the piping system. Each joint must be hydrostatically tested by the manufacturer prior to shipping at 350 PSIG for a minimum of 10 minutes.

.1.2.2 Materials: Bellows shall be constructed of ASTM A240 Grade 321 stainless steel, of uniform curvilinear shape without circumferential welds, and with not more than one longitudinal weld for each 10 inches of pipe diameter. Bellows shall be multi-ply construction. Provide carbon steel internal and external guide rings per ASTM A36 to maintain alignment of the expanding pipe. Weld bellows to internal and external guide rings via stainless steel collars. Do not weld bellows to the guide rings at the root or crest radii. Provide external housing and internal liner of expansion joint rated for the design conditions and constructed of seamless ASTM A53 Grade B or ASTM A106 Grade B carbon steel to limit bellows movement and prevent flow induced vibration. Vent internal guide rings to reduce the effects of sudden pressure changes. Provide a base for all expansion joints that is designed to serve as an intermediate

anchor. Provide a 3000-LB, forged steel, ASTM A105, 2-inch socket welded half coupling with a forged steel pipe plug on the cover at the 6 o'clock position to serve as a steam trap/liquid drain. Provide a lifting lug.

.1.3 Pumped Condensate Service:

.1.3.1 Design: Expansion joints shall be rated for 200 PSIG, 388°F steam service and liquid service of 200 PSIG at 387°F. Joints shall be designed for 1,000 full pressure/temperature cycles to the 200 PSIG, 388°F steam rating. Provide axial movement as indicated in the table on the drawings. Non-axial movement shall be minimal due to the internal/external guides of the joint itself and the guides of the piping system. Each joint must be hydrostatically tested by the manufacturer prior to shipping at 350 PSIG for a minimum of 10 minutes.

.1.3.2 Materials: All wetted parts shall be stainless steel to resist corrosion. Bellows shall be constructed of ASTM A240 Grade 321 stainless steel, of uniform curvilinear shape without circumferential welds, and with not more than one longitudinal weld for each 10 inches of pipe diameter. Bellows shall be multi-ply construction. Provide stainless steel internal and external guide rings to maintain alignment of the expanding pipe. Weld bellows to internal and external guide rings via stainless steel collars. Do not weld bellows to the guide rings at the root or crest radii. Provide external housing and internal liner of expansion joint rated for the design conditions and constructed of Type TP316L seamless stainless steel conforming to ASTM A312 to limit bellows movement and prevent flow induced vibration. Vent internal guide rings to reduce the effects of sudden pressure changes. Provide a base for all expansion joints that is designed to serve as an intermediate anchor and vertical support. Provide a 3000-LB, forged steel, ASTM A105, 1/2-inch socket welded half-coupling with a forged steel pipe plug on the cover at the 6 o'clock position to serve as a liquid drain. Provide a lifting lug.

.1.4 Connections: Expansion joints shall have butt weld ends, regardless of size.

.1.5 Acceptable Manufacturers: Provide expansion joints from Hyspan, Microflex, Pathway Bellows, or Senior Flexonics.

.1.6 Blanket: Insulation/weather covers shall be provided for each expansion joint as specified in this Section.

.1.7 Warranty: Expansion Joints shall be provided with a five-year minimum warranty against leaks for material defects which shall cover the material replacement. Repair of joint is not acceptable.

.1.8 Nameplate: Provide a weatherproof, temperature proof, metal nameplate on the exterior of each expansion joint with all of the following information etched or depressed into the metal: manufacturer, model number, serial number, year fabricated, maximum pressure and temperature rating, design compression and extension of expansion joint, and maximum design full pressure/temperature cycles of the expansion joint.

.2 INSULATION BLANKETS

.2.1 General: Provide an insulation jacket for each expansion joint provided. The insulation jacket shall be removable and reusable and shall be designed to expand and contract as necessary with the expansion joint and connected pipe. The contractor shall verify clearance requirements for insulation jackets for expansion joints located in restricted locations including pipe trenches.

.2.2 Design

.2.2.1 Provide non-porous inner and outer jackets rated for flooding conditions, constructed of minimum 20 ounce per square yard PTFE Teflon film laminated/impregnated Nomex woven cloth. Blanket construction shall be a double woven stitch with a minimum of 7 stitches per inch. No raw cut jacket edges shall be exposed.

.2.2.2 Insulation shall be minimum 5-inch thick fiberglass needled mat with minimum 11 lbs/ft density. All materials shall be rated for service of 600°F. Outer jacket wall temperature shall be under 120°F. Submit proof of outer temperature assuming wet conditions.

.2.2.3 Type: Provide different blanket style to accommodate features of each joint:

.2.2.3.1 Externally Pressurized Bellows Style: Blanket design shall encase the unit to be insulated and provide a minimum 4 inch overlap extension over insulation of adjacent piping at cold conditions. Coordinate requirements for support base mounting conditions for floor mounted and steel rack mounted expansion joints.

.2.2.4 To accommodate leaks and detect their origins, blanket pieces shall have either a low point drain grommet or a mating seam at the low point which will allow water to seep through.

.2.2.5 Provide means of prevention of shifting of insulation filler.

.2.2.6 Provide lacing twists made of durable noncorrosive, non-rotting material for fastening blankets. Velcro is not acceptable. Assembly shall allow removal and installation with no tools required.

PART 3 - EXECUTION

.1 PIPE EXPANSION JOINT INSTALLATION

.1.1 Dimensions and End Connections: The Contractor is responsible for ensuring that the expansion joints provide conform to the dimensions required by the piping, anchor and pipe guide configuration. Expansion joint end connections shall be butt welded. Welding shall conform to ASME and AWS and examined in accordance with specifications section 33 63 10 – "Common Work Results for Piping"

.1.2 Install pipe expansion joints according to manufacturer's written instructions.

.1.3 Align expansion joints to avoid end-loading and torsional stress. Metal-bellows expansion joints cannot accept any torsional loading. All expansion joints shall be provided with a base that shall be utilized for vertical support and for installation assistance, leveling shims or leveling bolts with nuts on the underside of the base shall be utilized for leveling and aligning the unit during installation. After alignment, high density calcium silicate insulation shall be inserted between the base and mounting steel or grout between the base and the floor. If a pipe anchor is adjacent to the expansion joint in accordance with the manufacturer's requirements and unless indicated otherwise, the expansion joint support base shall not have tightened nuts or be otherwise permanently fixed or secured to the mounting steel, floor or other parts of the structure.

.1.4 Provide insulation/weather cover which protects joints from moisture. Clean inside of expansion joints thoroughly before putting joints into service.

.1.5 Do not break shipping band until expansion joint is installed and system is complete from anchor to anchor. If shipping band is broken prematurely, consult Architect/Engineer and manufacturer immediately.

.1.6 Stretching of expansion joints to correct for piping misalignment or to accommodate available end-to-end spacing is not allowed.

.1.7 Laser align piping during welding and when aligning all supports, guides, and anchors. Ensure straight alignment so expansion joint will not bind. Follow all directions by expansion joint manufacturer for guide locations, except if a manufacturer states that the first guide closest to the expansion joint (within 4 pipe diameters) is not required, provide anyway.

.2 EXPANSION JOINT TESTING

.2.1 Contractor shall hydrostatically test piping system with joints in place after the shipping bands are broken and the entire piping system is connected as one system.

.2.2 Under no instance shall new expansion joints be hydrostatically tested, steam blown or put in any kind of service without the entire piping system being connected as one system, including all anchors and guides installed and completed.

.2.3 Water utilized for hydrostatic test must be at room temperature when hydrostatic test is performed.

.3 PIPE ALIGNMENT GUIDE INSTALLATION

.3.1 Install pipe alignment guides on piping as indicated on contract drawings. Pipe alignment guides shall be provided as indicated on the drawings and in accordance with the Expansion Joint Manufacturer's requirements. If the Expansion Joint Manufacturer's required installation conditions do not exist, the Contractor shall alert the Architect/Engineer and the Expansion Joint Manufacturer. Any damage resulting from pipe alignment guides not being located in accordance with the Expansion Joint Manufacturer's requirements shall be the responsibility of the Contractor.

.3.2 Secure pipe alignment guides to tunnel structures as indicated on the contract drawings.

.4 PIPE ANCHOR INSTALLATION

.4.1 Install pipe anchors at locations indicated on the drawings and in accordance with pipe anchor details indicated on the drawings. Comply with the Expansion Joint Manufacturer's requirements and recommendations for pipe anchor locations and placement. Notify the Architect/Engineer of pipe anchor installation conditions that do not conform to the locations indicated on the

drawings and the Expansion Joint Manufacturer's requirements or recommendations.

.4.2 Fabricate and install anchors by welding steel shapes, plates, and bars to piping and securing to structure. Coordinate requirements for pipe anchor - concrete cast–in and embedded structural elements with the concrete work. Comply with ASME B31.1 and with AWS D1.1.

.4.3 Provide grout for pipe anchors in accordance with 33 63 05 – GENERAL PIPING PROVISIONS.

.4.4 For hot dipped galvanized pipe anchors provide cold galvanizing repair coating at field welds and for touch-up of damaged galvanized surfaces.

33 63 33 STEAM ENERGY DISTRIBUTION METERING

PART 1 GENERAL

.1 APPLICATIONS:

.1.1 The main objective of this design standard is to outline the requirements of a steam meter, to measure the consumption of steam supply in total pounds (lbs) and total British Thermal Units (BTU) in the buildings owned by The Ohio State University, and to communicate this consumption locally and to the campus-wide Energy Metering & Monitoring system (InStep eDNA server). The steam meter shall include the instantaneous mass flow rate in pounds per hour (lbs/hr) and totalized mass consumption in pounds (lbs), as well as instantaneous energy flow rate in British Thermal Units per hour (BTU/hr) and totalized energy delivered in British Thermal Units (BTU), with steam pressure and steam temperature compensation.

.1.2 The steam meter, elements and devices shall meet custody transfer measurement requirements as indicated in Part 2 – PRODUCTS AND Part 3 - EXECUTION of this Section. Custody transfer measurement furnishes quantity and quality information which can be used as the basis for a change in ownership and/or a change in responsibility for materials, e.g., billing for rate of energy demand plus totalized energy transfer.

.1.3 Products: Describes the general requirements for the totalizing steam meter, primary element, a flow computer, secondary element, and an RTD temperature sensor/transmitter.

.2 DEFINITIONS:

.2.1 High Pressure Steam: Steam pressures higher than 70 psig.

.2.2 Medium Pressure Steam: Steam Pressures between 15 psig and 70 psig.

.2.3 Low Pressure Steam: Steam pressures below 15 psig.

.3 DOCUMENTATION

.3.1 Data sheets, wiring diagrams, catalog literature, installation instructions, and Operations & Maintenance data must be sent to OSEP for prior review and approval, to include the primary element flow sensor, secondary element(s) (transmitters, multivariable transmitter, etc.), RTD temperature sensor/transmitter, and flow computer. Instrument sheets as requested in ISA S20 Standard must be submitted.

.3.2 Interconnections and drawings for installation of the primary, secondary, and tertiary elements of the corresponding devices shall be submitted for review and approval prior to installation. P&ID's shall be furnished in accordance to ISA S5.

.3.3 Provide flow computer program setup parameters as Windows-based electronic file.

.3.4 Certificates for the conformance of the steam meter according to engineering procedures and practices, and standards, shall be provided. Temperature and pressure compensation, coefficients, linear regressions, constants, equations, methodologies and basis of calculations to establish the steam flow rates shall also be provided for review.

.3.5 Certificates of calibration for the steam meter with air or any other gas available in the calibration facility, as well as a certificate of calibration conformance for the transmitters in accordance to NIST shall be provided.

PART 2 PRODUCTS

.1 GENERAL

.1.1 The selection of the steam meter shall be based on the following parameters and recommendations to guarantee that the accuracy of the steam meter station stays within the ±1% of the actual reading from 5% to 100% of the maximum rated flow, and the repeatability within ± 0.5%.

.1.2 The supply pressure could vary between 120 psig and 200 psig, whereas the temperature changes between 370°F and 600°F.

.1.3 The mass flow rate shall be computed in lbs/hour and the energy flow rate shall be computed in BTU/hr; both shall be temperature and pressure compensated. The steam meter shall register the mass flow rate with no less than 30 to 1 turn down based on actual flow conditions.

.1.4 Steam meters and associated piping shall be sized for steam velocities between 5 fps and 100 fps unless otherwise specified by the meter manufacturer.

.1.5 The pressure drop through the primary element, sensor, shall not be greater than 200 inches w.g.c. for the maximum mass flow rate.

.1.6 The flow computer shall provide loop powered 4-20 mA inputs for the temperature and pressure compensated mass flow rate in lbs/hour and energy flow rate in BTU/hr. The flow computer shall totalize the mass flow rate, the energy flow rate, and shall be equipped with a MODBUS TCP/IP RTU communications port. Prior to flow computer approval, the flow computer must be submitted by the Contractor for testing by OSEP to prove interoperability with the campus-wide Energy Metering & Monitoring system (InStep eDNA server). Cat-6 bonded and shielded Ethernet cable and conduit shall be installed between the flow computer or group of flow computers connected by twisted pair and the nearest building network switch.

.1.7 The flow computer shall be supplied with two isolated outputs that permit external system, e.g. Building Automation Systems, to monitor selected meter parameters.

.1.8 All primary and secondary electronic elements shall support an ambient temperature equal to or greater than 150°F.

.2 PRIMARY ELEMENT, FLOW SENSOR

.2.1 A Variable Area flow sensor either non-spring loaded, or spring loaded shall be used as the primary element of the steam meter. The material of the components of the flow sensor must be 316 stainless steel or material approved by OSEP. The nominal size of the sensor shall match the size of the pipe where the flow sensor will be installed. The primary element shall comply with standard codes, ISO, ASME.

.2.2 For those cases that apply, the flow sensor shall be installed in a wafer or lug type arrangement, constructed of 316 stainless steel, or approved material, rated for 200 psig and 660°F. If the primary flow element is longer than its flange-to-flange dimension, then a spool piece shall be included of sufficient length such as to permit the removal of the primary flow element with spool

piece and eliminate disassembly of any downstream or upstream piping when servicing the element.

.2.3 Calculations, equations and/or methodology used to determine the size of the flow sensor shall be supplied to OSEP for acceptance. Where applicable, Reynolds Number dependent equations shall be checked for maximum and minimum mass flow rates.

.3 SECONDARY ELEMENT, TRANSMITTER(S)

.3.1 The output shall be 4-20mA with digital signal preferable with HART protocol. The accuracy shall be at least ±0.1% of span, 4 to 20mA, and ±0.07% of span, digital. Drift less than ±0.1% of URL over at least 8,000 hours.

.3.2 Range limits for the differential pressure measurement shall be 0 to 200 inches of H_2O with a minimum transmitter pressure rating of 300 psi. Range limits for absolute pressure shall be 0 to 300 psia. The transmitter shall be energized with a 24-VDC source or a 120-VAC source for flow computers. The differential pressure transmitter shall be mounted below the flow element using 316 stainless steel tubing.

.3.3 Programming shall be accomplished via a Windows-based software package or from the keypad of the flow computer without the need to open the cover; thus maintaining the NEMA 4 integrity of the enclosure.

.3.4 Standard LCD indicator with backlight shall be included with the flow computer.

.3.5 The flow computer shall provide precise and reliable measurement of absolute/gauge and differential pressures, sensor and electronics temperatures, and process temperature from an external transmitter/RTD combination. It shall calculate densities and specific enthalpies according to the Steam Tables ASME 1997, and mass flow rates for the actual pressure and in line temperature. Parameters and measurements shall be stored in non-volatile memory to avoid data loss during power failure. Data shall be restored from internal memory upon restoration of power.

.3.6 A 316 stainless steel 3-valve manifold to mount the pressure differential transmitter shall be supplied. Drain/vent material and isolation valves shall be 316 stainless steel and furnished.

.4 PROCESS CONNECTIONS AND PIPING

.4.1 All steam service piping shall comply with the requirements of ASME 31.1 Power Piping Code.

.4.2 Sensor connections that are normally NPT 1/4-inch shall be adapted to 1/2-inch.

.4.3 Sensor connections shall be minimum 1/2-inch, 316 stainless steel, heavy duty, schedule 80 pipe or 1/2-inch diameter 316 stainless steel tubing with compression fittings,

.4.4 Pipe sealants for threaded connections shall be rated for a minimum of 600°F.

.4.5 Process shutoff valves shall be supplied for all sensor connections, minimum 1/2-inch, class 600, 316 stainless steel, and full port gate style with graphite packing, Velan or approved equal.

.4.6 All pressure-sensing devices shall have a condensate loop (i.e. pigtail).

.5 RTD TEMPERATURE SENSOR/TRANSMITTER

.5.1 Furnish a spring loaded Dual Element, spiral wound 100-ohm platinum RTD temperature sensor assembly. The accuracy shall be ±0.5% at 32°F utilizing a three-wire single element with aluminum waterproof head, 316 stainless steel nipple-union-nipple extension. The length shall be determined by the piping system where the meter will be installed.

.5.2 The temperature process input range shall be 20°F to 800°F.

.5.3 The thermo-well shall be 316 stainless steel, long enough for the size of the process pipe with a 4-inch lagging allowance and provided with a 3/4-inch NPT process connection.

.6 STEAM METER MANUFACTURERS AND MODELS

.6.1 Spirax/Sarco ILVA flow sensor with Steam Flow Computer, including pressure transmitter, temperature sensor and transmitter, differential pressure transmitter and accessories including but not limited to flow straighteners.

.6.2 VERIS Accelabar flow sensor with Steam Flow Computer, including pressure transmitter, temperature sensor and transmitter, differential pressure transmitter and accessories.

.6.3 McCrometer V-Cone flow sensor with flow computer, including pressure transmitter, temperature sensor and transmitter, differential pressure

transmitter and accessories. Acceptable in limited applications where the turndown of the steam flow is relatively low, 10 to 1.

.6.4 A Kessler-Ellis Products (KEP) ES-749 flow computer with Modbus TCP communication card shall be supplied.

.6.5 Other models and manufacturers require submittal by the A/E and approval by OSEP before including in the Design Development Documents.

.6.6 All meters will be considered for approval based on life cycle cost analysis by the A/E.

.7 DIFFERENTIAL PRESSURE AND PRESSURE TRANSMITTERS - MANUFACTURERS

.7.1 Rosemount

.7.2 Yokogawa

.7.3 Siemens

.7.4 TEKTROL (Tek-Bar 3110B and 3120B)

.8 MANUFACTURERS

.8.1. RTDs shall be specified as Burns Engineering Series 200

.8.2. Temperature Transmitters shall be specified as HART SensorTec model Q4, PR Electronics Model 5335A, or Rosemount model 248.

PART 3 EXECUTION

.1 CERTIFICATIONS – CALIBRATION AND CALCUALTIONS

.1.1 A third-party conformance certificate for the calibration of the steam meter shall be provided.

.1.2 A certified calculation, for the maximum and minimum mass flow rates at 185 psig and 540°F shall be supplied**.**

.1.3 Calibration of the transmitter(s) shall be accomplished following NIST standards. A certification of conformance shall be submitted.

.2 COMMUNICATION

.2.1 Meter data in the form of total consumption, mass flow rate, energy flow rate, and a meter diagnostic must be communicated over the university Ethernet network back to the InStep eDNA server. Consumption will be in billable units, klbs of steam and kBTUs of steam. Flow rate will be in klbs/hr of steam. Meter diagnostic will be in the form of Normal or Failure. MODBUS data registers shall be provided, at a minimum, for instantaneous mass flow rate, energy flow rate, totalized mass and energy values, temperature, pressure, and differential pressure.

Flow computers will utilize MODBUS over Ethernet.

.3 WARRANTY

.3.1 The supplier/manufacturer of the above specified equipment shall guarantee for twenty four (24) months from equipment startup or thirty (30) months from date of shipment, whichever occurs first, that the equipment shall be free from defects in design, workmanship or materials.

.3.2 In the event a component fails to perform as specified or is proven defective in service during the warranty period, the manufacturer shall promptly repair or replace the defective part at no cost.

.3.3 The manufacturer or contractor shall furnish OSU FOD and its Energy Services and Sustainability group with an installation, operation and maintenance manual for the steam meter and all its components, in electronic media including a program manual for the flow computer.

.4 INSTALLATION

.4.1 Follow manufacturer's guidelines and submit installation drawings to OSEP for review and approval prior to installation.

.4.2 Outages to existing steam systems for meter installation must be planned and scheduled at least two weeks in advance. See outage procedure:

https://ap.osu.edu/sites/default/files/utility_outage_procedures.docx

.4.3 The Contractor shall obtain assistance from OSEP in following the manufacturer's installation specifications such as but not limited to location of the meter components, Ethernet connection, electrical connections, local disconnect, enclosure type, and all other applicable issues. Power shall be

obtained from a dedicated 20 Amp circuit in the nearest local building electrical panel.

.4.4 The pipe diameter shall be known and shall never be reduced or increased to install the steam meter.

.4.5 Steam meters shall be installed with the manufacturer's recommended straight run of pipe upstream and downstream of the meter.

.4.6 Work performed without the assistance of the manufacturer's technical erection supervisor and/or OSEP shall adhere to dimensional requirements, assembly methods, and installation procedures specified herein and in the manufacturer's instruction manuals and drawings.

.4.7 The Contractor shall comply with all erection and installation methods, techniques, sequence, and procedures requested by the manufacturer's representative and/or OSEP.

.4.8 Where manufacturer's written instructions differ significantly from those proposed by the manufacturer's representative, OSEP shall determine the method used.

.4.9 The steam meter shall be aligned with the direction of the flow in a horizontal line.

.4.10 Gaskets shall be installed in proper alignment, free of tears and wrinkles. Bolted connections shall be tightened per gasket manufacturer's torque and sequence requirements to provide a uniform tight seal to insure uniform stress over the entire gasket area.

.4.11 All conduit and conduit connections shall be sealed connections and meet the design and installation standards applicable for the installation area.

.4.12 Installation services shall include all conduit and wiring to provide a fully functional meter and communication wiring to the building Ethernet switch. Termination of Ethernet communication cable at the building Ethernet switch shall be by OSU.

.4.13 Panel addressing shall be assigned by OSEP.

.4.14 All meters and ancillary equipment shall be installed in such a manner as to provide access for routine inspections, maintenance, and a means of removal.

.4.15 The flow computer readout/display shall be located between 5 feet and 6 feet above finished floor level.

.4.16 All meters shall be supported independent from the piping systems.

.4.17 Structural steel supports and miscellaneous steel required for supporting and/or anchoring meters and piping furnished under this standard shall be provided and installed in accordance with Division 5.

.4.18 All anchors and structural steel supports shall be built to template and reinforced as required for loads imposed on them.

.4.19 Equipment and pipe internals shall be cleaned and inspected prior to placing in service.

.5 TRAINING

.5.1 The supplier/manufacturer shall train OSEP (ENGIE SERVICES) personnel to program, calibrate, operate, troubleshoot and maintain the above-mentioned devices for at least 3 hours. Training shall be scheduled within two weeks of completion of the installation.

.6 INSPECTION AND COMMISSIONING

.6.1 A representative of OSEP (Engie Services) will inspect the installation and performance of the steam meter for acceptance and approval before commissioning. OSEP reserves the right to witness factory testing and calibration.

.6.2 Provide for review of required closeout documentation.

.6.3 Provide for review loop sheets with point to point wiring diagrams in AutoCAD .dwg format.

.6.4 Document and provide for review all electrical power sources with breaker and panel numbers.

.6.5 Provide for review all calibration data sheets.

.6.6 Factory trained representatives shall field calibrate all transmitters and configure the flow computer. Field calibrations will be accomplished using calibrators with NIST traceable calibration certificates less than 6 months old.

.6.7 The installing contractor shall fill impulse lines with distilled water, if applicable.

.6.8 The integrity and polarity of all terminations shall be checked and verified.

.6.9 All piping connections must pass a service test.

.6.10 Final system checks, and closeout shall be performed.

.6.11 Steam service will not be reinstated by OSEP until installation of the steam meter is inspected by OSEP and found to meet the requirements of the steam meter manufacturer and these design and installation standards.

33 63 35 STEAM VALVES

PART 1 - GENERAL

.1 RELATED DOCUMENTS

.1.1 Requirements of the following OSU Building Design Standards apply to this Section:

.1.1.1 Section 33 63 10 – COMMON WORK RESULTS FOR PIPING

.1.1.2 Section 33 63 25 – PIPING SPECIALTIES

.1.1.3 Section 33 63 40 – HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

.2 DESCRIPTION OF WORK

.2.1 The A/E shall specify that valves furnished as part of factory-fabricated equipment shall conform to the requirements of this Section unless otherwise stated.

.2.2 The A/E shall note that strainers and other special valves are specified in Section 33 63 25 – PIPING SPECIALTIES.

.3 SUBMITTALS

.3.1 Shop Drawings and Product Data: The A/E shall specify that the contractor shall submit the following:

.3.1.1 Manufacturer's technical product data, including installation instructions, for each type of valve. Include pressure drop curve or chart for each type and size of valve.

.3.1.2 Submit valve schedule showing manufacturer's figure number for corresponding valve symbol used to specify valves on this specification. List all valve sizes to be supplied for each valve symbol.

.3.1.3 Manufacturer's assembly-type (exploded view) shop drawings for each type of valve and valve actuator indicating dimensions, weights, materials, and methods of assembly of components.

.3.1.4 Technical data for electric valve actuators that indicate all features specified.

.3.1.5 Manufacturer's technical product data indicating the service rating of each valve type. In addition, this information shall indicate the maximum hydrostatic test pressure that the valve can take when only one side of the valve is being pressurized. The indicated hydrostatic pressure shall be good for not only the structural integrity of the valve but should also take into consideration its continued effectiveness for providing tight shut-off service as a valve without requiring any modifications or maintenance.

.3.1.6 List country of manufacturer, fabrication, and assembly for all valves and valve components.

.3.1.7 Submit ISO 9001 and Independent Test reports, if applicable, per Quality Assurance paragraph below.

.4 QUALITY ASSURANCE

.4.1 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.

.4.2 Country of Fabrication – A/E shall specify the following:

.4.2.1 All valves and valve components not manufactured, fabricated, and/or assembled in the United States of America or Canada must be manufactured, fabricated, and/or assembled by an ISO 9001 registered corporation.

.4.2.2 The contractor shall submit ISO 9001 registration certificates for all corporations where valves and valve components are not manufactured, fabricated, and/or assembled in the United States or Canada.

.4.2.3 For all valves and valve components not fabricated in the United States or Canada, the contractor shall submit an independent test report for all materials to be provided.

.4.2.4 No valves or valve components manufactured, fabricated, and/or assembled in China including Taiwan are permitted.

.5 DELIVERY, STORAGE, AND HANDLING

.5.1 Preparation for Transport; A/E shall specify the following:

.5.1.1 Contractor shall ensure valves are dry and internally protected against rust and corrosion.

.5.1.2 Contractor shall protect valve ends against damage to threads, flange faces, and weld-end preps.

.5.1.3 Set valves in best position for handling. Set globe and gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.

.5.2 Storage: A/E shall specify the following:

.5.2.1 Contractor shall not remove valve end protectors unless necessary for inspection; then reinstall for storage.

.5.2.2 Contractor shall protect valves from weather. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. Outdoor storage of valves shall not be permitted.

.5.3 Handling: A/E shall specify that the contractor shall rig valves to avoid damage to exposed valve parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

.1 VALVE FEATURES

.1.1 General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by the manufacturer for installation requirements. Comply with ASME B31.1.

.1.2 Valve Design: A/E shall specify valves with outside screw and yoke (OS&Y) stems. If non-rising stem valves are needed due to operational constraints,

Utilities Division shall verify the constraints, shall review the submittals of the installation, and shall approve the installation of a non-rising stem valve.

.1.3 Pressure and Temperature Ratings: As specified according to the individual valve specifications.

.1.4 Sizes: Same size as upstream pipe, unless otherwise indicated.

.1.5 Operators: A/E shall specify the following special operator features:

.1.5.1 Handwheels fastened to valve stem, for valves other than quarter turn.

.1.5.2 Lever handles, on quarter-turn valves 3 inches and smaller, except for plug valves. Provide plug valves with square heads. For valves greater than 3-inch, provide gear operator with handwheel.

.1.5.3 Chain-wheel operators, for all valves installed 6 feet or higher above finished floor. Extend chains to an elevation of 5 feet above finished floor.

.1.6 Extended Stems: Where insulation is indicated or specified, A/E shall specify that the contractor shall provide extended stems arranged to receive insulation.

.1.7 By-pass and Drain Connections: Specify and design valved by-passes. The A/E shall indicate locations on the Contract Drawings. A/E shall specify and have the contractor comply with MSS SP-45 bypass and drain connections.

.1.8 Specify neck extensions and right angle drives where indicated and where required for access to the operator.

.1.9 Hot Tap Valves: The A/E shall design for hot taps into existing mains that will remain energized up to the piping system design pressure where a hot tap is shown and designed for in the Contract Drawings. This procedure is also known as wet tapping. For these instances, specify that the valve shall be a full port valve to satisfy the requirements of the hot tap machine and provide a true area pipe tap, and shall satisfy the requirements of the specification of the valve group. All hot taps shall be approved by OSEP.

.2 VALVE IDENTIFICATION SYSTEM DESCRIPTION

.2.1 General: The A/E shall establish a system which identifies the specific valves for each piping system being designed in the Contract Drawings. The specific

valve specification is linked by the service number as depicted in the "Valve Index" listed in this Section.

.2.2 Valves shall be identified on the Contract Drawings by symbol. Size is indicated by the upstream size.

.2.3 Valves are specified in this Section according to the "Valve Index". In general, the following is a description of the format:

.2.3.1 The first symbol, consisting of one or more numerals, indicates the valve group specification that applies to this valve.

.2.3.2 The second symbol, consisting of one or more letters, indicates the type of valve in accordance with the following listing:

- GB = Globe Valve
- BF = Butterfly Valve
- BL = Ball Valve
- CK = Check Valve
- GT = Gate Valve
- AG = Angle-Stop Globe Valve

.2.3.3 The third symbol consists of two numerals. The first numeral indicates the size group; the second numeral, when it is zero, indicates that the valve is standard type. Where the second numeral is greater than zero, it indicates modifications as described in the valve specifications herein.

.2.3.4 The fifth symbol, consisting of a letter, indicates the type of connection to the valve as follows:

- F = Flanged Ends
- S = Screwed Ends
- W = Weld Ends, Butt, or Socket

.2.3.5 For example: For a 10-inch high pressure steam (HPS) shutoff valve, refer to 3BF21W which indicates a valve of Valve Group 3, Butterfly Type, Non-Standard, and with butt weld ends. Refer to Section 33 63 35.3 - VALVE GROUP 3 for the specification of this valve.

.2.4 Note to the A/E: There may be some instances where it is desirable to substitute an item, such as a valve or gasket at a particular location, in place of the one specified in the groups listed in the Index. In that event, the item shall be clearly indicated and specified on the Contract Drawings, and such an indication is to take precedence over the item specified in the valve group specifications. All other terms of that group specification are to be observed.

.3 VALVE INDEX: THE FOLLOWING PAGES CONTAIN THE "VALVE INDEX"

.3.1 CONDENSATE, HIGH PRESSURE (Valve Group 3)

.3.1.1 Abbreviation: HPR

.3.1.2 Description: From HPS to PC System

.3.1.3 Maximum Design Conditions:

- Pressure: 200 PSIG
- Temperature: 600°F

.3.1.4 Normal Operating Conditions:

- Pressure: 185 PSIG
- Temperature: 585°F

.3.1.5 2 Inches and Smaller:

- Shutoff: 3GT15W
- Throttling: None
- Check: 3CK11W

.3.2 CONDENSATE, PUMPED (Valve Group 10)

.3.2.1 Abbreviation: PCR

.3.2.2 Description: Returned Condensate from Campus and Manhole Pumps to Plant

.3.2.3 Maximum Design Conditions:

- Pressure: 200 PSIG
- Temperature: 388°F

.3.2.4 Normal Operating Conditions:

- Pressure: 50 PSIG
- Temperature: 180°F

.3.2.5 Inches and Smaller:

- Shutoff: 10GT11W
- Throttling: None
- Check: 10CK10W

.3.2.6 2-1/2 Inches and Larger:

- Shutoff: 10GT20F
- Throttling: None
- Check: 10CK20F

.3.3 STEAM, HIGH PRESSURE (Valve Group 3)

.3.3.1 Abbreviation: HPS

.3.3.2 Description: HPS Campus Distribution

.3.3.3 Maximum Design Conditions:

- Pressure: 200 PSIG
- Temperature: 600°F

.3.3.4 Normal Operating Conditions:

- Pressure: 185 PSIG
- Temperature: 585°F

.3.3.5 Inches and Smaller:

- Shutoff: 3GT10W
- Throttling (Warm-up By-pass Service): 3AG10W
- Check: None

.3.3.6 2-1/2 Inches and Larger:

- Shutoff: 3GT20W

- Throttling: None
- Check: None

.3.4 CHILLED WATER, CHILLED WATER SUPPLY & RETURN (Valve Group 2)

.3.4.1 Abbreviation: CWS, CWR

.3.4.2 Description: CWS and CWR

.3.4.3 Maximum Design Conditions:

- Pressure: 100 PSIG
- Temperature: 140°F

.3.4.4 Normal Operating Conditions:

- Pressure: 100 PSIG
- Temperature: 42°F

.3.4.5 2" and Smaller:

- Shutoff: 2BL12S
- Check: 2CK11S

.3.4.6 2-1/2" and Larger:

- Shutoff: 2BF23F
- Check: 2CK20F

.4 CHAINWHEELS

.4.1 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:

.4.1.1 Babbitt Steam Specialty Co

.4.1.2 Roto Hammer Industries

.4.1.3 Trumbull Industries

.4.2 Description: Lockable valve actuation assembly with sprocket rim, brackets, and chain.

.4.2.1 Brackets: Type, number, size, and fasteners required to mount actuator on valve.

.4.2.2 Attachment: For connection to butterfly valve stems.

.4.2.3 Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve. Include zinc coating.

.4.2.4 Chain: Hot-dip, galvanized steel, Brass, or Stainless steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

.1 EXAMINATION – The A/E shall specify in the contract documents the following items as they relate to Examination:

.1.1 Examine valve interior through the end ports for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks used to prevent disc movement during shipping and handling.

.1.2 Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the shipping position.

.1.3 Examine threads on both the valve and the mating pipe for form (i.e., out-of-round or local indentation) and cleanliness.

.1.4 Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage. In cases where higher rated raised face steel flanges are mated to lower rated flat face cast iron flanges, remove raised face from steel flange before bolting together.

.1.5 Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.

.2 VALVE INSTALLATIONS – The A/E shall specify in the contract documents the following items as they relate to Valve Installations:

.2.1 General Application: The contractor shall refer to the Contract Drawings and piping system specification sections for specific valve applications and arrangements.

.2.2 Locate valves for easy access and provide separate support where necessary.

.2.3 Contractor shall install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

.2.4 The A/E shall design, and the contractor shall install a three-valve bypass around each control valve and throttling valve. Required locations shall be located on the Contract Drawings.

.2.5 The A/E shall design so that the stems of valves in horizontal lines shall be pointed up (vertical). If this is not practical, the stem may be pointed in a horizontal position with prior approval from the A/E and the applicable Operator (OSU or OSEP). Valves shall not be installed with stems pointed down. All valves shall have a readily accessible location. The Contractor shall be responsible to determine valve stem locations on field-routed piping prior to fabrication of the piping. When welding valves to piping, the Contractor shall insure that the valves are in the open position and shall take extreme care not to overheat and damage the seat area. All valves shall be installed in accordance with the manufacturer's instruction manual. Any valves damaged during installation shall be replaced with new, identical valves at the Contractor's expense.

.2.6 The Contractor shall install valves in a position to allow full stem movement.

.2.7 Installation of Swing Check Valves: Install for proper direction of flow and in horizontal position or vertical position with flow direction upwards, and with hinge pin level.

.2.8 Insulation: Where insulation is indicated for the service, insulation of valves shall be in accordance with Section 33 63 55 – PIPING INSULATION. Where required, the contractor shall provide valves with extended stems, arranged in manner to receive insulation.

.3 FLANGED CONNECTIONS – The A/E shall specify in the contract documents the following items as they relate to Flanged Connections:

.3.1 The contractor shall align flange surfaces parallel and level.

.3.2 The contractor shall assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use

suitable lubricants on bolt threads including anti-seize compound on bolts. Anti-seize compound shall be rated for temperatures to 600°F. Tighten bolts gradually and uniformly with a torque wrench.

.3.3 In cases where higher-rated steel raised face flanges mate to lower-rated cast iron flat face flanges, the contractor shall remove the raised face from the steel flange before bolting together.

.3.4 A/E shall specify gaskets according to the piping system and as specified in Section 33 63 45 - GASKETS.

.4 ADJUSTING, CLEANING, PAINTING AND IDENTIFICATION

.4.1 Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, the A/E, OSEP, and the contractor shall inspect each valve for possible leaks. Specify that the contractor shall adjust or replace packing to stop leaks. Specify that if a valve continues to leak that it shall be replaced.

.4.2 Cleaning: Specify that the contractor shall clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

33 63 35.2 VALVE GROUP 2: CHILLED WATER SUPPLY AND RETURN

.1 ANGLE VALVES

Not Used

.2 GATE VALVES

Not Used

.3 GLOBE VALVES

Not Used

.4 CHECK VALVES

.4.1 SYMBOL: 2CK11S - 2 Inches and Smaller:

.4.1.1 Type: Horizontal swing check valve, screwed cover

.4.1.2 Class: 150 pound or greater screwed end

.4.1.3 Body and cover: ASTM B61 or B62

.4.1.4 Disc: Bronze

.4.1.5 Seat: Bronze

.4.1.6 API 594 Trim: 15

.4.1.7 Standard: MSS SP-80

.4.2 SYMBOL: 2CK20F - 2-1/2 Inches and Larger:

.4.2.1 Type: Horizontal swing check valve, bolted cover

.4.2.2 Class: ANSI 150 flanged.

.4.2.3 Body and cover: ASTM A216, Grade WCB or ASTM A105

.4.2.4 Disc: 13 CR

.4.2.5 Seat: 13 CR

.4.2.6 API 594 Trim: 1

.4.2.7 Standard: ANSI B16.34

.5 BALL VALVES

.5.1 SYMBOL: 2BL12S – 2 Inches and Smaller:

.5.1.1 Type: Lever operated ball valve

.5.1.2 Class: 275-pound WOG or greater screwed end

.5.1.3 Body: ASTM B61 or B62

.5.1.4 Ball: Bronze

.5.1.5 Seat: Replaceable Teflon

.5.1.6 Standard: MSS SP-80

.6 BUTTERFLY VALVES

.6.1 SYMBOL: 2BF23F – 2-1/2 Inches and Larger:

.6.1.1 Type: Single flange high performance butterfly valve suitable for bidirectional dead-end service at rated pressure without use of downstream flange

.6.1.2 Class: ANSI 150 lug type flanged.

.6.1.3 Body: ASTM A216, Grade WCB or ASTM A105

.6.1.4 Disc: 316 Stainless Steel

.6.1.5 Seat: Reinforced R-PTFE

.6.1.6 Shaft: Stainless Steel (X4CrNIMo 16-5); offset from seat plane

.6.1.7 Shaft seal: Graphite

.6.1.8 Standard: MSS SP-68

.6.1.9 Actuator: Gear operator with highly visible position indicator, memory stop and lockable hand wheel

33 63 35.3 VALVE GROUP 3: HIGH PRESSURE STEAM

.1 ANGLE VALVES

.1.1 Symbol: 3AG10W – 2 Inches and Smaller:

.1.1.1 Type: Globe style valve with a "Y" style or 45-degree angle body, designed for high steam pressure drop application for by-pass service. Valve shall be in-line repairable.

.1.1.2 Class: 600 pound or greater socket weld

.1.1.3 Body and bonnet: ASTM A216, Grade WCB or ASTM A105

.1.1.4 Disc: HF Stellite

.1.1.5 Seat: HF Stellite

.1.1.6 API 600 Trim: 5

.1.1.7 Shaft: Stainless steel

.1.1.8 Packing: Graphite

.1.1.9 Standard: ANSI B16.34

.2 GATE VALVES

.2.1 Symbol: 3GT10W - 2 Inches and Smaller:

.2.1.1 Type: Full port gate valve, vertical bolted bonnet, outside screw and yoke, rising stem, solid wedge disc

.2.1.2 Class: 600 pound or greater socket weld

.2.1.3 Body and bonnet: ASTM A216, Grade WCB or ASTM A105

.2.1.4 Disc: HF Stellite

.2.1.5 Seat: HF Stellite

.2.1.6 API 600 Trim: 5

.2.1.7 Shaft: Stainless steel

.2.1.8 Packing: Graphite

.2.1.9 Standard: ANSI B16.34

.2.2 Symbol 3GT15W – 2 Inches and Smaller:

.2.2.1 Type: Full port gate valve, vertical bolted bonnet, outside screw and yoke, rising stem, solid wedge disc

.2.2.2 Class: 600 pound or greater socket weld

.2.2.3 Body and bonnet: ASTM A351/A744, Grade CF3M Type 316L or ASTM A182, Grade F316L

.2.2.4 Disc: 13 CR or HF stellite

.2.2.5 Seat: HF Stellite

.2.2.6 API 600 Trim: 8

.2.2.7 Shaft: Stainless steel

.2.2.8 Packing: Graphite

.2.2.9 Standard: ANSI B16.34

.2.3 Symbol 3GT20W - 2-1/2 Inches and Larger:

.2.3.1 Type: Gate valve, vertical bolted bonnet, outside screw and yoke, rising stem, flexible or solid wedge disc

.2.3.2 Class: 300 pound or greater butt weld

.2.3.3 Body and bonnet: ASTM A216, Grade WCB or ASTM A105

.2.3.4 Disc: HF Stellite

.2.3.5 Seat: HF Stellite

.2.3.6 API 600 Trim: 5

.2.3.7 Shaft: 13 CR

.2.3.8 Packing: Graphite

.2.3.9 Standard: ANSI B16.34

.2.3.10 Actuator: Where noted on the contract drawings, provide an enclosed gear operator

.3 GLOBE VALVES

Not Used

.4 CHECK VALVES

.4.1 Symbol: 3CK11W - 2 Inches and Smaller:

.4.1.1 Type: Vertical lift check valve, bolted cover

.4.1.2 Class: 600 pound or greater socket weld

.4.1.3 Body and bonnet: ASTM A351/A744, Grade CF3M Type 316L or ASTM A182, Grade F316L

.4.1.4 Disc: 13 CR or HF Stellite

.4.1.5 Seat: HF Stellite

.4.1.6 Trim: 8

.4.1.7 Standard: ANSI B16.34

.5 BALL VALVES

.5.1 Symbol: 3BL15W - 2 Inches and Smaller:

.5.1.1 Type: Ball valve, designed shut-off service, in-line repairable, top-entry. Valve shall have capability of being welded into line without disassembly. Configuration shall be regular port. Operation of the valve shall automatically wipe the ball clean. The valve shall be

blow-out proof and shall be fully-guided to reduce side thrust effect. Tightness rate shall be per ASME Class V at 200 PSIG at 600°F. Valve shall be Velan “Securaseal” Type T or approved equivalent.

.5.1.1 Class: 600 pound socket weld ends

.5.1.2 Body and bonnet: 316 stainless steel, Grade CF8M

.5.1.3 Ball: 316SS/HC

.5.1.4 Seat: 316SS/Stellite

.5.1.5 Packing and back-up seal: Graphite

.5.1.6 Stem: Stainless steel

.6 BUTTERFLY VALVES

.6.1 Symbol 3BF21W - 2-1/2 Inches and Larger:

.6.1.1 Type: High performance butterfly style, rotary valve, suitable for bidirectional dead-end service at rated pressure without the use of downstream flange. The disk movement relative to the shaft rotation shall be triple offset design. Valve shall be Adams MAK-6 or approved equivalent.

.6.1.2 Class: 600-pound, butt weld ends

.6.1.3 Body: Carbon steel body conforming to ASTM A216, Type WCB. The hardened bearing with bearing seal shall be retained in the body.

.6.1.4 Disc: Retainer screws, disk, and plate shall be stainless steel.

.6.1.5 Seat: Stellite or similar hard-surfaced metal. Seats shall be resilient, non-flexing laminate metal seal composite of stainless steel and graphite retained such that centering movement is permitted.

.6.1.6 Shaft: Blow-out proof, 17-4 PH stainless, and single piece construction

.6.1.7 Shaft Seal: Graphite with multiple-stud packing gland followers for adjustability utilizing Belleville style washers

.6.1.8 Standard: API 607

.6.1.9 Actuator: Position indicator for sizes 2-1/2 through 24 inches. Provide right angle gear operator with 2-inch AWWA nut, with loose steel hand wheel or chain wheel attachment for remote "tee"

handle operation as shown on drawings. Valve actuator shall be provided with self-locking gears. Provide stem housing to allow for minimum of 5 inches of insulation.

33 63 35.10 VALVE GROUP 10: CONDENSATE RETURN

.1 GATE VALVES

.1.1 Symbol: 10GT11W - 2 Inches and Smaller:

.1.1.1 Type: Gate valve, vertical bolted bonnet, outside screw and yoke, rising stem, solid wedge disc

.1.1.2 Class: 600 pound or greater socket weld

.1.1.3 Body and bonnet: ASTM A351/A744, Grade CF3M Type 316L or ASTM A182, Grade F316L

.1.1.4 Disc: 13 CR or HF Stellite

.1.1.5 Seat: HF Stellite

.1.1.6 API 600 Trim: 8

.1.1.7 Shaft: Stainless steel

.1.1.8 Packing: Graphite

.1.1.9 Standard: ANSI B16.34

.1.2 Symbol 10GT20F - 2-1/2 Inches and Larger:

.1.2.1 Type: Gate valve, vertical bolted bonnet, outside screw and yoke, rising stem, flexible or solid wedge disc

.1.2.2 Class: ANSI 300 flanged

.1.2.3 Body and bonnet: ASTM A351/A744, Grade CF3M Type 316L or ASTM A182, Grade F316L

.1.2.4 Disc: HF Stellite

.1.2.5 Seat: HF Stellite

.1.2.6 API 600 Trim: 5

.1.2.7 Shaft: 13 CR

.1.2.8 Packing: Graphite

.1.2.9 Standard: ANSI B16.34

.1.2.10 Actuator: Where noted on the contract drawings, provide an enclosed gear operator.

.2 CHECK VALVES

.2.1 Symbol: 10CK10W - 2 Inches and Smaller:

.2.1.1 Type: Horizontal swing check valve, bolted cover. Vertical check valves are to be used only upon approval of applicable Operator (OSU or OSEP) and must be lift check type.

.2.1.2 Class: 600 pound or greater socket weld

.2.1.3 Body and bonnet: ASTM A351/A744, Grade CF3M Type 316L or ASTM A182, Grade F316L

.2.1.4 Disc: 13 CR or HF Stellite

.2.1.5 Seat: 13 CR or HF Stellite

.2.1.6 API 594 Trim: 1

.2.1.7 Standard: ANSI B16.34

.2.2 Symbol: 10CK20F - 2-1/2 Inches and Larger:

.2.2.1 Type: Horizontal swing check valve, bolted cover. Vertical check valves are to be used only upon approval of the applicable Operator (OSU or OSEP) and must be lift check type.

.2.2.2 Class: ANSI 300 flanged

.2.2.3 Body and bonnet: ASTM A351/A744, Grade CF3M Type 316L or ASTM A182, Grade F316L

.2.2.4 Disc: 13 CR or HF Stellite

.2.2.5 Seat: 13 CR or HF Stellite

.2.2.6 API 594 Trim: 1

.2.2.7 Standard: ANSI B16.34

.3 BALL VALVES

.3.1 Symbol: 10BL11W – 2 Inches and Smaller:

.3.1.1 Type: Rated for steam service at 200 PSIG, 600°F conditions; two-piece construction, with stainless steel body, regular port, 316 SS ball and stem, replaceable seats and seals rated for temperature, blowout proof stem, vinyl-covered steel handle, socket weld ends and extended stem for insulated piping. Packing shall be graphite.

.4 BUTTERFLY VALVES

Not Used

33 63 40 HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.1.2 Requirements of the following Division 33 Sections apply to this Section for the installation package only:

.1.2.1 Section 33 63 05 – GENERAL PIPING PROVISIONS

.1.2.2 Section 33 63 10 – COMMON WORK RESULTS FOR PIPING

.1.2.3 Section 33 63 25 – PIPING SPECIALTIES

.1.2.4 Section 33 63 35 – VALVES

.1.2.5 Section 33 63 55 – PIPING INSULATION

.2 DESCRIPTION OF WORK

.2.1 This Section provides the specification for the installation of owner furnished pre-insulated supports and is included in the pre-purchase specification package for reference only. Additionally, this Section provides the specification for providing all non-insulated pipe hangers and supports. Only the pre-insulated supports for steam and condensate are being pre-purchased by OSU. The Contractor shall provide all other anchors and supports necessary for a fully functional system. This includes all ASME B31.1 piping systems. The

A/E has performed an ASME B31.1 thermal stress analysis on the high-pressure steam and pumped condensate piping systems for this project. The Contractor shall provide the pipe supports, hangers and anchors as detailed in the Contract Drawings and shall provide all supports for these systems to satisfy ASME B31.1 requirements of supporting the weight of the piping systems and to accommodate lateral and axial travel in the piping system associated with thermal pipe expansion and contraction. For all other piping systems, the Contractor shall design and provide pipe support systems to satisfy ASME B31.1 code requirements for all design conditions such as dead loads (weight of pipe, insulation, etc.), thermal loads (due to thermal expansion), and other loads (earthquake, etc.).

.2.2 The Contractor shall design and provide an engineered pipe hanger system for all pipe systems of this project as specified in this Section.

.2.3 This Section provides the specification for the following components:

.2.3.1 Horizontal-piping hangers and supports

.2.3.2 Vertical-piping clamps

.2.3.3 Hanger-rod attachments

.2.3.4 Saddles and shields

.2.3.5 Miscellaneous materials

.2.3.6 Pipe alignment guides

.2.3.7 Pipe slides and rollers

.2.3.8 Anchors

.2.4 Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 33 Sections.

.3 SUBMITTALS

.3.1 Shop Drawings, Product Data, and Quality Assurance Submittals: In accordance with Section 01 33 00 – SUBMITTAL PROCEDURES, submit the following:

.3.1.1 Pipe hanger and support schedule for the pipe systems, including isometric drawings of the piping system. Schedule shall list all pipe supports.

.3.1.2 Product data, including installation instructions for each type of hanger and support component. This information shall consist of copies of the manufacturer's catalog data for the items provided in the pipe hanger assembly drawings and shall indicate dimensions, materials of construction, maximum recommended load if applicable, any operating instructions, approximate weight, and MSS SP-69 approval. Together with the pipe system isometric drawings and the manufacturer's catalog data, the assembly of the complete system should be clearly identifiable.

.3.1.3 Shop drawings of hangers, anchors, guides and slides to include hanger, pipe slides and guides data indicating the pipe service, location in the piping system, size, lateral and axial travel and vertical and lateral forces.

.3.1.4 Product data for high temperature sealant.

.4 QUALITY ASSURANCE

.4.1 For all pipe support related welding performed on site, qualify welding processes and welding operators in accordance with AWS D1.1 and ASME Boiler Pressure Vessel Code Section IX. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

.4.2 MSS Standard Compliance

.4.2.1 Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.

.4.2.2 Select and apply pipe hangers and supports, complying with MSS SP-69.

.4.2.3 Fabricate and install pipe hangers and supports, complying with MSS SP-89.

.4.2.4 Terminology used in this Section is defined in MSS SP-90.

.4.3 All hangers and supports shall comply with seismic design requirements seismic requirements are stated on the drawings and are not stated in this specification. You must get the drawings to conform to this specification.

.5 DELIVERY, STORAGE, AND HANDLING

.5.1 Packaging, marking, shipping, receiving, and storage shall be performed per the recommendations of Paragraph 9 of MSS SP-89.

.6 APPLICABLE PUBLICATIONS

.6.1 The publications listed below form a part of this Specification to the extent referenced. The publications are referenced in the text by basic designation only.

.6.2 American Society of Mechanical Engineers (ASME)

.6.2.1 B31.1 Power Piping Code

.6.2.2 BPVC Boiler Pressure Vessel Code

.6.2.3 BPVC Section IX Welding and Brazing Qualifications

.6.3 American Society for Testing and Materials (ASTM)

.6.3.1 ASTM A36 Carbon Structural Steel

.6.3.2 ASTM C150 Portland Cement

.6.3.3 ASTM C404 Aggregates for Masonry Grout

.6.4 American Welding Society (AWS)

.6.4.1 AWS D1.1 Structural Welding Code - Steel

.6.5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

.6.5.1 SP-58 Pipe Hangers and Supports - Materials, Design, and Manufacturer

.6.5.2 SP-69 Pipe Hangers and Supports - Selection and Application

.6.5.3 SP-89 Pipe Hangers and Supports - Fabrication and Installation Practices

.6.5.4 SP-90 Guidelines on Terminology for Pipe Hangers and Supports

PART 2 - PRODUCTS

.1 GENERAL

.1.1 The Contractor shall provide all necessary pipe slides, pipe guides, hangers, beam clamps, hanger rods, turnbuckles, bracing, rolls, plates, brackets, saddles, and other accessories necessary to support the pipes from the trench structures. Drilling, welding, cutting, and other operations required to attach the piping to such structures shall be part of the Contract. Channels, angles, beams, and other structural steel items indicated and necessary to attach or brace pipe supports to the structure and used solely for that purpose shall be furnished by the Contractor and the cost thereof included in the Contract.

.1.2 All pipe lines shall be provided with complete hanger and support assemblies. Included but not limited to shall be the pipe hanger, load-bearing insulation inserts, saddles, shields, hardware, washers, nuts, turnbuckles, rods, strap, clip angles, beam clamps, through bolts, ceiling plates and grout. Pipe hangers for all pipe lines shall comply with MSS SP-58, SP-69, and SP-89.

.1.3 Pipe lines to be supported include all new piping and tubing, existing piping that requires temporary supporting due to structural related work, and existing piping where required due to new piping connecting to existing piping.

.2 HANGER DESIGN SERVICES

.2.1 The A/E has provided a pipe support design for the high-pressure steam and pumped condensate piping as described in .2 - DESCRIPTION OF WORK Section .2.1. The Contractor shall design an engineered pipe hanger system for all other pipe systems of this Contract. A detailed analysis is not required to be submitted, however, the Contractor shall perform calculations to the detail necessary to demonstrate that the pipe support system is adequate for the service. For all pipe hangers, supports, anchors, guides, etc., the Contractor shall submit pipe system isometric drawings. Provide proposed equipment manufacturer, manufacturer's model number and size, construction, finish, quantities and/or lengths. Indicate pipe group, line size, insulation thickness.

.2.2 The Contractor shall provide engineering and design services and submit calculations and analysis for any deviation or modification to the pipe support systems designed by the A/E.

.2.3 The design conditions utilized to generate the hanger system design shall be taken from the piping system specification in Section 33 63 10 – COMMON WORK RESULTS FOR PIPING.

.2.4 Piping Connecting to Existing Systems

.2.4.1 The Contractor shall be responsible for verifying that existing supports are acceptable where tie-ins to existing piping occur. The Contractor shall consider all additional material required as part of this Contract.

.2.4.2 In order to perform calculations of the movement and support of the piping systems, it is recognized that the Contractor will have to identify existing piping and supports not currently shown on the Contract Drawings.

.3 GENERAL DESIGN GUIDELINES

.3.1 All supports and parts shall conform to the latest requirements of the ASME Code for Pressure Piping B31.1, and MSS SP-58, MSS SP-69, and MSS SP-89, except as supplemented or modified by the requirements of this Section.

.3.2 Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized wherever possible.

.3.3 Weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

.3.4 Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction while providing continuous support of the piping and prevent excessive stress resulting from transferred weight or force being introduced into the pipe or connected specialties and equipment.

.3.5 Hanger Rods and Supports

.3.5.1 All rigid rod hangers shall provide a means of vertical adjustment after erection.

.3.5.2 Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.

.3.5.3 Where horizontal piping movements are such that hanger rod angularity is greater than or equal to 4 degrees from the cold to hot position of the pipe, the hanger pipe and structural attachments shall be designed and positioned in such manner that the rod is vertical in the hot and cold position.

.3.5.4 Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

.3.6 Pipe Anchors, Guides and Bracing Requirements

.3.6.1 All pipe anchors and guides shall be of welded steel construction designed with a safety factor of not less than five.

.3.6.2 The Contract Drawings for this project indicate the location of all anticipated anchors, guides, and braces required to control excessive forces and moments on equipment, over stressing of pipe material, and/or extreme mal-positioning and misalignment of supports or expansion joints caused by thermal expansion and contraction.

.3.6.3 The Contractor shall recognize the necessity and provide anchors, guides, and sway braces to prevent extreme mal-positioning and misalignment pipe supports, over stressing of pipe, and/or excessive forces and moments on equipment caused by hydraulic surge in the lines associated with normal operation and hydrostatic testing. These anchors, guides, and braces are not indicated on the Contract Drawings; the Contractor shall anticipate that such are necessary and shall allow for same in his contract; the Contractor shall also provide these items as necessary in the design of pipe support systems for piping systems included in the Contractor's scope of piping systems support designs.

.3.6.4 After flushing and startup of all pipe lines, each shall be observed to locate excessive movement and then shall be guided or anchored by the Contractor at this time.

.3.6.5 Where the piping system is subject to shock loads, such as seismic disturbances or thrusts imposed by the actuation of safety valves or hydrostatic testing hanger design shall include provisions for rigid restraints or shock absorbing devices of approved design, such as Anvil Fig. 200 or approved equal shock and sway suppressor.

.3.6.6 Supports, guides, and anchors shall be so designed that excessive heat will not be transmitted to the supporting steel. The temperature of supporting parts shall be based on a temperature gradient of 100°F per inch distance from the outside surface of the pipe.

.3.7 Thin-wall Stainless Steel Lines: Ceiling hung thin-wall stainless steel pipes shall be supported by pre-insulated clamp type hangers and rollers with a stainless steel bearing plate or shield secured in place between the hanger or roller and the pipe. The bearing plate or shield shall be a minimum 12-inches long, cover a minimum of 1/2 of the pipe circumference, and be made 1/8-inch thick stainless steel bent to fit the pipe insulation. The maximum spacing of pipe hangers on thin wall stainless steel lines shall be no more than:

.3.7.1 1/2 inch through 1-1/4 inch = 8 feet

.3.7.2 1-1/2 inch through 4 inch = 10 feet

.3.7.3 5 inch and larger = 12 feet

.3.8 Finishes: All hangers and support assemblies, associated accessories and hardware shall have factory galvanized finish.

.4 HORIZONTAL-PIPING HANGERS AND SUPPORTS

.4.1 Hangers shall be so spaced as to prevent sag and permit proper drainage. Hanger spacing shall be in accordance with MSS SP-69 except where indicated on the drawing and specified herein. Provide a hanger at elbows (within 2 feet) and terminations.

.4.2 Horizontal pipe attachments shall be selected in accordance with Table 1 of MSS SP-69. Selection of components must strictly adhere to the allowable temperature ranges listed and the presence of insulation.

.4.3 Pipe Clamps: Double-bolt pipe clamps when used on insulated pipe shall match the insulated pipe outer diameter. High density insulation inserts matching the pipe insulation shall be provided.

.4.4 Clevis Hangers

.4.4.1 Clevis hangers used on uninsulated lines shall match the pipe outer diameter. Clevis hangers used on insulated pipes shall be so sized that the inner diameter of the hanger matches the outer diameter of the piping insulation.

.4.5 Brackets used for supporting piping shall be of welded steel construction with a design safety factor of not less than five.

.5 PIPING AND SUPPORTS, ROUTING AND LOCATION

.5.1 Piping and conduits shall be run parallel with the lines of the structure, unless otherwise shown or noted on the Contract Drawings. The different service pipes, valves, and fittings shall be so installed that after the covering is applied there will not be less than one-inch clear space between the finished covering and other work and between the finished coverings of parallel adjacent pipes. Hangers and supports on different service lines, running parallel with each other and parallel to the lines of the structure. Where conflicts between the trades result, they shall be resolved by the Contractor to the A/E's satisfaction and at no expense to the University.

.6 VERTICAL-PIPING CLAMPS

.6.1 Provide Factory-fabricated vertical-piping clamps complying with MSS SP-58 selected by Contractor to suit vertical piping systems in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.

.7 HANGER-ROD ATTACHMENTS

.7.1 Provide factory-fabricated hanger-rod attachments complying with MSS SP-58 as indicated on the drawings to suit pipe hangers and structure attachments in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each pipe support application. Select size of hanger-rod attachments to suit hanger rods and pipe support load. Provide copper-plated hanger-rod attachments for copper-piping systems.

.8 STRUCTURE ATTACHMENTS

.8.1 Provide factory-fabricated structure attachments complying with MSS SP-58 as indicated on the drawings to suit substrate conditions in accordance with MSS SP-69 and manufacturer's published product information. Provide copper-plated building attachments for copper-piping systems.

.9 SADDLES AND SHIELDS

.9.1 As required for the pipe support load and the load bearing capacity of the insulation. Comply with MS SP 58 and MSS SP-69 type 40.

.10 MISCELLANEOUS MATERIALS

.10.1 Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

.10.2 Cement Grout: Portland Cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration. Refer to Section 33 63 05 – GENERAL PIPING PROVISIONS. Pipe anchors shall utilize a high temperature rated grout mix.

.10.3 Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

.11 PIPE SLIDES AND GUIDES

.11.1 Pipe Slides and Guides: The A/E shall specify that the Contractor shall review carefully the insulation type, materials, and movements and submittal requirements in order to meet the design intent. Specify that units shall be rated for temperature for each service – steam and condensate to 600°F, pumped equipment drain to 212°F and chilled water to 120°F. Specify that all steel clamps and steel shapes components shall be ASTM A36 hot-dipped galvanized. Slide pads shall be graphite rated to 2000 PSI with a 0.1 coefficient of friction, bonded and secured to backing plates with recessed set screws. Hardware shall be ASTM A307 or B7 plated bolts, studs, and nuts. Structural insulation inserts shall be high density/high compressive strength Marinite P. Insulation shall be calcium silicate with moisture repellant on steam and condensate pipe services in buildings, tunnels and manholes and shall be high density/high compressive strength Cellular Glass on steam and condensate pipe services in trenches. (A/E refer to Section 33 63 55 – PIPING INSULATION for insulation thickness). Specify and design that the pipe slides and guides shall be selected for the anticipated lateral and axial travel and vertical and lateral forces at each pipe support location. Specify and design that the pipe slides and guides shall be designed and constructed in accordance with ASME B31.1 and MSS-SP 58 and have a design safety factor of 5.

.11.2 Identification: Specify that the Contractor shall, for each support and base plate, clearly identify with the pipe support designation. Each support and

base plate shall have markings that identify the axial and lateral positions of the support in the cold position. This must be installed and coordinated in the field with the A/E's thermal stress analysis and design documents.

.12 HARDWARE FOR PRE-INSULATED SUPPORTS

12.1 The contractor shall provide the levering nut, expansion anchor, expansion anchor nut, washer, and grout pad for each support.

.13 HIGH TEMPERATURE SEALANT

13.1 Provide high temperature, one part, silicone rubber sealant. Sealant shall be rated to 500°F for continuous operation. Basis of design: Tremco Trempro 644.

PART 3 - EXECUTION

.1 GENERAL

.1.1 Specifications of this part apply to the execution of contractor provided and owner furnished supports.

.2 RECEIPT OF PRE-PURCHASED SUPPORTS

.2.1 Contractor shall remove pre-purchased supports from the delivery vehicle on or near the jobsite.

.3 INSPECTION

.3.1 The installation, adjustment, and inspection of all hangers' systems shall be performed by the Contractor in accordance with Paragraph 10 of MSS SP-89.

.3.2 During renovation and installation of equipment, the Contractor shall be responsible for the temporary support of all piping systems where necessary due to the phasing of construction. Temporary support systems shall be in accordance with the requirements of this Section.

.4 PREPARATION

.4.1 Proceed with installation of permanent hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors and other building structural attachments.

.4.2 Prior to installation of hangers, supports, anchors and associated work but after the pipe hanger submittal has been reviewed by the A/E, the Installer shall meet at project site with Contractor, installer of each component of associated work, installers of other work requiring coordination with work of this Section, and A/E for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with this Section.

.5 INSTALLATION OF HANGERS AND SUPPORTS

.5.1 General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Install supports with maximum spacing complying with MSS SP-69 and to permit normal pitch of pipe with deflection and bending stress maintained at a minimum.

.5.2 During the hydrostatic testing of any line with spring hangers designed for fluids lighter than water, travel stops or locks must be installed on the hangers or temporary solid rod supports must be provided during the entire time the line is filled with water to support its additional weight and thereby prevent overloading the springs. When tests are completed, the stops, locks, or solid rods must be removed, and the hanger springs set for their cold loads.

.5.3 On the first occasion that any line is brought to operating temperature, the Contractor shall immediately reset each spring hanger to its hot load position and lock the adjusting nut or screw.

.5.4 Install building attachments to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.

.5.5 Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

.5.6 Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

.5.7 Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

.5.8 Seal the connection between each pre-insulated support and the adjoining insulation with high temperature silicone sealant.

.6 INSTALLATION OF ANCHORS

.6.1 Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.1 and to prevent transfer of loading and stresses to connected equipment.

.6.2 Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.1 and with AWS Standards D1.1.

.7 METAL FABRICATION

.7.1 Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

.7.2 Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

.7.3 Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

.7.3.1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

.7.3.2 Obtain fusion without undercut or overlap.

.7.3.3 Remove welding flux immediately.

.7.3.4 Finish welds at exposed connections so that no roughness shows after finishing and so that contours welded surfaces to match adjacent contours.

.8 ADJUSTING

.8.1 Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve proper slope of pipe.

.8.2 Touch-Up and Cleaning: Clean and touch-up all field welds, bolted connections, and abraded areas of the shop finish on al support components with cold galvanizing repair.

.8.3 Refer to Section 33 63 05 – GENERAL PIPING PROVISIONS.

33 63 45 GASKETS

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.1.2 Requirements of the following Specification Sections apply to this Section:

.1.2.1 Section 33 63 05 – GENERAL PIPING PROVISIONS

.1.2.2 Section 33 63 10 – COMMON WORK RESULTS FOR PIPING

.1.2.3 All related specific piping specification Sections.

.2 DESCRIPTION OF WORK

.2.1 The extent and type of gaskets required by this Section shall be as indicated on the Contract Drawings and/or specified in other Division 48 Electrical Sections.

.3 SUBMITTALS

.3.1 Product Data: In accordance with Section 01 33 00 – SUBMITTAL PROCEDURES, submit the following:

.3.1.1 Manufacturer's technical product data, including materials of construction, thickness, pressure and temperature rating, manufacturer's model number, and storage requirements.

.4 DELIVERY AND STORAGE

.4.1 Transport, Storage, and Handling:

.4.1.1 Keep gaskets in dry area protected from weather.

.4.1.2 Do not prepare gaskets until ready for installation.

.4.1.3 Do not reuse gaskets.

PART 2 - PRODUCTS

.1 Gasket Identification System: a system has been established which identifies the specific gasket for each service identified in the contract drawings. The specific gasket group is linked by the service number as listed in the "Piping, Gasket, and Service Group Index", which appears in Section 33 63 10 – COMMON WORK RESULTS FOR PIPING. An example is also presented in that section.

.2 GASKET GROUPS

.2.1 Gasket Group HP: Gaskets shall be spirally wound, Type 304 stainless steel with non-asbestos filler material and carbon steel outer ring. Gaskets shall be 1/16-inch thick and conform to the flange face on which they are used. Acceptable products from acceptable manufacturers include: Flexitallic Style CG with Flexicarb filler and 316L winding, manufactured by Flexitallic Inc., or approved equivalent.

.2.2 Gasket Group HPB: Gaskets shall be spirally wound, Type 316L stainless steel with non-asbestos filler material and carbon steel outer ring. Gaskets shall be 1/8-inch-thick and conform to the flange face on which they are used. Acceptable products from acceptable manufacturers include: Flexitallic Style CG with Flexite Super filler, manufactured by Flexitallic Inc., or approved equivalent.

PART 3 - EXECUTION

.3 INSTALLATION

.3.1 Match flanges within piping system and at connections with valves and equipment where specified.

.3.2 Clean flange faces and install gaskets.

.3.3 Tighten bolts to provide uniform compression of gaskets.

33 63 50 IDENTIFICATION FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

.1 RELATED DOCUMENTS

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

.2 DESCRIPTION OF WORK

.2.1 Piping identification shall be provided for all new work in accordance with the requirements of this Specification Section.

.2.2 Types of identification devices specified in this Section include the following:

2.2.1 Pipe Contents and Identification Markers

2.2.2 Equipment Identification

2.2.3 Brass Valve Tags

.2.3 Piping identification furnished as part of factory-fabricated equipment is specified as part of equipment assembly in other Division 33 Sections.

.3 SUBMITTALS

.3.1 Product Data and Samples: In accordance with Section 01 33 00 - SUBMITTAL PROCEDURES, submit the following:

.3.1.1 Manufacturers' technical product data and installation instructions for each type of identification device specified; Include a list of all piping systems indicating a proposed nomenclature.

.3.1.2 Samples of each color, lettering style, and other graphic representation required for Pipe contents and identification markers.

.4 QUALITY ASSURANCE

.4.1 Codes and Standards:

.4.1.1 ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

.5 SEQUENCING AND SCHEDULING

.5.1 Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

.5.2 Install identifying devices before installing concealment.

PART 2 - PRODUCTS

.1 PIPING IDENTIFICATION MATERIALS

.1.1 General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 33 Sections. For each identification type, provide all tags from same manufacturer with same text, style, color, shape, and other identification features.

.2 PIPE CONTENTS AND IDENTIFICATION MARKERS

.2.1 Description: The Contractor shall provide pipe markers or painted stenciled identification on all pipe systems as described below. Pipe markers and stencils shall indicate line contents, direction of flow, and that insulation is asbestos free. Line contents shall match service. Obtain approval from A/E for identification of each service.

.2.2 Material: Fade-resistant, non-ferrous metal material. Snap-on or strap-on type. All markers shall have a minimum service temperature of -40°F to 175°F and be rated for outdoor service.

.2.3 Arrangement: For external diameters (including insulation) equal to or greater than 3 inches, provide stencils. For external diameters (including insulation) equal to or greater than 1-1/2 inch and less than 3 inches,

rectangular pipe contents indication marker shall contain only one line of text and appear on both sides of the pipe with a flow direction arrow roll wrapping 360 degrees around at both ends of the pipe contents indication marker. For external diameters less than 1-1/2 inch, provide full-band marker extending 360 degrees around pipe. The working of each marker shall be spelled out in the direction of the travel of the pipe.

.2.4 Colors: For steam, condensate, and other related systems, stencil shall be orange letters and arrows. "Asbestos Free" stencils shall have a blue background with white letters. See Part 3 – EXECUTION, Sections .3 and .4 for painting considerations.

.2.5 Text Height: Content minimum text height shall be as follows:

Overall OD Including Insulation	Min. Letter Size
3/4 to 1-1/4 inch	1/2 inch
1-1/2 to 2 inches	3/4 inch
2-1/2 to 6 inches	1-1/4 inches
8 to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

.3 EQUIPMENT IDENTIFICATION

.3.1 All equipment shall have a manufacturer's data tag. When this tag has been removed, painted over, or rendered illegible, the Contractor shall provide new tags. Tags shall be brass plates on which operational data plus information regarding areas or other equipment served is stamped. Permanently attach tags to the equipment in locations where they can easily be read.

.4 BRASS IDENTIFICATION TAGS

.4.1 Description: For the purpose of identifying valves. Provide on each valve a brass identification tag. OSU shall provide a schedule of valve tags to the Contractor.

.4.2 Lettering: Symbol letters and numerals shall be not less than 1/2 inch high, shall be deeply impressed into the metal tag, and shall be Black filled.

.4.3 Size and Shape: Rectangular, minimum 1-1/2 inch high by 1-1/2 inch wide by 0.040 inch thick.

.4.4 Fastening: For valves, attach through punched hole on side of tag to valve body or yoke, not the valve handwheel, with Monel wire.

PART 3 - EXECUTION

.1 GENERAL INSTALLATION REQUIREMENTS

.1.1 Coordination: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, install identification after completion of covering and painting. In addition, provide pipe markers only after each line has been complete, erected, purged, tested, and/or painted.

.2 PIPE SYSTEM IDENTIFICATION

.2.1 General: Provide pipe markers on every system including pipe contents and flow direction. Provide "Asbestos Free" insulation markers for all pipe that is insulated under this contract. Locations of all markers shall be subject to final approval by the A/E.

.2.2 Location:

2.2.1 Location: Locate pipe markers in a conspicuous manner at a minimum of every 40 feet as follows:

- Upstream and downstream each isolation valve, control valve and pressure regulating station
- Near each valve station and control device
- Near each branch or change of direction
- On both sides where pipe passes through walls, floors, or ceilings within 4 feet of the barrier
- Near major equipment origination and termination points
- Near the inside and outside of concealed points
- In each Manhole and Valve Vault
- At elevation changes

2.2.2 Where pipes run parallel to each other, identify each pipe in the same general location.

.3 PAINTING COLOR SCHEME

.3.1 All piping systems shall receive an aluminum jacket so no paint is required for piping insulation systems.

.4 ADJUSTING AND CLEANING

.4.1 Painting and Insulating: Do not paint or insulate over any identification tags. Tags shall be installed after all painting is completed or shall be covered during painting.

33 63 55 PIPING INSULATION

PART 1 - GENERAL

.1 RELATED DOCUMENTS:

.1.1 Contract Drawings and General Provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections apply to this Section.

.1.2 Requirements of the following Specification Sections apply to this Section:

.1.2.1 Section 33 63 10 – COMMON WORK RESULTS FOR PIPING

.1.2.2 Section 33 63 25 – PIPING SPECIALTIES

.1.2.3 Section 33 63 35 – VALVES

.1.2.4 Section 33 63 40 – HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

.1.2.5 Section 33 63 50 – IDENTIFICATION FOR PIPING AND EQUIPMENT

.2 DESCRIPTION OF WORK

.2.1 Scope: Extent of the piping system and equipment required to be insulated by this Section is indicated in this Section, on the Contract Drawings, and other Division 33 Sections.

.2.2 Types: Types of piping insulation systems specified in this Section include the following:

2.2.1 Pipe insulation

2.2.2 Equipment insulation

2.2.3 Insulation jackets

2.2.4 Insulation accessories

.3 QUALITY ASSURANCE

.3.1 Codes and Standards: Provide insulation conforming to the following standards:

.3.1.1 American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM standards, including:

- ASTM B 209 Aluminum Alloys
- ASTM C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- ASTM C 195 Mineral Fiber Thermal Insulating Cement
- ASTM C 196 Expanded or Exfoliated Vermiculite Thermal Insulating Cement
- ASTM C 302 Test Method for Density of Preformed Pipe Covering-Type Thermal Insulation
- ASTM C 335 Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation
- ASTM C 356 Test Method for Linear Shrinkage of Preformed High Temperature Thermal Insulation Subjected to Soaking Heat
- ASTM C 411 Test Method for Hot Surface Performance of High Temperature Thermal Insulation
- ASTM C 449 Mineral Fiber Hydraulic - Setting Thermal Insulating and Finishing Cement
- ASTM C 534 Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

- ASTM C 547 Mineral Fiber Preformed Pipe Insulation
- ASTM C 553 Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
- ASTM C 612 Mineral fiber Block and Board Thermal Insulation
- ASTM C 795 Thermal Insulation for Use in Contact with Austenitic Stainless Steel
- ASTM C 921 Practice for Determining Properties of Jacketing Materials for Thermal Insulation
- ASTM D 579 Greige Woven Glass Fabrics
- ASTM E 84 Test Method for Surface Burning Characteristics of Building Materials
- ASTM C591 Pre-Formed Polyurethane Pipe Insulation

.3.1.2 National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:

- NFPA 25 Test Methods, Surface Burning Characteristics of Building Materials.

.3.1.3 Underwriter's Laboratory Inc.

- UL 723 Tests for Surface Burning Characteristics of Building Materials.

.3.2 Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity, where applicable.

.3.3 Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame spread index specified herein, and smoke developed index specified herein, as tested by ASTM E 84 (NFPA 255) method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove that fire hazard ratings for materials proposed for use do not exceed those specified.

.3.4 The work shall be done only by mechanics thoroughly experienced in pipe insulation, and the quality of workmanship shall be the best attainable.

.4 SUBMITTALS

.4.1 Shop Drawings, Product Data, and Samples: In accordance with Section 01 33 00 – SUBMITTAL PROCEDURES, submit the following:

.4.1.1 Manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K value, flame spread and smoke developed ratings, thickness, and furnished accessories for each mechanical system requiring insulation. Furnish necessary test data certified by an independent testing laboratory. Provide manufacturer's certification that insulation or any other materials provided shall not accelerate stress corrosion of stainless steel pipe per ASTM C795.

.4.1.2 Submit manufacturer's sample of each piping insulation type required, and of each duct and equipment insulation type required. Affix label to sample completely describing product.

.4.1.3 Insulation application schedule indicating equipment or piping systems sizes, insulation material, thickness, insulation vapor barriers, jackets, types of insulated fittings, accessories, and methods for each insulated system.

.5 DELIVERY, STORAGE, AND HANDLING

.5.1 Delivery: Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.

.5.2 Storage and Handling: Protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

.5.3 Outside storage of insulating materials is prohibited.

.5.4 Insulating materials and accessory materials shall be packed in shipping containers so constructed as to ensure safe delivery of the materials in a satisfactory condition. The shipping containers shall be legibly marked with

the name of the manufacturer, material, size, type, thickness, density, and quality contained in each container.

.5.5 The Contractor shall provide a storage area for weather protection of all insulation materials and accessory materials after their arrival at the job site.

.5.6 Installed insulation which has not been weather-proofed shall be protected from inclement weather by approved waterproof sheeting installed by the Contractor. Any wet or damaged insulation shall be removed and replaced by the Contractor at no additional cost.

PART 2 - PRODUCTS

.1 INSULATION GENERAL REQUIREMENTS

.1.1 General: Provide insulation conforming to the referenced publications and the specified temperature ranges and approved manufacturers products.

.2 INSULATION IDENTIFICATION SYSTEM

.2.1 A system has been established which identifies the specific insulation type, insulation thickness, and insulation finish for each service indicated in the Contract Drawings. The specific insulation type, insulation thickness, and insulation finish is linked by the service number as listed in the "Piping Insulation Service Group Index" which appears in this Section. In addition, the insulation group only is listed in the "Piping, Gasket, Insulation, and Service Group Index" in Section 33 63 10 – COMMON WORK RESULTS FOR PIPING. See that Section for an example.

.2.2 Where insulation is scheduled for a pipe system below, insulation is required regardless of whether or not the letter designation for the insulation group is specifically called out on the pipe line description in the Contract Drawings. In some cases, a different amount of Insulation may be required for a piping line than what is specified in the indexes. In these cases, the required insulation group will be changed and called out on the pipeline description on the Contract Drawings and its corresponding thickness shall prevail.

.3 PIPING INSULATION SERVICE GROUP INDEX:

.3.1 PIPING INSULATION SERVICE GROUP INDEX – FOR PIPING LOCATED IN TRENCHES AND STEAM AND CONDENSATE MANHOLES

SERVICE	LINE DESCRIPTION	INSULATION GROUP	INSULATION FINISH	SERVICE GROUP ON DWGS
EQUIPMENT	50 PSIG at 212°F Max.	N/A	N/A	PED
DRAIN, PUMPED	Sump Pump Discharge in Trenches			
CONDENSATE, HIGH PRESSURE	200 PSIG at 600°F Max., from HPS to PC System	E	AA	HPR
CONDENSATE, PUMPED	200 PSIG at 388°F Max., Returned Condensate from Campus and Manhole Pumps to Plant	C	AA	PCR
STEAM, HIGH PRESSURE	200 PSIG at 600°F Max., HPS Campus Distribution	E	AA	HPS

.3.2 PIPING INSULATION SERVICE GROUP INDEX – FOR PIPING LOCATED IN TUNNELS AND VAULTS

SERVICE	LINE DESCRIPTION	INSULATION GROUP	INSULATION FINISH	SERVICE GROUP ON DWGS
EQUIPMENT DRAIN, PUMPED	50 PSIG at 212°F Max., from Sump Pump Discharge in Trenches	N/A	N/A	PED
CONDENSATE, HIGH PRESSURE	200 PSIG at 600°F Max., from HPS to PC System	J	CC	HPR
CONDENSATE, PUMPED	200 PSIG at 388°F Max., Returned Condensate from Campus and Manhole Pumps to Plant	H	CC	PCR

STEAM, HIGH PRESSURE	200 PSIG at 600°F Max., HPS Campus Distribution	J	CC	HPS
CHILLED WATER	150 PSIG at 140°F Max., CWS & CWR Campus Distribution	A	AA	CWS & CWR

.4 INSULATION THICKNESS SCHEDULE: Nominal insulation thickness shall be as follows:

Insulation Group	**A**	**B**	**C**	**D**	**E**	**J**
PIPE TEMPERATURE (°F)						
Pipe Size	**32 to 199**	**200 to 299**	**300 to 399**	**400 to 500**	**500 to 600**	**500 to 600**
1/2"	1	1-1/2	1-1/2	1-1/2	2	1-1/2
3/4"	1	1-1/2	1-1/2	1-1/2	2	1-1/2
1"	1	1-1/2	2	2	2	2
1-1/4"	1	1-1/2	2	2	2	2
1-1/2"	1	1-1/2	2	2	2	2
2"	1	1-1/2	2-1/2	2-1/2	2-1/2	2-1/2
2-1/2"	1	1-1/2	2-1/2	2-1/2	2-1/2	2-1/2
3"	1-1/2	1-1/2	2-1/2	2-1/2	2-1/2	2-1/2
4"	1-1/2	1-1/2	3	3	3	3
6"	2	3	3	3	3	3
8"	2	3	3	3	4	4
10”	2	3	3-1/2	3-1/2	5	4
12”	2	3	3-1/2	3-1/2	5	4
14”	2	4	3-1/2	3-1/2	6	4

16”	2	4	3-1/2	3-1/2	6	4

Note: Insulation thicknesses listed are nominal thickness in inches.

.5 PIPE INSULATION GROUP SPECIFICATIONS

.5.1 General: Provide pipe insulation as specified below as dictated by the "Piping Insulation Service Group Index". Provide removable/reusable blankets in accordance with Insulation Group "R".

.5.2 Groups "A" Through "E" - Pipe Insulation:

.5.2.1 Insulation shall be 100 percent rigid cellular glass, totally inorganic, with no binder. Absorption of moisture shall be 0.2% or less per ASTM C240. Water-vapor permeability shall be 0 perm-in per ASTM E96. Average compressive strength shall be 90 psi ASTM C165. Average density shall be 7.5 lb per cubic foot per ASTM C303. Maximum service temperature shall be 900°F. Thermal conductivity shall be no greater than 0.29 Btu-in/hr-Ft^2 - °F at mean temperature of 75°F per ASTM C177 and C518. The insulation shall conform to ASTM E84 (5 Flame, 0 Smoke). Linear expansion shall be 3 inches per 100 linear feet at 600°F. Insulation shall be fabricated in half sections wherever possible. For large diameter piping where half sections are not practical, curved side wall segments are preferred. Provide double layer system with staggered joints for all systems where pipe temperature is listed as 400°F or greater.

.5.2.2 Fittings and valves shall be insulated with the same insulation system and built-up to the same thickness as the insulation for the adjoining pipe in accordance with insulation manufacturer's instructions.

.5.2.3 Provide insulation from one of the following manufacturers and product trade names:

Manufacturer	**Trade Name of Approved Product**
Pittsburgh Corning	FOAMGLAS

.5.2.4 Provide insulation with thickness as specified in Paragraph "Insulation Thickness Schedule".

.5.2.5 Pipe surfaces shall be clean and dry prior to insulating. Insulation may be temporarily held in place with stainless steel wire or fiber

reinforced tape overlapped a minimum of 6 inches prior to the insulation finish being installed. The tape and/or wire may remain on the insulation beneath the insulation finish.

.5.2.6 The finish shall be as designated in "Piping Insulation Service Group Index" and specified in this Section.

.5.3 Group “J” – Pipe Insulation:

.5.3.1. Insulation shall be molded sections of inorganic silicate (calcium or sodium) or expanded perlite. The insulation shall conform to ASTM C533 - Type 1, ASTM C795, and ASTM E84 (0 Flame, 0 Smoke). The calcium silicate shall have a maximum service temperature of 1200°F, a density of 14 LB per cubic foot, and a thermal conductivity of 0.65 BTU-in/hr-sq. ft. deg F. at a mean temperature of 700°F per ASTM C335. Compressive strength shall be 100 psi to produce 5% compression per ASTM C165. Linear shrinkage shall be less than 1%. This insulation shall be certified by the manufacturer not to accelerate stress corrosion off stainless steel pipe and shall conform to ASTM C795.

.5.3.2. Fittings and valves shall be insulated with the same insulation system and built-up to the same thickness as the insulation for the adjoining pipe in accordance with insulation manufacturer's instructions.

.5.3.3. Provide insulation from one of the following manufacturers and product trade names:

Manufacturer	Trade Name of Approved Product
National Insulation Group, LLC	Thermo-12 Gold
Nesa Insulation (Formerly Pabco)	SUPER CALTEMP GOLD

.5.3.4. Provide insulation with thickness as specified in Paragraph "Insulation Thickness Schedule".

.5.3.5. The insulation shall be certified by the manufacturer not to accelerate stress corrosion of stainless steel pipe and shall conform to ASTM C795.

.5.3.6. The finish shall be as designated in “Piping Insulation Service Group Index” and specified in this Section.

.5.3.7. The insulation shall be applied in double layers since line temperatures are 600°F and greater as required to make up the thickness as specified in Table: "Insulation Thickness Schedule".

.5.4 Pipe Insulation from glass fiber specifications can be referenced in BDS 40 07 00. Division 40 of the OSU BDS has not been published, therefore, the project A/E shall contact the applicable operator (OSU or OSEP) project lead for specific insulation details.

.5.5 Group "P" – Pipe Insulation:

.5.5.1 Pipe insulation on steam and condensate may be this type where pipes are close together which may present interference with the standard specified insulation type and thicknesses. Insulation thicknesses may not be reduced where potential interferences exist and therefore this insulation thickness must be considered. Potential interferences are called out on the drawings. If other potential interferences exist, notify the University and the Engineer for approval prior to using this insulation system.

.5.5.2 Insulation shall be Aspen Aerogels, Inc. Pyrogel XT with minimum 11 lb/ft density with k value of 0.26 Btu-in/hr – ft^2 –°F at a mean temperature of 330°F. Thickness shall be 2" for 16" HPS, 1 1/2" for 12" HPS, 1" for 10" HPS, 3/4" for 8" PCR, 1/2" for 6" and 4" PCR.

.5.5.3 Fittings and valves shall be insulated with same insulation and built up to the same thickness.

.5.5.4 Provide an aluminum jacket with aluminum bands as specified for other systems in this section.

.5.6 Group "R" – Removable/Reusable Insulation

.5.6.1 Insulating material shall be tailor-made removable/reusable blankets. The blankets shall be made with a high temperature fiberglass mat without the use of chemical binders and suitable for temperatures up to 1200°F.

.6 PIPE INSULATION FINISH SPECIFICATIONS

.6.1 General: Provide pipe insulation finish as specified below and where stated in the "Piping Insulation Service Group Index".

.6.2 Group "AA" - Insulation Finish

.6.2.1 Steam, High Pressure Condensate, and Pumped Condensate Piping: Provide PITT WRAP jacketing system suitable for 200°F that requires heat fused seal.

.6.2.2 Provide an aluminum jacket over the PITT WRAP as specified below.

.6.2.2.1 Apply directly over the insulation an aluminum weatherproof jacket. This jacket shall be manufactured from aluminum alloy 5005 or 3003 half hard, not less than 0.016-inch thick, fabricated with 3/16-inch corrugations running lengthwise of pipeline. The aluminum shall be factory attached to a moisture barrier of kraft paper treated for this service.

.6.2.2.2 All joints shall be made rain or drip proof. Longitudinal joints shall be located on the side of the pipe with the open edge of the lap turned down to shed water. Circumferential joints on pipes that do not have enough slope to get a good shingle effect to keep water out of the joint shall have the inside end of the lap beaded or sealed with a permanently elastic mastic type sealant designed for this service.

.6.2.2.3 The aluminum jacket shall be secured by aluminum straps 1/2-inch wide by 0.020-inch thick. The straps shall be placed on 12-inch centers (maximum). Each circumferential joint shall have a strap at the midpoint of the lap.

.6.2.2.4 On long radius bends, the aluminum jacket shall be in sections cut on the miter, overlapped, and forming a neat snug fit, using sufficient bands and fasteners to hold jacket properly in place.

.6.2.2.5 All 30-inch diameter and smaller insulated elbows shall be protected with a prefabricated elbow jacket. The jacket shall be manufactured of high purity 0.024-inch aluminum with a suitable moisture barrier on the interior of the jacket to prevent decomposition of the aluminum. The prefabricated elbow jacket shall be applied directly over the insulated fitting.

.6.2.2.6 All insulation on fittings, flanges, valves, and other irregular shaped items on which the aluminum jacket cannot be neatly applied shall be finished as follows:

- Over the smooth insulation surface and cloth reinforcing as described below, apply the mastic in two or more coats at a sufficient rate to provide a dry film thickness of 1/8 inch.
- The mastic shall be applied by trowel or spray. The exact application conditions, procedures and recoat time shall be as recommended by the mastic manufacturer.
- Reinforcing shall consist of a No. 10 mesh nylon or Dynel cloth. Flat surfaces shall be secured to the insulated structure on 18-inch centers maximum.
- The mastic shall be gray or metallic gray vinyl VI-CRYL, CP-10 or CP-11 manufactured by Childers Products Company, or WC-1 manufactured by Vimasco Corporation.
- Upon completion of the work, the Contractor shall furnish the A/E a certificate stating that the mastic has been applied in the same manner as specified or approved by its manufacturer.

.6.3 Group "CC" - Insulation Finish

.6.3.1 Insulation jacket shall be weatherproof aluminum. The jacket shall be manufactured from aluminum alloy 5005 or 3003 half hard, not less than 0.016-inch thick, fabricated with 3/16-inch corrugations running lengthwise of pipeline. The aluminum shall be factory attached to a moisture barrier of kraft paper treated for this service.

.6.3.2 All joints shall be made rain or drip proof. Longitudinal joints shall be located on the side of the pipe with the open edge of the lap turned down to shed water. Circumferential joints on pipes that do not have enough slope to get a good shingle effect to keep water out of the joint shall have the inside end of the lap beaded or sealed with a permanently elastic mastic type sealant designed for this service.

.6.3.3 The aluminum jacket shall be secured by aluminum straps 1/2 inch-wide by 0.020-inch thick. The straps shall be placed on 12-inch centers (maximum). Each circumferential joint shall have a strap at the midpoint of the lap.

.6.3.4 Provide mastic for all insulation on fittings, flanges, valves, and other irregular shaped items on which the aluminum jacket cannot be neatly applied.

PART 3 - EXECUTION

.1 GENERAL INSULATION INSTALLATION

.1.1 General: Install insulation material with smooth and even surfaces. Unless otherwise specified, install insulation materials, accessories, and finishes in accordance with the manufacturer's published recommendations.

.1.2 Fire Precaution: Care shall be exercised by the Contractor that no cutting, welding, or open flames are permitted in the areas where flammable mastics or other materials are used. The precaution period shall extend until the material has cured sufficiently so that no further fire hazard exists.

.1.3 Insulation Release: Before insulation is applied to any piping or equipment, the Contractor shall obtain from the Engineers a written release stating that the item is ready for insulation.

.1.4 Manufacturer's Recommendations: All materials specified herein shall be installed in full accordance with the manufacturer's recommendations for the best performance and durability of his product, notwithstanding any requirements or omissions herein with respect to preparation of equipment before insulating or method of application.

.1.5 Expansion Joints in Insulation: Where necessary, the Contractor shall furnish suitable expansion joints in the insulation to prevent cracking or wrinkling due to expansion and contraction of the surface being insulated.

.1.6 Surface Condition: Do not apply insulation materials until all surfaces to be covered are clean and dry, all foreign materials, such as rust, scale, and dirt have been removed, and surfaces have been painted. Insulation shall be clean and dry when installed and during the application of any finish.

.1.7 Moisture and Vapor Seal: Provide a complete moisture and vapor seal wherever insulation terminates against metal hangers, anchors and other projections through insulation on cold surfaces for which a vapor seal is specified.

.1.8 Asbestos Containing Material:

.1.8.1 No Contractor, Subcontractor, or Supplier shall furnish any asbestos containing material.

.1.8.2 Provide "Asbestos Free" identification labels for insulated piping and equipment as specified in Section 33 63 50 – IDENTIFICATION FOR PIPING AND EQUIPMENT.

.2 INSULATION FOR PIPING

.2.1 General: Installation

.2.1.1 All sectional pipe insulation shall be applied with staggered girth joints tightly butted together as recommended by the insulation manufacturer. Each section of insulation is to be held in place with separate loops of 16 gauge annealed stainless steel wire placed not more than 12 inches on center.

.2.1.2 Insulation shall not be applied to any flanged, machined, or welded surfaces until they have passed all field tests, including hydrostatic, and have been released for insulation.

.2.2 Insulation of Valves, Flanges, Fittings, Etc.

.2.2.1 High maintenance items such as control valves, some flanged valves, flanged joints, strainers and similar type items located in insulated lines shall be insulated with removable/reusable blankets. The Contractor shall insulate all high maintenance items as directed by the A/E with removable/reusable blankets in accordance with Insulation Group “R” of this Section.

.2.2.2 In all insulated lines, with the exception of the high maintenance items which are insulated with blankets, the valve bodies, fittings, and flanges shall be insulated with the same material and the same thickness as the pipe insulation using mitered pipe insulation and/or block insulation securely cemented together. All flange insulation shall be the removable type, but not the replaceable type.

.2.3 Gaps and Terminations: Neatly terminate all insulation at each end of unions and at other points where required and seal. Fill gaps occurring at hangers with insulating cement and finish flush with the adjoining pipe insulation as specified for fittings.

.2.4 Butt pipe insulation against pipe hanger insulation inserts. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 inch wide vapor barrier tape or band.

.3 PAINTING AND IDENTIFICATION

.3.1 Aluminum jackets shall not be painted. Paint all glass canvas jacket insulated surfaces Section 33 63 50 – IDENTIFICATION FOR PIPING AND EQUIPMENT.

.3.2 Provide identification labels and tags for all piping systems and equipment as specified in Section 33 63 50 – IDENTIFICATION FOR PIPING AND EQUIPMENT.

.3.3 Do not insulate or paint over factory attached nameplate labels on equipment, valves, and other devices.

33 70 00. ELECTRICAL UTILITIES METERING

PART 1 GENERAL

.1 APPLICATIONS:

.1.1 The objective of this design standard is to outline the requirements of electric meters.

.1.1.1 The permanent building meters in buildings on the Columbus campus utilized by The Ohio State University shall communicate this consumption to a local display and to the campus-wide Energy Metering & Monitoring system (InStep eDNA server). The electric meter shall include the instantaneous kilowatt rate.

.1.1.2 A meter with system display is required for each Main and Distribution feeder circuit. The metering device and its display may be mounted on the Feeder Breaker or its associated Metering compartment. Additional duplicate metering shall be displayed on the Substation main control boards associated with the Main Transformers and their MV transformer Secondary feeders and report its information back to the campus distribution monitoring system, (ION Enterprise).

.1.2 The electric meter, elements and devices shall meet custody transfer measurement requirements. Custody transfer measurement furnishes quantity and quality information which can be used as the basis for a change

in ownership and/or a change in responsibility for materials, e.g., billing for rate of energy demand plus totalized energy transfer.

.1.3 All Primary System Meters, potential and current transformers shall be of utility acceptable quality and accuracy, and shall be considered the property of OSEP once placed in services. An engraved name plate displaying potential transformer primary and secondary voltage ratings and current transformer primary and secondary current ratings shall be installed below the meter.

.1.4 If complete meter setup cannot be done from the front panel, any required software, cables, and keys shall be provided to OSEP.

.1.5 As a standard feature on all secondary metering, with the exception of temporary construction meters, a 4-pole GE PK-2 panel-mounted test block and 4 pole current test plug shall be installed flush on switchgear for portable test metering connection and use by OSEP personnel. Current transformer poles shall have shorting auxiliary contacts and all CT wiring shall be on shorting type terminal blocks. (See Figure 5 for typical connection diagram).

.1.6 If the meter used for kWh reading does not have a meter serial number on the front of the display, then an engraved name plate shall be installed below the meter displaying the meter serial number.

PART 2 PRODUCTS

.1 Distribution Metering – Revenue

.1.1 Feeder/Distribution metering serves the dual purpose of providing instantaneous values of feeder operating conditions and provides trending, logging and historical data for planning and operations use over a secure OSEP data acquisition network.

.1.1.1 The monitor shall provide the following information:
.1.1.2 Voltage (kiloVolts) - phase to neutral and phase to phase ABC
.1.1.3 Current (kiloAmps)- line and neutral (residual) ABCN
.1.1.4 Kilowatts (kW)
.1.1.5 Kilowatt hours (kWh)
.1.1.6 Kilo-vars (kVAR)
.1.1.7 Kilo-voltamperes (kVA
.1.1.8 Voltage maximum and averages over 15-minute intervals
.1.1.9 Current Maximum and averages over 15-minute intervals
.1.1.10 Kilowatt maximum demand based on 15-minute intervals
.1.1.11 Kilo-voltampere maximum demand based on 15-minute intervals
.1.1.12 Power Factor
.1.1.13 Transient waveform capture
.1.1.14 Power Quality measurements, logging and trending

.1.2 Permanent Building/System Metering – Revenue

.1.2.1 The monitor shall provide the following information:

.1.2.1.1 Voltage – phase to neutral and phase to ABC
.1.2.1.2 Amps – present reading and 15-minute maximum demand ABCN
.1.2.1.3 Kilowatt-hours
.1.2.1.4 Kilowatt maximum demand base on 15-minute intervals
.1.2.1.5 Power Factor, Kilo VAR, Kilo VAR Hour, KVA

.1.2.2 Avoid metering schemes that are only capable of measuring partial loads connected to the distribution system or electrical apparatus being monitored. Specify that a meter shall be installed to measure electrical load from the distribution system, including, but not limited to fire pumps.

.1.2.3 Primary Service (customer) metering shall be performed by metering installed on the low voltage side of the Primary Transformer, before or after the Secondary main feeder circuit breaker or fused disconnect.

.1.2.4 Meters will be specified to operate from -20°C to +60°C in environments up to 95% Relative Humidity (non-condensing).

.1.3 Construction Metering – Revenue

The prime construction contractor shall provide one kW-hr meter suitable to record the total electrical consumption of the construction site. The contractor is responsible for the proper connection and installation of the meter and associated sources of current and potential. OSU and OSEP support an application process that the Contractor must follow as indicated herein.

.1.3.1 Meters shall be maintained accessible to and will be read by University Personnel. Failure to place a proper functioning meter into service prior to drawing electrical load will result in electrical usage charges that are estimated by the University based on the greater of the first full month of properly metered service or an estimate by OSEP of likely usage based on worst case connected load for the period, whichever is greater. OSEP reserves the right to refuse new electrical service to any site not metered in accordance with design standards. Dysfunctional metering installation/systems are subject to estimated billing and back charges.

.2 CERTIFICATIONS

.2.1 All devices shall be certified to be used the way it is being applied meeting all local and governing building codes.

.2.2 Provide “Certificate of Compliance and Calibration” for each meter, which provides test tracing back to (NIST).

.2.3 Provide IEC 60687 Class 0.5S and ANSI 12.20 Class 0.5 accuracy.

.3 COMMUNICATIONS

.3.1 Distribution Metering

.3.1.1 Each individual kW-hr meter specified must have communications capability. The communications shall be MODBUS RTU TCP/IP Ethernet over single mode fiber to medium voltage gear, to satisfy the information flow requirements to the OSEP ION Enterprise meter data collection system. The final design configuration shall be determined by OSEP.

.3.2 Permanent Building/System Metering

.3.2.1 Each individual kW-hr meter specified must have communications capability. The communications shall be MODBUS RTU TCP/IP Ethernet over CAT6 cable to the campus-wide Energy Metering & Monitoring system (InStep eDNA server). The final design configuration shall be determined by OSEP.

.4 WARRANTY TERMS

.4.1 THE SUPPLIER/MANUFACTURER OF THE ABOVE SPECIFIED EQUIPMENT shall guarantee for twenty-four (24) months from equipment startup or thirty (30) months from date of shipment, whichever occurs first, that the equipment shall be free from defects in design, workmanship or materials.

.4.2 In the event a component fails to perform as specified or is proven defective in service during the warranty period, the contractor shall promptly repair or replace the defective part at no cost to the University.

.4.3 The manufacturer or contractor shall furnish OSEP with an installation, operation and maintenance manual for the electric meter and all its components.

.5 ELECTRIC METER MANUFACTURERS AND MODELS

.5.1 Low voltage building meters

.5.1.1 Shark 100 or Eaton IQ 150 meter with fused control transformer. (See Figure 5).

.5.1.2 Schneider PM5330 or PM5340

.5.1.3 Other models and manufacturers require submittal by the A/E and approval by OSEP before including in the Design Development Documents

.5.2 Medium voltage metering

.5.2.1 Schneider Electric, PowerLogic model ION7600 series meter with fused control transformer or with its power supplied from the meter potential transformer fused secondary. The 125 VDC power supply is the preferred option if a reliable DC source is available. Meter shall use Ethernet communications over CAT-6 Industrial grade, bonded and shielded Ethernet cable.

.5.2.2 Other models and manufacturers require submittal by the A/E and approval by OSEP before including in the Design Development Documents

.6 SHORTING BLOCKS

.6.1 A 4-pole GE PK-2 panel-mounted test plug.

.6.2 Other models and manufacturers require submittal by the A/E and approval by OSEP before including in the Design Development Documents

PART 3 EXECUTION

.1 INSTALLATION

.1.1 Follow manufacturer's guidelines and submit installation drawings to OSEP for review and approval prior to installation.

.1.2 The Contractor shall give OSEP 10 working days' notification by calling Service2Facilities at 614-292-HELP prior to the installation of the electric meter for assistance in following the manufacturer's installation specifications such as, but not limited to, location of the meter components, Ethernet connection, electrical connections, local disconnect, enclosure type, and all other applicable issues.

.1.3 Work performed without the assistance of the manufacturer's technical erection supervisor and/or OSEP shall adhere to dimensional requirements, assembly methods, and installation procedures specified herein and in the manufacturer's instruction manuals and drawings.

.1.4 The Contractor shall comply with all erection and installation methods, techniques, sequence, and procedures requested by the manufacturer's representative and/or OSEP.

.1.5 Where manufacturer's written instructions differ significantly from those proposed by the manufacturer's representative, OSEP shall determine the method used.

.1.6 All conduit and conduit connections shall meet the design and installation standards applicable for the installation area.

.1.7 Installation services shall include all conduit and wiring to provide a fully functional meter and communication wiring to the building Ethernet switch. Connection of Ethernet communication cable at the building Ethernet switch shall be coordinated through OSEP. If necessary, Cat-6 bonded and shielded Ethernet cable or single mode fiber and conduit shall be installed between the electric meter and the nearest building network switch.

.1.8 In cases where more than one meter is to be installed in a building, the contractor shall provide a Hirschmann or Sixnet managed switch to aggregate all Ethernet connection with one uplink to the building switch.

.1.9 Panel/Meter IP and MODBUS addressing shall be assigned by OSEP.

.1.10 MODBUS data registers shall be provided, at a minimum, for instantaneous kW rate, and totalized value.

.1.11 All meters and ancillary equipment shall be installed in such a manner as to provide access for routine inspections, maintenance, and a means of removal.

.1.12 All anchors and structural steel supports shall be built to template and reinforced as required for loads imposed on them.

.1.13 The height of the meter display shall be five feet (5.0') from the finished floor or 4-½ feet from the floor elevation to the center of the meter if mounted on a vertical panel or cabinet. If mounted in switchgear, the meter display should be mounted at a height that facilitates meter access and viewing.

.1.14 The meter compartment shall not have any bus exposure.

.2 TRAINING

.2.1 The supplier/manufacturer shall train OSEP personnel to program, calibrate, operate and maintain the above-mentioned devices for at least 3 hours. Training shall be scheduled within two weeks of completion of the installation.

.3 INSPECTION AND COMMISSIONING

.3.1 A representative of OSEP will inspect the installation and performance of the electric meter for acceptance and approval before commissioning. OSEP reserves the right to witness factory testing and calibration.

.3.2 Provide for review of required closeout documentation.

.3.3 Provide for review, of wiring schematics with point to point wiring diagrams in AutoCAD .dwg format.

.3.4 Document and provide for review, all electrical power sources with breaker and panel numbers.

.3.5 Electric meters shall be commissioned, and a commissioning record document shall be issued identifying each meter by its serial number and location and confirming its correct installation and function.

.3.6 Electric meter commissioning shall be a joint effort between the project's Contractor, A/E and/or Commissioning Agent, and OSEP. Electrical service will not be connected or reinstated by OSEP until installation of the electric meter is inspected by OSEP and found to meet the requirements of the electric meter manufacturer and these design and installation standards.

33 71 00. ELECTRICAL UTILITY TRANSMISSION AND DISTRIBUTION

33 71 26. TRANSMISSION AND DISTRIBUTION EQUIPMENT

.1 MAIN SUBSTATION(s) POWER DISTRIBUTION

.1.1 Bulk electrical power is delivered to the University at 138,000 Volts. The University transforms this power down to 13.6 kV at the main substation(s) bus(es), which in turn then distributes it to Primary feeder pairs that traverse the campus. See Figure 1 for overall MV Distribution system layout and nomenclature. All permanent buildings, and building complexes, and construction temporary power are provided with service drops from both circuits of a feeder pair through one or more primary switches. These switches allow the buildings to be switched between primary feeders when feeders need to be de-energized for construction work, maintenance, or due to failure. Each building or building complex has one or more transformers fed from the primary switches through a variety of switch and secondary feeder

arrangements designed to suit the specific needs of the buildings. See Figure 2 for typical Primary Service arrangements.

.1.2 Primary service is generally restricted to significant 3 phase loads. The number of primary services on any given feeder pairs must be limited for reliability reasons and to ensure that circuit feeders can be quickly isolated and restored after experiencing a circuit failure. Preference is given to providing primary service switches that can separately switch multiple building loads from one primary service tap.

.1.3 Buildings are assigned a normal and an alternate feed. This assignment may be changed by UTHVS to meet the needs of the High Voltage system. The alternate feed is not a "Back-up" feed. Circuits are routinely removed from service to accommodate construction needs, maintenance and repair of cable and switches. The practice of assigning a "Regular" and "Backup" building feed is generally prohibited Certain campus circuit pairs have designated "third feeders". In such instances, some buildings fed from the circuit pair will have an assigned "Regular" feed and a "Backup" from the associated third feeder.

.1.4 Some of the larger buildings or building complexes are equipped with third feeders and a set of two Primary Select switches. This design allows a "Switched Primary" feeder pair to be run throughout the building or building complex. This arrangement provides extra switching flexibility and greater failure tolerance.

.1.5 Some Feeder pairs have a set of two Primary select switches feeding branch circuits with a switched pair of feeders. This feature is provided to reduce switching time and aid in location of system faults. See Figures 2 and 3.

.1.6 Third Feeders have been added to the MV Distribution system to increase feeder capacity and improve system reliability and availability. See Figure 3

.1.7 The addition of Dual Primary Select switches with switched primary pairs along with the third feeders will ultimately increase Feeder Protection selectivity and support automation of the Campus electrical distribution system while reducing the time it takes to locate, isolate and transfer campus loads in the case of feeder failure.

.2 Columbus Campus Primary voltage: The available underground primary distribution voltage is 13.2 kV volt 3-wire, 3-phase, 60-cycle. This system is a solidly grounded Wye system.

.3 Regional Campuses Primary voltage: While the University strives to maintain a level of consistency between regional campuses, each campus is unique. Consult the UTHVS or TSG for specifics of the power distribution systems at Regional Campuses.

33 71 49 MEDIUM VOLTAGE DISTRIBUTION SYSTEM

.1 EXTERIOR UNDERGROUND RACEWAYS:

.1.1 All underground cables of any classification shall be installed in approved duct raceway systems. The number and size of conduits depend on the service classification and are designed to meet the electrical system and facility needs. See Figure 4 for typical Primary duct bank configurations.

.1.2 Direct burial of underground cables is prohibited.

.1.3 Cold bending of PVC conduits is prohibited.

.1.4 New raceway installations shall be designed for future capacity addition.

.1.5 Additional spare ducts shall be included as required by the University to afford spare ducts for failure or circuit additions. Duct banks that are intended to carry Primary circuits shall be provided with enough spare ducts to accommodate a minimum of one additional circuit pair. Duct banks intended to carry lateral building feeder taps shall be designed with a minimum of one spare duct per duct bank.

.1.6 Raceway ducts within duct banks for Primary cables shall be schedule 40 PVC conduit. PVC conduit shall be adapted to rigid steel conduit beginning at ten feet (10') before entrance to outside of building foundations.

.1.7 PVC conduit shall be adapted to rigid steel conduit beginning at ten feet (10') before entrance into manholes. This requirement may be waved with the written approval of UTHVS in specific instances where adequate structural integrity can be demonstrated and where the duct bank design uses the added reinforcement and is four or more 6” ducts high by two wide. Raceways shall be encased in concrete as Primary duct bank.

.2 PRIMARY DUCT BANKS

.2.1 Raceways for primary electric shall be encased in a reinforced concrete (3" minimum cover) envelope. The standard size for primary electric ducts shall be 6 inches for Primary mains, and 5 inches for Primary building laterals and Primary load ways.

.2.2 Ducts for Primary mains shall be placed on 9 1/2-inch centers for 3-inch spacing between power ducts. Ducts for Primary laterals and Primary load ways shall be in duct banks with power ducts placed on 8 1/2-inch centers for 3-inch spacing between power ducts. Primary mains shall contain a minimum of six 6-inch diameter schedule 40 PVC power ducts and two concentrically located 2-inch diameter schedule 40 PVC ducts provided for ancillary use. Primary laterals and Primary load ways shall contain a minimum of four 5-inch diameter schedule 40 PVC power ducts and one concentrically located 2-inch diameter schedule 40 PVC conduit provided for ancillary use. Carlon Snap-Loc Spacers, or approved equivalent, supported on concrete or ceramic blocks shall be placed at eight (8) ft intervals. See Figure 4 for duct bank details.

.2.3 Ducts shall be installed below the frost line at a minimum thirty (30) inches below finished grade and shall be sloped to drain into manholes.

.2.4 Multiple parallel duct bank installations shall observe a minimum horizontal spacing of two (2) feet of soil, thermally conductive sand or compacted 304 aggregate. This provision does not apply to duct bank crossings with an acute angle of greater than 30 degrees.

.2.5 Two longitudinal steel reinforcing bars with a minimum of 18-inch overlap shall be used for each layer of duct in all duct banks. In instances where the duct bank crosses a roadway or high vehicle traffic area, two additional steel reinforcing bars shall be provided at the top and bottom of the bank to assist in distributing the load. Ducts shall be bundled and tie-wired to assure integrity of the duct array during pour. Concrete shall encase the duct bank installation a minimum of 3-inches on all sides. Provide one (1) #5 steel reinforcing bar for each conduit in the duct bank). Tie off the reinforcing bars to the plastic supports holding the conduit in place. Allow for a minimum of 2” of concrete over the reinforcing. Concrete envelopes shall extend through foundation and manhole walls designed so that the envelope becomes a structural member providing support for bridging the area that has been excavated and back filled for foundation or manhole walls. Encasement concrete shall be City of Columbus CMS 499 Class C, 4000 psi @ 28 days.

.2.6 Tear tape shall be placed approximately one foot above the duct bank when being backfilled.

.2.7 Elbows shall be long-radius rigid steel conduit.

.2.8 End Bells shall be PVC End bells on conduit entering a building or manhole shall have their broader opening mounted flush with the interior surface of the wall penetrated by the duct.

.2.9 Duct banks of 6 or more ducts should avoid crossing an area with an unfavorable thermal environment (i.e., crossing steam pipes, parking lots) as such cable installations may require de-rating.

.2.10 Ducts banks shall not pass within 10 feet of a buried steam line in any direction. If it becomes necessary to cross a steam line, acceptable insulation of the crossing must be provided and approved by UTHVS.

.2.11 Primary ducts banks shall cross gas lines below the gas piping without exception.

.2.12 Primary voltage cable within a building shall be installed in rigid steel conduit with UL approved steel pull boxes. Label conduit every 10 feet and pull boxes shall be labeled "DANGER 13,200 VOLTS".

.2.13 Cable or conductor bending radius shall not be less than eight times the overall diameter for non-shielded cable and twelve times the diameter of shielded cable during or after installation. On systems operating above 1 kV to ground, cables installed in nonmetallic conduit shall have an effectively grounded shield, and one 4/0 single conductor 600 V insulated ground wire run with the three-phase circuit in the same conduit.

.2.14 Primary cable ducts between manholes or other terminal points shall be as straight as practical. All bends shall be "sweep" bends and any bend greater than ten (10) degrees per ten (10) foot length of duct, shall be made with rigid steel conduit. Where possible, duct banks shall be run straight from manhole to manhole; where bends are necessary, the total shall not exceed 90 degrees in addition to any turn up at the pad or equipment.

.2.15 Layout: Primary duct banks shall be a maximum of two ducts wide by four ducts high. Exception may be taken on a case-by-case basis for accommodation of site specific issues and to address special circumstances of loading or for instances where duct installation is by boring or other means where a rectangular array is not practical. All requests for exception must be approved in advance of installation by UTHVS.

.2.16 For final preparation, a properly sized steel mandrel shall be pulled through all new or repaired ducts. Mandrel shall be ¼" to ½" smaller in diameter than the duct; this shall be a test witnessed by UTHVS. Each duct shall be proved clear and usable, cleaned, have a No. 12 type TW pull wire left in place, and spare ducts shall have duct plugs installed.

.2.17 Color Additive: Concrete for Primary duct banks shall have a red color additive mixed in the concrete for identification. Specify Solomon 417 Apple Red; suggested mix approximately three and a half pounds (3-1/2 lbs.) per 80 pounds of cement to provide identifiable red color as warning to any one

digging into the high voltage cable run. The concrete supplier shall premix concrete. Color additive shall not be hand-troweled in and shall not be sprinkled.

.2.18 A member of UTHVS shall inspect and approve primary ducts before concrete is poured. A member of UTHVS shall witness the concrete pour.

.2.19 Excess concrete shall not be placed in the hole or used to raise the top of the duct bank greater than 3 " above the top of the ducts. Duct banks shall be a continuous pour from bottom to top. Concrete shall be poured and compacted so as to avoid inclusion of air pockets or areas where concrete doesn't completely cover ducts and reinforcements. Remove all excess concrete from University property.

.2.20 Soil may be used to backfill duct bank excavations provided they are not in streets or where recurrent heavy surface loadings are anticipated. High traffic and heavy load areas must be backfilled with ¾" crushed stone or CDF with a covering layer of compacted soil or gravel and resurfaced to original wear surface.

.2.21 MV electrical duct banks are not to be routed under buildings or through locations where subsurface conditions are unsuitable or where major construction is anticipated that could destabilize adjacent soils and place the duct bank and the Primary circuits contained in jeopardy.

.3 MANHOLES

.3.1 Manhole specifications in this section apply to all new manholes as well as existing manholes with new cabling.

.3.2 Manholes shall not be installed inside buildings or in areas of public assembly.

.3.3 All medium voltage manholes or vaults shall have High Voltage Line and Utility truck access. It is common practice to place vaults under Primary switches to facilitate cabling and to allow for a lower switch profile. Such vaults follow the design for manholes and are constructed with not only manhole cover access but also an opening for cable entrance directly from the vault area into the bottom of the Primary switch enclosure.

.3.4 Manhole covers shall be round, 32-inch diameter, heavy duty, traffic rated (H20) with the word "ELECTRIC" cast in cover as applicable. Covers shall not have gaskets or be bolted down. Two slots, on opposite edges, shall be provided to permit using manhole hooks to remove cover.

.3.5 Flame Proofing: Cables in manholes, vaults, cable spreading areas, and at conductor terminations where more than one Primary Circuit is present shall be flame proofed with tape (3M #77l). Control cables and fiber optic cables shall also be flame proofed in manholes, vaults and cable spreading areas where power cables are present and can pose a threat if faulted.

.3.6 Cables in manholes shall be tagged with phase and feeder numbers marked using 1" x 3" plastic tags with 1/2" high by 1/16" thick engraved lettering (black on white).

.3.7 Primary Cables to the Transformers and Switches: Cables going into buildings from manholes shall be marked with the building's name for identification using plastic with engraved 1/2" high by 1/16" thick lettering (black on white).

.3.8 Manholes shall be located and sized to allow workable pulling tension on cables and other considerations in planning. Minimum inside measurement of the medium voltage compartment shall be 6’ wide by 10’ long by 7’ high. Maximum spacing between successive manholes shall be 400’ measured along the length of the duct bank. Throat and manhole overall depth shall be limited to facilitate cable pulling activity and limit the risk of injury from falling. (48” throat and overall depth to floor from finished grade of 16’)

.3.9 Access shall not be less than a 32-inch round chimney equipped with removable steel ladder placed in each manhole.

.3.10 Hardware shall include pulling eyes in each wall opposite of a duct bank at 3’ above finished floor and the center of the floor, inserts, and cable racks. Racks shall be Underground Devices CR 36 brackets with RA 14 or RA 20 support arms Hardware to be secured by stainless steel fasteners.

.3.11 At least one 5/8" diameter by 10' long driven copper-clad steel ground rod shall be installed in each manhole 6 inches from a wall.

.3.12 A 1" x 1/4" copper ground bus shall be placed around the perimeter of the manhole walls 6" from the ceiling for bonding all cable shields. Connect to ground rod with 4/0 copper cable. Connect manhole reinforcing steel, duct bank reinforcing steel and manhole metal hardware with #2 copper cable. Use Cadweld® for ground connections.

.3.13 All electrical ducts entering manhole shall be perpendicular to the manhole wall and shall be at least a minimum of ten feet (10 ft.) straight from the manhole wall. All ducts banks shall enter manhole within one foot of a corner. Do not center manhole on duct bank.

.3.14 End bells shall have their wide end positioned flush with the interior of the manhole wall.

.3.15 Provide a sump hole in manhole floor in area below cover. Slope floor to sump.

.3.16 Manhole covers shall be at finished grade. The ring and cover shall be centered over chimney.

.3.17 In applications where the duct bank employs a four or more high by two wide 6" duct design, Utilities UTHVS, as stated in previously in paragraph 33 71 49.1.6, may permit the duct bank to enter manholes without the requisite ten foot steel conduits and the use of cast steel end bells. This may be permitted in instances where the duct bank approach to the manhole is straight for ten feet or more and the intersection of the duct bank and manhole is at right angles.

.4 WIRE AND CABLE

.4.1 Copper conductors of 98 percent conductivity shall be used unless use is restricted by Government Agencies. Aluminum conductors are prohibited.

.4.2 COLOR CODING

Color coding for 13.2 kV cables and 5 kV cables shall be as follows:

Phase	Voltage 13.2 kV and 5 kV
(Each with identifiable colored stripe)	
Neutral	White or Gray
A	Brown
B	Orange
C	Yellow
Equipment Ground	Green, Black

.5 PRIMARY VOLTAGE CABLES (13,200 Volt)

.5.1 The insulation must be compounded and mixed by the cable manufacturer in its own facilities using a closed, clean process to ensure maximum control and continuity of quality. The strand shield and insulation shield shall be extruded, semi-conducting thermosetting material that is compatible with the insulation.

.5.2 Cable shall be suitable for normal installation in conduit and shall be suitable for continuous submersion in water. The cable shall be capable of continuous operation in both a wet or dry environment at a conductor temperature of 105°C in normal operation, 130°C in emergency overload operation, and of 250°C in short-circuit operation.

.5.3 Main feeders in the Columbus campus power system shall be a minimum of 500 kcmil 4/0 cables shall be used for the laterals and load ways from the primary circuit taps into a building for each primary selective switch pair. Some circuit pairs have associated "Third Feeders" which are designed to back up multiple feeder pairs. Where applied, these circuits shall be conductored with 750 kcmil cable from the source CB in the Main substation to its end. Laterals to individual Primary switches are 750, 500, or 4/0 depending on the individual service requirements. In instances where building services are 1500 kVA or less, individual load ways may be sized #2 AWG or the standard 4/0. Any load way less than 4/0 must be designed to accommodate a replacement 4/0 cable including the duct bank housing the conductors.

.5.4 Only cables from companies with an established reputation and an excellent track record in the medium voltage power cable manufacturing industry shall be installed in primary system applications.

.5.5 13,200-volt primary feeder and service cables shall be UL Listed and from a list of manufacturers approved by UTHVS.

.5.5.1 One compact conductor per ASTM B496 or compressed soft-annealed copper per ASTM B-3, stranding per ASTM B-8.

.5.5.2 220 mil Ethylene Propylene Rubber (EPR) insulated, 15 kV, 133% rated, MV 105°C cables.

.5.5.3 The shields shall be uncoated 5 mil bare copper tape applied helically over the insulation with a minimum overlap of 25 percent of the tape width.

.5.5.4 The jacket shall be continuously extruded, 80-mil, 'low-smoke (Critical Temperature Index > 240°C) zero halogen'.

.5.5.5 Cable construction shall comply with the latest requirements of ICEA S-93-639/NEMA WC-74.

.5.5.6 Under limited circumstances and on a case by case basis, where risk to personnel and equipment is considered to be minimal, the requirement for a zero halogen jacket may be waived with Utilities (UTHVS) approval. Utilities maintains a listing of approved MV cable suppliers and approved cable jacket materials and constructions.

.5.6 Each primary circuit shall have the power conductors arranged in a three-phase array sharing a common duct. Each 3-conductor array shall include within its duct a 4/0, 600 volt insulation class ground wire bonded to all splices and terminations and grounded in substation(s) and manholes.

.5.7 Primary circuits comprised of multiple conductors per phase shall have the power conductors arranged in three phase arrays in multiple ducts. Each 3-conductor array shall include within its duct a 4/0, 600 volt insulation class ground wire bonded to all splices and terminations and grounded in substation(s) and manholes

.5.8 Phase rotation of primary service termination shall be established prior to termination. Phase positions at terminating equipment shall be Phase "A", "B", and "C" left to right facing the front, or "A", "B", and "C" front to rear. Circuit phasing shall be from the Substation to the point of splicing/termination and be performed with the assistance and under the observation of an UTHVS representative.

.6 SPLICING AND CABLE TERMINATIONS

.6.1 Cables shall be spliced and wrapped around 360 degrees at all manholes. Cable shall not be pulled through manholes without a splice.

.6.2 All work performed on non-lead, medium voltage (1 kV to 35 kV) cables shall be performed by personnel with adequate training and experience and certified as qualified by the UTHVS. To be considered qualified for cable splicing, the individual's employer must submit a resume with past training and experience supported by documentation of their having had the appropriate formal training in the preparation of relevant medium voltage splices and terminations prior to the individual performing any work. Splicing and termination experience shall be recent (one to five years depending on extent of prior experience) and relevant to the type of splice and cables being spliced.

.6.3 Add label, which is applied to each phase wire where all terminations and splices occur. Every splice shall be labeled with an engraved plastic tag (black on white) containing the following information:

- Date of splicing
- Name of company that performed splicing; this shall include both lead and non-lead splices.

- Label shall include phase identification and circuit number.

.6.4 All work performed on lead sheathed, medium voltage (1 kV to 35 kV) cables shall be performed only by personnel who have been tested and certified by UTHVS to be qualified. Contractor personnel approved by UTHVS as certified lead-cable splicers shall perform Paper Insulated Lead Covered (PILC) to PILC Splices and shall use UTHVS approved materials utilizing historical lead-wiping methods.

.6.5 PILC to Polymeric Splices (and PILC to PILC) wye, X and straight shall meet the requirements of ANSI/IEEE 404 (Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2,500 V to 500,000 V, most current version) for 15 kV 133% voltage rating. It must be rated for continuous operation at 105°C, with an emergency overload rating of 130°C. The joint manufacturer shall provide a test report, upon request, demonstrating the joint performance is equivalent to the cables per relevant sections of IEEE-48 (Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV, most current version), IEEE 404 (Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 to 500000 V, most current version), AEIC-1, most current version. The joints shall be subjected to a UTHVS approved voltage withstand test sequence. The splice shall include a solder-less mechanical ground jumper. The splice shall be designed for splicing the types and sizes of power cable used. The splice shall be rated for indoor, outdoor, and immersion in water.

.6.6 A split-tinned solder connector may be used to join the cables conductors. As an approved alternative to soldering, a 360 degree crimped lug may also be employed. Crimps are to be made by a crimp tool approved by the lug manufacturer following their approved procedures. All crimps shall employ a 360-degree crimp.

.6.7 UTHVS approved, Raychem factory-manufactured heat shrink splice kits shall be used exclusively.

.6.8 Kits shall be factory-engineered to contain all necessary materials, except connector, to provide an oil block and oil seal electrical stress control, insulation, shielding and environmental sealing. The kit shall allow for external grounding.

.6.8.1 Straight splices shall use Raychem Number:

- HVS-1532-LC for 4/0 Cable Poly to Poly
- HVS-1533-LC for 500 KCMIL Cable Poly to Poly

- HVS-1582D for 4/0 Cable PILC to Poly
- HVS-1583D for 500 KCMIL Cable PILC to Poly
- HVS-1523S for 750 KCMIL Cable Poly to Poly

.6.8.2 Wye splices shall use Raychem Number:

- HVSY-1522-S for 4/0 Cable Poly to Poly
- HVSY-1523-S for 500 KCMIL Cable Poly to Poly
- HVSY-1582-D for 4/0 Cable PILC to Poly
- HVSY-1583-D for 500 KCMIL Cable PILC to Poly
- HVSY-1523-S for 750 KCMIL Poly to Poly
- HVSY-1523-MOD for 750-750-4/0 KCM Cable Poly to Poly X splice

.6.8.3 For 4/0 taps of 500 KCMIL Cable, use 500 KCMIL kit with HVS-shim-3 for 4/0 Cable.

.6.8.4 In advance of installation with written approval obtained from Utilities UTHVS Management wye, X and straight splices, exclusively for temporary purposes, may be constructed using the following separable cable joints or multi-point junctions:

- 600 Series Deadbreak Separable Cable Joints
- J Series 15kV EPDM Molded Multi-Point Junctions

.6.9 Polymeric to Polymeric splices wye, X and straight shall be the same as paragraph .6.7 above except without oil barrier tubing. Joints shall be Raychem HVS-1530-LC series (straight), HVSY-1520S-SC series (wye) with adapters as required for cable type.

.6.10 Terminations shall meet Class I requirements and be design-proof tested to IEEE Standard 48, most current edition, and be capable of passing a test sequence per IEEE 404, most current edition. Termination kits shall be approved for the type and size of cables used and rated for 15 kV 133%.

.6.11 Polymeric Terminations shall consist of shrinkable stress control and outer non-tracking silicone rubber insulation tubing with two or greater silicone

rubber skirts. In addition, PILC terminations require an oil stop tube. All terminations and splices shall be grounded. Heat-shrinkable tubing shall have high relative permittivity stress relief mastic for insulation shield cutback treatment with a heat-activated sealant for environmental sealing. Termination kits shall be from Raychem Corporation:

.6.11.1 For 4/0 cables - use type HVT-152-SG for outdoor -unheated areas.

.6.11.2 For 500 KCMIL cable - use HVT-153G for indoor or HVT-152-SG for outdoor/unheated areas.

.6.12 Cold-Shrink splice kits and terminations are prohibited for use on 15 kV and 5 kV class cables.

.6.13 Potheads may only be used to replace existing potheads in outdoor installations of existing PILC cable.

.7 PRIMARY VOLTAGE CABLES (5 kV)

.7.1 5,000-volt service cables shall be UL Listed, 1/c, copper, 115 mil EPR insulated, 15 kV, 133% rated, shielded, MV 105°C cables with low-smoke (260°C spread temperature) zero Halogen. Tape Shield Cables shall have a 5-mil bare copper tape applied helically over the extruded insulation with an average minimum overlap of 25 percent of the tape width. The overall jacket shall be a continuous extruded, 80-mil polyolefin jacket, which meets or exceeds the requirements of ICEA S-93-736, latest edition.

.7.2 Extension or modification of existing 4,160-volt cables can only be done with prior written approval of UTHVS.

.7.3 All work performed on 5 kV cable shall be done by qualified individuals subject to the requirements of paragraph .6 above.

.8 Requirements for Application of Fire Tape to Medium Voltage Cables

.8.1 Fire tape is applied to an exposed cable for the purpose of protecting that cable from the failure of adjacent cables. For the purposes of this discussion, “exposed cable” refers to cable hung in air or run in ventilated tray. Cable in conduit requires taping only where the cable enters and exits the conduit. Cable vaults and manholes are areas commonly associated with the need to fire tape, however the criteria governing fire taping is broader and may call for taping in other areas of a substation or industrial facility where there are extensive runs of MV cable such as are found in chiller plants and power plants.

.8.2 The application of fire tape serves two purposes. It limits the proximal damage caused by a cable failure and reduces the probability that a cable failure will result in the loss of redundant circuits. This is true for instances where there is a little risk of a general area fire caused by a large combustible inventory. Where an area fire is a serious concern, the recommended solution is to re-route critical cables and/or their redundant cables. The application of fire tape to cables in or out of trays offers some protection from an area fire of limited duration and intensity. Where there is little or no risk of an area or tray fire, adding barriers to trays containing redundant cables or placing redundant cables in separate trays is an acceptable alternative design approach.

33 71 73. ELECTRIC UTILITY SERVICES

.1 PRIMARY SERVICE

.1.1 PRIMARY SERVICE DROPS: Primary service drops and their associated equipment applications are strictly regulated for acceptability of design, impact on power system reliability, safety to University personnel, and human error concern. Other considerations include Codes and Standards compliance, personnel access, switching flexibility, aesthetics and design consistency. A design review and Primary Electrical Service Policy:

https://fod.osu.edu/sites/default/files/primary_electrical_service.pdf

is in place to insure that all primary services meet the applicable requirements for design, reliability, maintenance and operation. See Figure 2 for examples of approved configurations for Primary Service Drops are available from UTHVS. UTHVS maintains a listing of approved switch manufacturers, and designs.

Principal responsibility for the design of the low voltage portions of the service rests with Engineer designing pursuant to the requirements of DIV 26 of the BDS and conformant to the requirements of this document. OSU FOD will inspect all MV circuits and equipment prior to service energization and conduct a low voltage switchgear readiness inspection that covers completeness, housekeeping and safety considerations such as signage. The formal inspection and determination of readiness for energization of the low voltage portions of the Service rests with the Project and the inspection authority(s) for the building. UTHVS inspection of the low voltage portions of the building service does not in any way constitute a formal building inspection as would be routinely conducted by designated State and Local authorities.

.1.2 PRIMARY SELECT SWITCHES and SERVICE CONNECTIONS: Primary switches and service connections shall be fused load break designs with an interrupt rating greater than the maximum primary feeder fault duty (9600 amps). All new and upgraded Primary Select switches are to be SF_6 (Gas) switches. The use of air break switches is restricted to switch applications such as transfers and equipment disconnection that do not serve a Primary Select function and will not be operated routinely by UTHVS personnel. Primary switches shall employ fully insulated bus. Exposed energized bus terminations and connection points are to be taped or booted. All bus connections are to be bolted or brazed. All internal bus jumpers and connecting cables are to be made with 15 kV cable. Internal jumpers and connections to mating equipment such as primary transformers are to be made with unshielded 15 kV rated cable. All jumpers or connectors routed outside the switch to components remote from the switch cabinets are to be made with 15 kV shielded cable of a construction compliant with the requirements of this Standard. Jumper cables shall be terminated in crimped lugs in conformance with the requirements set forth in this Standard for medium voltage cable termination. Power cables are to be terminated in UTHVS approved solid, long barrel, plated lugs secured with two or more bolts. Crimps are to be made by a crimp tool approved by the lug manufacturer following their approved procedures. All crimps shall be six points or more. A 360-degree crimp is preferred. In instances where the equipment accepting the termination does not support two or more bolts, UTHVS shall be consulted and will determine the acceptability of the single bolt termination. Mechanical type connectors are not generally considered acceptable for power applications.

.2 PRIMARY SELECT SWITCHES - MEDIUM VOLTAGE

.2.1 A medium voltage service shall consist of a set of primary lightning/surge arrestors (line side of primary select), primary selective switches, fused primary disconnect switches, lightning/surge arrestors (load side of primary disconnect), medium voltage transformer, and low voltage unit substation application section. See Figure 2.

.2.2 The transformer primary fuses shall be located in a fully rated fuse cabinet in an accessible area and shall not be located within the transformer enclosure.

.2.3 If the anticipated load requires a transformer larger than 1,500 KVA, or if the interruption of building power for maintenance of the low voltage unit substation is unacceptable, then the low voltage unit substation shall be double-ended with the appropriate number of primary selective switches, two separately fused primary disconnect switches, two transformers, and two low

voltage sections with a tie breaker provided. On double-ended substations, the main secondary breakers shall be sized per requirements of Division 26.

.2.4 For critical installations, such as a Hospitals, research laboratories, vivaria, or computer centers, a complete double ended switchgear lineup shall be provided consisting of:

.2.4.1 A pair of Primary Select Switches with cross-tie

.2.4.2 Two sets of fused primary disconnect switches, two sets of lightning/surge arrestors, two medium voltage transformers, and two low voltage sections with the main breakers and tie breaker

.2.4.3 Secondary bus tie and busses shall be sized for the emergency ratings of the transformers.

.2.4.4 Secondary Mains and Tie breakers shall be rackable, metal enclosed electrically operated, with provisions for remote operation from a location outside the arc flash area.

.2.4.5 UTHVS may require specific Medium Voltage switch and cable arrangements for buildings with large distribution load requirements in order the facilitate power distribution system load balancing.

.2.5 Primary Select Switches shall be rated electrically and mechanically for a minimum of 1,000 load break operations.

.2.6 The Primary Select switches for the incoming power to each building shall be located outside or in a dedicated switch room directly accessible from the outside at ground level. When located inside a building, the Primary Select switch must be in plain sight from the point of entry to the building or within twenty (20) feet of entering into a building. The room containing the Primary Select switch shall be of a two-hour fire rated construction. The switch must be directly accessible from the outside. Primary cable pull boxes and conduit, ahead of the current limiting fuses shall not be located in or above public occupied areas.

.2.7 Indoor applications shall be rodent proof and have drip shields to protect exposed High Voltage surfaces; outdoor applications shall be rodent and weatherproof. Switches shall not have floors. Switches shall be constructed to provide safe access to terminals without de-energizing the switch. Switches and bussing shall use porcelain insulators throughout. Switches shall be built on a specially designed pre-cast vaults, raised channel or I-beams, or

minimum six (6) inch height concrete slabs above finished grade. The choice of mounting system shall be coordinated with OSEP and be approved by UTHVS.

.2.8 There shall be provisions to protect outdoor mounted switches and associated enclosures from physical damage from Building and Grounds maintenance equipment and private, commercial or delivery vehicles (mowers, tractors, motor vehicles).

.2.9 Switches shall not be placed in open underground or below grade vaults subject to flooding.

.2.10 Gas switch handles and elbows shall face the front of the switch enclosure. UTHVS approved, Elastimold factory-manufactured dead break, load break, and fused elbows shall be used exclusively.

.2.11 In primary select applications, low profile SF_6 switches are to be applied exclusively where electrical cable access permits. Adequate termination space must be provided to accommodate elbow fuses if approved in writing by UTHVS (TSG consulting), stress cones and minimum cable bend radius. The termination space provided shall not require bending the cable in the area of the stress cone.

.2.12 SF_6 switch gear design shall be three-phase, 15 kV, and shall be rated 60 Hz, 600 amps minimum continuous, load break, and pad mount for outdoor at grade type applications. The switch shall be three-phase with 3-way, 4-way, 5-way, or 6-way circuit configurations as required and may be provided with a tie switch. Load ways shall be rated at a minimum 600 A; but are generally fitted with 200 AMP deep well load break bushings unless inappropriate for the application. The choice of Primary Select configuration must be coordinated with UTHVS and be approved by UTHVS as it is first and foremost a part of the Campus Medium Voltage Distribution System.

.2.13 The switch shall be equipped with an automatic transfer capability. This includes automatic transfer to an alternate power supply upon loss of voltage on the preferred feeder. The switch shall also be equipped with user friendly, Human-Machine Interface (HMI) that allows personnel to set and adjust parameters for operation, maintenance and configuration. The UTHVS shall be the sole judge as to whether or not this transfer shall be set up as automatic transfer or shall be set up as manual transfer.

.2.14 Switch housings shall be installed to provide sufficient safe access for switching and maintenance personnel.

.2.15 Cable connection points to the Primary Select switch shall all be 600-amp dead break bushing for incoming cables and 600-amp apparatus or 200 A

deep well load break bushings as required for the switch design. Bushings shall be welded, not gasketed. The switch tank shall be stainless steel with all welded construction. Self-contained switch tripping protection, when required, shall be a three-phase resettable fault interrupter (RFI) field adjustable simulating E fuses. Load ways shall be either RFI or gas switch equipped in accordance with the technical requirements of the installation. An RFI is required when the load way powers a transformer through a fused air break disconnect switch. A gas switch is required when the transformer is supplied through a fuse directly and there is no air break switch installed. Power and sensing for the fault interrupter control shall be supplied by integral current transformers and not require auxiliary power or batteries. Power for the Transfer control is normally supplied from a CPT connected through a fuse to a bus tap in the switch. A dedicated building power fed at 120 VAC may also be provided in place of this feed if the Primary Select Switch in located inside a building and building power source is secure. A battery back-up is required and provided with the switch.

.2.16 The minimum Primary connection shall consist of one Primary Selective switch (three way) with two primary feeds off two associated primary pairs. Building specific usage and design considerations shall determine the appropriate number of primary switch ways and fused sub-switches. Single-phase Primary transformer connections are prohibited. UTHVS shall establish the required Primary Selective switch configuration for each Primary Service based upon a careful evaluation of building service requirements and what is appropriate for the campus power system.

.2.17 A primary selective switch may be used to provide primary power to as many as four sub-switches or transformers through separate load ways and fuses. The maximum number of transformers that can be powered on a single way is dependent on the acceptability of simultaneous transformer outages for the buildings or services involved. The general practice is to have no more than one building in outage for a single transformer outage.

.2.18 Multiple buildings may be fed from one primary select switch equipped with multiple load ways.

.2.19 The primary selective switch shall not be used as a junction box or a tie point to provide power to another building when two transformers are not in the same building or room.

2.20 Provide intermediate class, 10 kV, 8.4 kV MCOV (Maximum Continuous line-to-neutral Operating Voltage) polymer enclosed surge arresters on the line side of all primary select switches, and on the load side of all fused primary disconnect switches. Arresters shall be mounted inside of the switchgear

compartment with the line side cables they are protecting. Arresters shall be mounted and connected in a manner to be easily disconnected for Hi potting or Hi potential testing of cables.

.2.21 When the primary select switch is equipped with electronic fuse emulation, the chosen characteristic must provide coordination with the fused primary disconnect switch fuse.

.2.22 Doors to primary select switches shall be key-locked with locks and cylinders complying with the BDS standard of Best Access System key cylinders with removable 7-pin cores. Refer to DIVISION 8 for further details. In addition to the locking provision, a seven-flat tamper resistant security bolting shall be provided to reduce the likelihood of unauthorized access to live parts and connections.

.3 PRIMARY DISCONNECT SWITCHES

.3.1 Air switch handles, fuses, and elbows (if used) shall face the front of the switch enclosure.

.3.2 Primary disconnect air switches shall be a minimum rated 600 amp, 15 kV, stored energy, load break fault interrupting switches. The switches shall be capable of being operated with the operator standing safely away from the front of the switch.

.3.3 Primary air break switches shall be Kirk key interlocked. Spare keys shall be provided to UTHVS. Both switches shall be capable of being closed at the same time, paralleled, and provided the spare key is used. Both fuse compartment doors shall be key-interlocked with the switches. The spare key shall permit opening the fuse compartment doors with the switch closed.

.3.4 All medium voltage switches shall be top fed with fuses (if used) below the switch. The switchblades shall pivot at the bottom (load side). Provide bussing to the top of the switch, if the switch enclosure is to be bottom feed.

.3.5 Doors to fused primary disconnect switches shall be key-locked with locks and cylinders complying with the BDS standard of Best Access System key cylinders with removable 7-pin cores. Refer to DIVISION 8 for further details.

.4 GENERAL

.4.1 Where applied, fuses shall be E fuses sized to provide thermal short circuit protection to the transformer and effective fault current limiting.

.4.2 The selected E fuse shall be applied to the Primary of the Transformer based on the size (KVA) of the transformer. The fuse chosen shall accommodate transformer in rush and the ANSI damage curve.

TABLE # 1 RECOMMENDED FUSE SIZES

TRANSFORMER RATING KVA@13.2kV	FLA	MINIMUM	133% DRY TYPE DOUBLE-ENDED
112.5	4.9	10E	10E
150	6.6	10E	10E
225	9.8	15E	15E
300	13	15E	20E
500	22	25E	30E
750	33	40E	50E
1000	44	50E	65E
1500	66	80E	100E
2000	88	100E	125E
2500	109	125E	150E
3000	131	150E	200E

.4.3 All locks shall have manufacturer furnished covers and be provided with two sets of keys. Contractor is to provide all spare keys to UTHVS.

.4.4 Switch access door handles shall have provisions for padlocks or other locking means acceptable to UTHVS in both the open and closed positions. Front and rear compartment doors shall be hinged and have provisions for padlocks. If a door is required to be opened to operate a switch, the door shall be hinged on the opposite side from the switch handle.

.4.5 Padlocks for all fused primary disconnect switch handles (open and closed position); doors, and panels shall be supplied by the contractor. At final UTHVS inspection and acceptance, contractor shall supply all locks with a Utility approved core. Keys for these padlocks shall not to be provided to the

contractor(s). All padlocks shall be able to accept BEST 7 pin interchangeable cores.

.4.6 Electric Heaters: All fused primary disconnect air switches located outdoor or located in unheated rooms shall be equipped with electric heaters, the size of the heaters shall be 500 watts/cubicle front and rear. The power supply to the heaters shall be from the secondary side of the transformer or from a reliable, labeled, and supervised building power source.

.4.7 Tempered viewing windows shall be provided through which it shall be possible to verify that all phases are opened or closed. All air break primary disconnect switches shall have visible contact with a 6" minimum break. Switch contact status for gas switches or vacuum switches shall be derived from positive position sensing of the primary contacts and be visually inspectable with the switch energized.

.4.8 Insulation: All medium voltage connections, bus bars, and devices in switchgear shall be insulated. Insulated barriers shall not be allowed to come in contact with insulated conductors and shall maintain a 3" clearance. A minimum of 6" clearance shall be observed as minimum required spacing for insulated and uninsulated barriers from uninsulated conductors.

.4.9 All primary switches shall be marked on the front by the switch handle with the feeder numbers and phases identified by 1" x 3" engraved, plastic tags screwed to front door or panel near the handle.

.4.10 The electrical contractor shall be responsible for ensuring that a level concrete pad is provided. Electrical gear must be installed plumb and level on a concrete pad or mounted on rails embedded in a level concrete pad.

.5 SWITCHGEAR - LOW VOLTAGE

5.1 The trip settings on the Secondary Main shall support proper coordination with the Primary Transformer fuses and any intervening devices. The A/E and Contractor shall provide design and As-Built settings and coordination information prior to Primary Service initial energization. See DIVISION 26, for specific requirements concerning sizing of facility distribution system, arc flash, coordination study, load flow, and short circuit analysis.

.5.2 The Secondary Mains and Secondary Bus tie breakers, where they exist, shall be fully rated, metal clad, draw-out circuit breakers. The breakers shall be electrically operated both for close and for trip. A control station shall be provided and mounted external from the switchgear, located outside the arc flash hazard boundary, for remote closing and tripping of the secondary main

and secondary bus tie breakers. The maximum operating force required to manually open or close a switch or breaker shall not be greater than 75 pounds force applied to the operating handle.

.5.3 All dual-fed switchgear with a tiebreaker shall have trapped key interlocks per ANSI/ASSE Z244.1-2003 to prevent paralleling two electrical sources. The testing, phasing, and startup of dual fed switchgear shall be under the supervision of OSEP Utilities High Voltage Services.

.5.4 Building Emergency generation shall be designed so that no single failure of switching equipment or controls can result in back-feeding the primary transformer and inadvertently energizing the Primary system.

.5.5 Metering equipment shall be in a separate compartment with no bus exposure.

.6 DISTRIBUTED GENERATION

.6.1 Generation sources intended to be run in parallel with the OSU MV Distribution System are required to meet the appropriate provisions of the Ohio Revised Code and IEEE standards in addition to the following OSU Electrical Utility requirements for interface of Distributed Generation (DG):

.6.1.1 A primary safety consideration of DG systems interconnected to the OSU Electric Utility is that the DG system shall disconnect from a de-energized distribution service irrespective of connected loads or other generators. This is to prevent the back-feeding of the service, which could create a hazardous situation for OSU utility personnel and facility maintenance personnel. A distribution service can be de-energized for several reasons. De-energization can be caused by a substation feeder breaker opening due to fault conditions or the distribution feeder may be de-energized for maintenance or construction reasons.

.6.1.2 When the interface voltage deviates outside the range of chart below, the DG shall disconnect from the point of electrical interface to the Utility or facility distribution system. This applies to any phase of the three-phase system.

Voltage	Maximum Trip Time
V<45%	10 cycles

45%≤V<60%	60 cycles
60%≤V<88%	120 cycles
110%<V<120%	60 cycles
V≥120%	10 cycles

.6.1.3 When the interface frequency exceeds the bounds of 59.5 Hz to 60.5 Hz for longer than 2 seconds, the DG system shall disconnect from the OSU Electric Utility.

.6.1.4 Following DG system disconnects as a result of an out of bounds voltage or frequency event, the DG system shall remain disconnected until OSU utility service voltage has recovered to within acceptable voltage and frequency limits for at least 1 minute or until manually reset.

.6.1.5 The DG system shall not inject dc into the ac interface under normal or abnormal conditions. An isolation transformer connected between the power conditioning subsystems and the ac interface is one approved method that can be used to satisfy this requirement.

.6.1.6 The DG system and interfacing equipment shall be grounded in accord with other appropriate sections of the BDS DIV 33 and or DIV 26.

.6.1.7 The DG shall have surge protection in accord with this standard as well as comply with local and national codes.

.6.1.8 A lockable, visible, and accessible manual load break disconnect switch shall be provided for control by UTHVS.

.6.2 Permitting of Distributed Resources

.6.2.1 Distributed generation sources on Campus for connection to the OSU Campus MV Distribution System either directly or through a building service require a thorough review by UTHVS at the planning, design and startup phases. UTHVS will review the initial application for connection and continue to coordinate with the local utility throughout the planning, design and installation.

.6.2.2 Requirements imposed by the University on Distributed Generation go beyond design and initial installation and include routine testing

and power quality monitoring. Depending on the type of Distributed Generation involved, there may be other constraints imposed relating to such considerations as time of day switching and loading, circuit loading limits and operational constraints based on Distribution System operating constraints and accommodating emergency system conditions. Permitting Distributed Generation is not a guarantee of access to the OSU Distribution System. Granting access to the OSU Medium Voltage Distribution System remains at the discretion of UTHVS.

33 72 00. UTILITY SUBSTATIONS

33 72 33. SUBSTATION CONTROL HOUSES AND ASSOCIATED FACILITIES

.1 WIRE AND CABLE

.1.1 Copper conductors of 98 percent conductivity shall be used unless use is restricted by Government Agencies. Aluminum conductors are prohibited.

.1.2 COLOR CODING

Color coding for 480/277V and 208/120V shall be as follows:

Phase	Voltage	Voltage
	480/277	208/120
Neutral	White or Gray	White
(Each with identifiable colored stripe)		
A	Brown	Black
B	Orange	Red
C	Yellow	Blue
Equipment Ground	Green w/Yellow stripe	Green or Bare

.2 LOW VOLTAGE CABLE (600 volt): For Power, Control and Protection

.2.1 Solid and Stranded Wire: No 12 AWG and smaller may be solid. No 10 and larger shall be stranded.

.2.2 Minimum size for all 125 V DC and 124/240 V AC branch circuits is No 12 AWG.

.2.3 Use of minimum No 14 AWG stranded for AC control wiring and auxiliary system circuits is permitted.

.2.4 Use of No 12 AWG, or greater, for 125 V DC control wiring is required.

.2.5 Use of No 10 AWG for all current transformer circuit wiring is required.

.2.6 Use No 16 AWG TSP or TSQ for instrumentation analog current loop or voltage signal.

.2.7 General Use insulation for 600 volt rated wire and cable shall be NEC, 600-volt class type XHHW2 with SIS allowed for power component internal control wiring. Jacketing shall be Low Smoke Zero Halogen. Nylon conductor jackets and the use of PVC for conductor insulation or jacketing are prohibited for Utility applications. All wiring between equipment, cabinets or control panels for low voltage power equipment power and control circuits shall be in conduit or tray. All control wiring between power components, cabinets and control panels shall be in jacketed color-coded cables bearing suitable durable cable identifiers. Cable conductor color coding shall conform to ICEA Method 1 table E2. Panel and component wiring shall have individual wire labels. Wiring shall not be color coded. Acceptable labeling conventions include: destination labeling, unique wire numbering.

.2.8 Power cables are to be terminated in UTHVS approved solid, long barrel, plated lugs. Power cables carrying high current (greater than 50 Amps) shall have two or more bolts. Crimps are to be made by a crimp tool approved by the lug manufacturer following their approved procedures. All crimps shall be six points or more. A 360-degree crimp is preferred. In instances where the equipment taking the termination does not support two or more bolts, UTHVS shall be consulted and will determine the acceptability of the single bolt termination. Mechanical type connectors are not considered acceptable for power applications.

.3 INSTRUMENTATION (300-volt class and below)

.3.1 Use of minimum No 16 AWG for all analog instrument circuit wiring is required.

.3.2 Use of manufacturers approved plenum rated cable for all communications and digitally based signal cables is required within Substation Control Houses, Power Plants, Regional Chilled Water Plants, and Associated Facilities.

.4 GENERAL REQUIREMENTS FOR CONTROL AND INSTRUMENTATION

.4.1 AC and DC control circuits shall not be run in the same control cable. Low level (< 50 volts) instrument cables shall not be run in conduit or in tray shared by power or 110-volt AC, 125 volt DC control cables. Note: 120 VAC PLC inputs may be treated as instrument cable for the purposes of determining tray system placement. 120-volt AC and 125 volt DC branch circuits providing control power to equipment and systems shall be run via color coded jacketed cable of approved construction from the point or origin at the source distribution panel to the point of connection at the equipment, control panel, switchgear or enclosure. These cables shall be classified as control cable not power cable. These requirements pertain to all branch circuits providing control power to electrical and I&C equipment with wire sizes AWG 10 or smaller. AWG 8 and larger are exempted from the color coded, jacketed cable requirement.

.4.2 All control panel, control cabinet and switchgear wiring No 10 AWG and smaller shall be landed on UTHVS approved terminal blocks. Stranded wire termination shall be with approved ring type solid uninsulated barrel design. No more than two wires shall be terminated on any screw type terminal point. Thread on wire nuts or split bolt connectors are prohibited. In-line control wire splices are not acceptable for new installations. Control cable butt splicing for modifications or upgrades is permitted with prior written approval of UTHVS. Butt splices in control and instrument cable conductors shall be made with the appropriate sized Butt Connectors and insulated with electrical tape or approved heat shrink tubing with appropriate shimming.

.4.3 All control components are to be secured firmly to their supporting structures. Self-adhesive fasteners and thermo plastic fasteners are not acceptable.

.4.4 All cable and wiring that is field run to control panels or equipment enclosures shall be terminated on UTHVS approved terminal blocks. Landing field wires directly on serviceable components is prohibited. Small local control stations, local starters and local instruments may be excluded from this requirement. Purchased equipment and systems may come supplied with high density terminations. Termination of stranded wire to high density terminal blocks, or to terminal blocks that employ pressure type terminal clamping, shall be via ferrule. In instances where the use of ferrules is not practical, the wires are to be stripped to allow enough exposed conductor to permit full penetration into the terminal and tinned to form a solid conductor. Terminations made to terminal blocks that employ a pressure type terminal shall have conductor insulation extend up to the block and not show exposed conductor. High density screw or post type terminations, where permitted, shall employ insulated barrel lugs where necessary to maintain adequate electrical clearance between adjacent terminations

.4.5 All current transformer secondary circuits shall be wired through shorting type terminal blocks.

.4.6 All control cabinet and enclosure control wiring shall be dressed neatly, bundled and laced. Heavy duty UV resistant tie-wraps are an acceptable method of lacing. In general, Panduit or wire raceways shall not be used to organize wiring. Panduit may be used subject to UTHVS approval to organize and support control wiring in high density applications. Cable bundles shall be supported at regular intervals. Generally lacing to cabinet mounted tie points is an acceptable approach. Self-adhesive tie-downs are not acceptable.

.4.7 Every reasonable effort shall be made to separate 480 V equipment and circuits from control wiring. 480 V components and wiring shall be mounted separate from control components and provided separate access. Control components accessed for operations or maintenance shall not share the same enclosure with the power switching components or exposed power wiring without adequate protection from accidental contact by personnel or tools.

.4.8 In instances where low voltage (125 volts or less) control components and wiring must be housed in a common enclosure with power circuits (208 volts or above), exposed power circuit conductor surfaces shall be provided with a barrier to reduce the likelihood of accidental shock or burn.

.4.9 The preferred configuration for the separation of power and control is to have the power cabinet separate and to the side of the control cabinet. If this is not possible, the power cabinet and components should be mounted above rather than below the control cabinet or panel. Points of interface between control and power circuits, such as control transformers, shall be located with the power equipment. Secondary (control) fuses shall be located in the control area, not on the control transformer or in the power area.

.4.10 Adequate consideration shall be given to the operating temperature environment for temperature sensitive components. Electronics shall be mounted below the mid-plane of their housing enclosure. Sources of heat generation such as transformers and power supplies shall be mounted above, not under temperature sensitive equipment and enclosures shall be sized to operate closed without forced ventilation or the need for fans or filters. A maximum of 10°C temperature rise is allowed on enclosures for equipment rated 60°C or less. This shall be verified by heat run test or analysis and the rise shall be measured at the top of the enclosure.

.4.11 All control cables entering control cabinets and enclosures shall be secured by their jackets to a cabinet or enclosure support to provide a strain relief for the cable wire terminations.

.4.12 Control wiring traversing hinges or other forms of flexible constructions shall be high stranded and shall traverse the area of bending normal to the plane of rotation to impart a twisting rather than a bending motion to the cable or wire bundle.

.5 CONDUIT and FITTINGS

.5.1 Conduits shall be galvanized rigid steel. The use of EMT or aluminum for conduit or fittings is strictly prohibited for power and control circuits within Substation Control Houses, Power Plants, Regional Chilled Water Plants, and Associated Facilities. Fiberglass conduit may be used in tunnels or basements where wet conditions persist, only by written approval from UTHVS (TSG consulting). The fiberglass conduit installation shall be filament wound reinforced epoxy manufactured in accordance with the latest revision of NEMA TC 2002 and UL 1684. The manufacturer selected shall offer a full line of fittings, adaptors and elbows manufactured from the same materials and process as the conduit. Joining shall be by compatible adhesive or in areas where expansion or contraction may be a concern, the use of an EPDM gasket O-ring in a tapered bell to provide a non-adhesive, moisture resistant mechanical joint is acceptable. Acceptable systems are Champion Fiberglass and United Fiberglass. Fiberglass conduit is prohibited for general use or in explosion hazard areas (Class I Div II or more stringent). Where appropriate for the application, the materials used to manufacture conduits, raceways, ducts, boxes, equipment enclosures, and the finished products shall conform to the latest edition of NFPA 130, NPA 502, NFPA 70(NAC) and shall have the capability to withstand high temperatures up to 500°F, low temperatures down to -60°F and have a maximum 2-hour rating of up to 1850°F.

.5.2 Conduit carrying power conductors shall be sized for the number and gauge of the wire contained. The minimum conduit size allowed is 1-inch conduit. NEC requirements for conductor count and fill shall be followed, except for control cables, and where specifically waived by UTHVS.

.5.3 Pull boxes shall be spaced at appropriate intervals to allow for pulling cable and not exceeding the manufacturer's maximum pulling tension or sidewall pressures.

.5.4 Cable minimum bend radius limits shall be observed for all cables during installation and in the final installed condition. "L" boxes shall not be used for shielded power cables, multi-conductor control or instrument cables with more than four conductors of AWG #14 wire or greater.

.5.5 Conduits and boxes shall be routed and installed clear of traffic areas, equipment access lay-down or removal areas, mechanical equipment subject to high temperatures or movement or thermal displacement.

.5.6 Conduit shall be supported at regular intervals in both the vertical and horizontal directions.

.5.7 Multiple circuit power cables shall have all three phases and ground present in each conduit.

.5.8 All rigid steel conduits shall be provided with grounding bushings.

.5.9 Fittings for rigid steel conduit shall be galvanized steel, threaded, 2" diameter and below with insulated throats, 2.5" and above with grounding bushings. Compression fittings are permitted where use of threaded fittings is not practical, based on prior approval by UTHVS. Setscrew type fittings are prohibited.

.6 TRAY

.6.1 Tray may be used for power, control or instrument cable in areas known to be free from significant dirt or debris accumulation, physical, and explosion hazards.

.6.2 Power tray shall be ventilated, expanded metal or ladder construction. In mildly corrosive or damp environments galvanized steel tray is required or conduit shall be used. Multi-circuit power cables shall have their phase circuits transposed to avoid heating from circulating currents in the tray. Power cables are defined as cables supplying power to motor driven equipment, heaters, transformers etc. or power distribution panels where the loading of the cable may be substantial. Branch circuits serving only control loads with low to negligible circuit loading should treated as control.

.6.3 Control and Instrument tray may be ventilated or enclosed construction, solid metal, expanded metal or ladder construction. In mildly corrosive or damp environments, galvanized steel tray is required, or conduit shall be used. The tray shall be closed and covered in areas where excessive dirt accumulation is anticipated.

.6.4 Tray shall be grounded. A continuous 4/0 stranded bare copper conductor shall be run the length of the tray clamped or bonded to each tray section and run to building ground directly or to building steel at regular intervals along the tray run, not to exceed 100 lineal feet of tray. This ground cable shall be run external to the tray and not placed in the tray with the electrical cables.

.6.5 All trays shall be sized for the intended loading and supported at regular intervals to building structural elements. Supporting tray from equipment, ductwork, pipes or pipe hangers is prohibited.

.7 DC BATTERY SYSTEM

.7.1 Battery

.7.1.1 A central substation battery system operating isolated from ground at a nominal 125 VDC is provided. The battery must be rated to handle worst-case switchgear and anticipated DC system loads for a minimum of 8 hours from an 80% charge condition. Battery cells shall be connected in series to achieve the desired battery terminal voltage. Battery cells shall be rated for the entire ampere-hour rating of the battery. Paralleling of cell strings is not acceptable.

.7.1.2 Batteries shall be located in clean dry and temperature-controlled areas. They shall not be located within one foot of uninsulated outside walls to insure uniform cell temperatures are maintained. If batteries are contained in self standing enclosed cabinets, this one-foot limitation may be reduced to 3”. In cases where batteries are located near insulated walls, batteries and or their cabinets shall be placed to insure an air space to allow free movement of room air. Batteries and battery cabinets are not to be mounted on or against exterior walls.

.7.1.3 Central DC system batteries shall be of the Substation type rechargeable wet cell design. They shall have a 20-year service life or better and be contained in transparent jars deigned to facilitate the inspection of the battery internals. The jar size (number of individual cells contained) shall be limited to what can be managed for replacement by two persons. The entire battery shall be housed in a ventilated, lockable enclosure. The selection of battery technology shall appropriately reflect the service requirements and the ratings and limitations of the powered equipment.

.7.2 Battery Charger

.7.2.1 A dedicated Battery charger is provided that is rated to handle full dead battery charging current simultaneously with normal DC system continuous loads. The battery charger shall be rated to carry

the DC system normal continuous load and recharge the battery from a 100% discharged state in a maximum of 16 hours.

.7.2.2 Battery chargers shall be located in clean dry and temperature-controlled areas.

.7.2.3 The battery charger must be designed to maintain a float voltage on the battery while carrying the DC system load and be rated to support full DC system load currents for a worst case switching scenario.

.7.2.4 The battery charger must be designed to apply a programmed equalizing charge to the battery manufacturers' requirements.

.7.2.5 The battery charger shall have an output breaker sized to automatically isolate the charger from the DC system battery for an internal charger fault without loss of DC system load or opening of the battery output breaker/fuse.

.7.2.6 The battery distribution system shall be designed to facilitate the use of a load bank for periodic battery discharge testing. Such testing shall be conducted without the need to shut down any DC system loads either for connection of the bank or during the test itself. For redundant battery systems, the system shall be designed to accommodate the test battery's load from the redundant battery without the need for DC power interruption, or temporary connections. For single battery systems, the system shall be designed to allow all loads to be powered directly off the battery charge(s) without the need for DC power interruption, or temporary connections prior to or during discharge testing.

.7.3 DC System

.7.3.1 The DC system must be supplied with:

- Battery voltage and current indication
- Ground detection and alarming
- Off-nominal voltage and alarming
- Charger failure alarming
- Alarming for loss of charger AC power

Note: See Figures 6 and 7 for typical DC metering panel

.7.3.2 DC system protection shall be provided either by selectively applied Fuses or Circuit breakers. Protection is designed to isolate and eliminate faults. Battery and main distribution circuit fuses and breakers shall be sized to accommodate the short circuit duty of the system. If provided with a main breaker or fuse, the battery powered DC system circuit breaker or fuse shall be rated to ride through all DC system load faults.

.7.3.3 DC system loads shall be restricted to loads required for the safe and reliable operation of the power system.

.7.3.4 The normal source of power to DC loads shall be the battery charger. In critical applications the UTHVS may require redundant battery chargers aligned in a primary and backup configuration. Switching shall be accomplished with a transfer switch or using output isolation devices in each charger. An acceptable alternative to two (2) permanently installed chargers is a cross-tie to another battery system or a provision to attach a temporary charger.

.7.3.5 The battery is the principal source of power. The system control, monitoring, provisions for maintenance and protection shall reflect this.

.7.3.6 DC System loads shall not require a battery tap but shall be designed to operate at full battery voltage under normal and equalize voltage conditions. The use of low voltage control devices with series resistors is discouraged except for indicating lamps that require series fusing for circuit reliability reasons.

.7.3.7 Surge or transient suppression schemes that can provide a short circuit path between battery positive and negative or from battery positive and negative to ground shall be fused.

.7.3.8 All circuit alarming and monitoring devices connected to the DC Battery System shall be protected by breaker or fuse.

.8 Annunciators

.8.1 Local annunciators and remote annunciators shall be equipped with identical displays. All annunciators and remote annunciators shall be fully supervised, and the annunciator system shall be self-monitoring. The alarm state on the annunciators shall remain locked in until manually reset.

.8.2 Annunciation shall be provided to support the maintenance and operational needs of the system or equipment being monitored. Individual annunciation points shall be grouped into one of three categories:

.8.2.1 Operations (critical) - Operations alarms are alarms requiring prompt remedial corrective action.

.8.2.2 Maintenance (non-critical) - Maintenance alarms are alarms for conditions that need to be addressed in a planned or routine manner.

.8.2.3 Status (informational) - Status alarms are alarms that provide information on the condition or change of state of equipment that might be of interest but of limited immediate concern to operations or maintenance staff.

.8.2.4 Operations and maintenance alarms must be communicated to a manned location. Local annunciation shall be provided only in instances where the operators or maintenance personnel can be expected to require this information to be presented locally.

.8.3 Annunciator power shall be supplied from the plant or substation 125 VDC system. Communications relaying the annunciator activity to a remote manned location shall also be powered from the plant or substation 125 VDC system.

.9 LIGHTING

.9.1 The lighting design shall provide for both task and access/egress lighting.

.9.2 Task lighting shall be at illumination levels appropriate for reading labels, metering, test instruments, and written instructions.

.9.3 Access/Egress lighting levels shall be adequate to ensure that personnel gaining access to and traversing high voltage areas or leaving those areas can move safely and efficiently without concern for obstacles, tripping and bumping hazards.

33 73 00. UTILITY TRANSFORMERS

.1 GENERAL

.1.1 Position transformers for proper cooling, service, replacement and expansion room for future capacity addition.

.1.2 Indoor dry type and liquid type transformers shall be power cast or resibloc-cast Dry Type, or silicon filled. In Dry type designs, both HV and LV windings shall each be separately cast as one rigid tubular coil. Indoor liquid filled transformers are not approved for general use as Primary transformers (see Section .1.4.2).

.1.3 Outdoor transformers shall be either pad mounted liquid filled, or substation liquid filled type.

.1.4 Liquid filled pad mount and dry type transformers shall have a low loss, amorphous metal core. If other domain refined grain-oriented silicon steels are used rather than amorphous metal core to achieve high performance unit then, the Manufacturer(s) must supply to the UTHVS and TSG the Certified Test Reports (CTR) referencing actual data taken from the units ordered for related project and the electrical, thermal and audible noise requirements. Measurements taken must meet the requirements of NIST Standards. Insulating fluid shall be type 2 mineral oil, silicone, FR 3 or an alternative fluid approved for use in the intended application by the University. Liquid-filled transformers shall be labeled as to the type of dialectic fluid contained in the transformer.

.1.4.1 No-load losses for new primary service transformers shall not exceed the following:

Transformer Size	No-Load Losses
• 300 KVA	532 Watts
• 500 KVA	650 Watts
• 750 KVA	830 Watts
• 1,000 KVA	1,000 Watts
• 1,500 KVA	1,300 Watts
• 2,000 KVA	1,660 Watts
• 2,500 KVA	2,050 Watts
• 3,000 KVA	2,500 Watts
• >3,000 KVA*	

*Any proposed design for a transformer 3,000 KVA or larger must be submitted by the A/E for prior review and approval by UTHVS and TSG. Submittal must include proposed load-losses, no-load-losses, and auxiliary losses and will be subjected to an economic

comparison based on the estimated present worth of the combined losses over the service life of the transformer.

.1.4.2 Note: The requirements of this section apply in whole to all new installations. When the transformer application is for a repair or replacement or an upgrade to an existing building; one or more of the above requirements may be relaxed with the written consent from UTHVS and TSG, through the Project Manager.

.1.5 Primary winding shall be 13.2 kV 3 phase connected Delta. The secondary winding shall be connected grounded Wye. Primary winding shall be equipped with no load tap changing switch with a nominal tap and two 2½% taps above rated voltage, plus two 2½% taps below rated voltage. Special applications may require different secondary connections. Any variance from the specified configuration to meet the service requirements of an application must be reviewed and approved by Technical Service Group (TSG) and UTHVS.

.1.6 The transformer coils shall be wound of electrical grade copper and continuous wound construction; aluminum windings are prohibited.

.1.6.1 Transformers applied in primary service shall be supplied with a minimum 95 kV BIL on the primary and an appropriate BIL on the secondary (10 kV for 480 V dry type, 30 kV liquid filled).

.1.7 Buildings with critical loads such as research or main computer facilities or medical buildings shall have double ended substations with transformers sized to handle 120% of anticipated maximum normal secondary load without fan cooling or 110% of emergency loading with fan cooling whichever requires the larger self-cooled rating.

.1.8 For liquid-filled transformers, provide pressure-vacuum and liquid level gauges. Provide a temperature gauge with max pointer and alarm contacts. Provide fan control on all cooling fan assisted transformers. Liquid-filled transformers shall have an over pressure relief with indicator.

.1.9 Silicone oil transformer shall be equipped with service Viton gaskets.

.1.10 The name of original manufacturer of the transformer shall be identified on the transformer nameplate. If the transformer has been supplied through another manufacturer or vendor, the name of that manufacturer or vendor shall also appear on the nameplate.

.1.11 Dry type Primary transformers shall have bolted terminations on their high voltage windings. Liquid-filled Primary transformers shall be provided with Dead Front high side terminations with load break elbows and load break arrestors as well as provisions for grounding and parking stands. UTHVS approved, Elastimold factory-manufactured load break elbows shall be used exclusively. All Primary transformers with cabled secondaries shall be provided with adequate secondary termination capacity and termination space to accommodate termination of secondary cable equivalent to twice the thermal capacity of the transformer rating.

.1.12 All transformer fans are to be fully guarded. Guarding must be effective for personnel protection and for protecting transformer bus and windings from loose blades and blade assemblies.

.1.13 The transformer shall be equipped with Intermediate class polymer enclosed surge arresters to protect the primary of the transformer. Porcelain enclosed arrestors are not acceptable. Arresters shall be 10 kV rated, 8.4 kV MCOV (Maximum Continuous line to neutral Operating Voltage). Locate arresters as close to the transformer primary bushing with phase and ground leads as short as practical.

.1.14 The fuses in the primary selective switches and the primary disconnect switches shall be "E" fuses sized to supply and isolate their associated transformer. (See Table 1) If more than one transformer is fed from the same primary select switch or primary disconnect switch, then each shall be separately switched and fused. For transformers larger than 1500 kVA, fuses must be in a separate fuse cabinet.

.1.15 Power transformers shall be housed in their own enclosure and not be located within switchgear or switchboards. Transformer enclosures shall not house primary fuses. Enclosures for Dry Type transformers shall have removable panels on all sides as needed to facilitate access to core, coils, bus work and terminations for inspection and maintenance. Liquid-filled transformer termination enclosures shall provide adequate termination room for both primary and secondary terminations, and a reasonable level of physical separation consistent with the voltages involved. Liquid-filled transformers shall not have any fuses or fusible links inside the tank. All fusing shall be external to the transformer tank and enclosure.

.1.16 Outdoor, oil filled transformers shall not be located within ten feet of building openings or fire escapes. If directly opposite a window or door, a blast wall shall be erected.

.1.17 Work Space about transformers shall have minimum clear working space of five feet (5’0) to permit ready and safe access for preventative maintenance, emergency repair and inspection.

.1.18 The transformer load and secondary bus voltage regulation requirements of the design, and practical fault limits of the applied switchgear, shall determine the Primary Transformer impedance. Low transformer impedance provides good voltage regulation and low flicker but increases the cost of the downstream switchgear and may also interfere with the proper coordination of Primary Transformer fuse and secondary main circuit breaker. It will also increase Arc Flash values and make in-service maintenance more difficult. High impedance can lead to excessive voltage dips on starting large motors and unacceptable levels of flicker in the lighting system. In general, for the size transformers applied as Primary Transformers and the types of loads supplied, the impedance will not need to exceed 7% or be less than 3% on the transformer Base KVA.

.1.18.1 Acceptable Primary transformer impedances are impedance values that allow for proper coordination between Secondary Main Circuit breaker protection and standard Primary transformer protection without the need to resort to external reactors or current limiting devices, and still provide acceptable voltage regulation for power quality considerations, and acceptable arc flash values. UTHVS reserves the right to deny primary electrical service to any facility that cannot demonstrate proper coordination or fault rating of secondary switchgear. See DIVISION 26 for specific requirements concerning sizing of facility distribution, arc flash, coordination study, load flow, and short circuit analysis.

.1.18.2 Main and Primary Distribution System Fault, Load Flow, Arc Flash, and Coordination studies are maintained centrally by UTHVS. System fault levels (phase and ground fault currents, X/R ratios and coordination requirements) for l building service connections are available to the A/E for their use in performing facility electrical systems studies, by written request to UTHVS. System fault contribution is established by considering system conditions and possible future system conditions and reconfigurations. On the Columbus campus, the system contribution is 10,000 Amps Three phase, 8500 Amps phase to Ground with an X/R of 30 for both. System Nominal operating voltage is 13.2 kV with a maximum continuous operating voltage of 13.6 kV.

.1.19 The transformer manufacturer shall provide the ANSI damage curve for the transformer.

.1.20 Dry type transformers shall be designed for continuous operation at the rated KVA with a nominal 40-year life expectancy and overload capabilities in accordance with the latest ANSI-C57. The temperature rise of these transformers shall be 80°C and the transformer shall be insulated with a UL-recognized 220°C insulation system. Cast or resibloc-cast coil transformers shall employ Nomex 410 (preferred) or Nomex E56 insulation turn to turn with the remainder of the insulation system and encapsulation meeting an overall 185°C insulation class rating.

.1.21 Liquid-filled transformers shall be designed for continuous operation at the rated KVA with a nominal 40-year life expectancy in accordance to the latest ANSI Standards. The temperature rise of these transformers shall be 55°C over a 40°C ambient.

.1.22 The sound levels of the transformer shall be designed in accordance with ANSI/NEMA recommended levels.

.1.23 Transformer enclosures shall match or exceed the NEMA class associated with the location and service chosen for the transformer. The transformer enclosure shall not rely on the addition of external enclosures, hoods or other forms of drip proofing to avoid the risk of spillage or contamination from sources known to be in the area.

.1.24 Transformers shall be Factory tested prior to shipment in conformance with the applicable IEEE/ANSI Standards.

.1.25 The Primary Transformer enclosure shall not be used as a place to mount metering CT's or a point of connection for cables providing a power to the secondary bus for fire pumps or other loads. Metering CT's and PT's are prohibited from being installed within the primary transformer enclosure. Power taps to serve the Fire Pump are prohibited from being installed within the primary transformer enclosure.

.1.26 When hinged-enclosure doors are provided for access to primary transformers, the doors shall be key-locked with locks and cylinders complying with the BDS standard of Best Access System key cylinders with removable 7-pin cores. Refer to DIVISION 8 for further details.

33 79 00. SITE GROUNDING

33 79 19. UTILITIES GROUNDING - ELECTRICAL

.1 GENERAL

.1.1 Station grounding is provided for personnel protection, reduce equipment over-voltage exposure due to lightning, and to control stray voltage caused by static charges and electrical faults. Perimeter grounds are run to reduce the likelihood of personnel experiencing injury from stray contact potential. Equipment case or enclosure grounding serves the same purpose.

.1.2 The 13.2 kV power system is a multiple grounded design. There are no single-phase loads connected phase-to-ground. All major primary power circuits are provided with grounds that run continuously back to the power source. Loads on the system are connected phase to phase. Feeders that traverse the campus to supply building loads are shielded cables with their shields grounded at all splice and termination points.

.1.3 Grounding of major power components serves the purpose of conducting equipment fault currents safely away with very little increase in local contact potential.

.2. PRACTICES:

.2.1 Design and installation of grounds shall follow IEEE 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems, most current edition.

.2.2 Submitted designs and Contract Documents shall show ground systems, protective conduit sizes, and relative locations. Specifications and Drawings shall include detailed requirements of the grounding system.

.2.3 Grounding systems applied shall at a minimum conform to applicable requirements of the National Electric Safety Code (NESC) for medium voltage installations (13.2 and 5 kV) and the NEC for low voltage installations. Where NEC requirements conflict with this Standard, this Standard shall govern.

.2.4 All connections in the primary grounding system shall be clamped, exothermic welded, Cadweld® or equivalent. Individual grounding rods connected to the grounding system shall have a measured ground resistance of ten ohms (10 Ω) or less. This measurement may be made by any of the commonly accepted methods for measuring ground rod resistance to earth. Grounding for power equipment power circuit neutral grounding shall be no greater than one tenth ohm (0.1 Ω) measured from the neutral bus to the local ground bus or building structural steel. Primary circuit (13.2 kV system) grounding shall

conform to the NESC for potential rise during ground fault. Ground resistance shall be no greater than three ohms (3 Ω) for cabinet and control circuit grounds. Only copper-to-copper ground connections may be clamped or bolted. With limited exceptions, all other terminations shall be Cadweld®ed.

.3 SERVICE GROUND

.3.1 Grounding rods shall be a minimum size of 5/8" x 10' copper clad steel and shall not be placed in back-fill, but driven into undisturbed soil.

.3.2 Interconnection of the service ground, system neutral, and equipment ground conductors shall be made within the service equipment.

.3.3 All feeder circuit conduits shall include a 4/0 insulated ground conductor. The equipment enclosure (transformer case, etc.) shall not be used as a power grounding path. Two independent paths to a common ground point or ground reference shall ground all high voltage apparatus enclosures.

.3.4 Ground conductors shall be 600-volt insulated installed in rigid PVC or rigid galvanized conduit along with the circuit phase conductors. Main and Primary service transformers shall have a bonded secondary neutral that connects to an established ground grid, or grounding system. Cabinet grounds shall be 4/0 solid bare copper and run to an existing grounding system, an adjacent grounded cabinet or, in the absence of an established grounding system, to grounded building steel.

.3.5 Except where specifically allowed by UTHVS, all electrical equipment grounding shall be via 4/0 copper conductors. Conductor and insulation when specified shall conform to the following requirements:

.3.5.1 4/0 bare solid conductor shall be used in applications where the conductor is placed below grade or in a corrosive environment.

.3.5.2 4/0 bare medium stranded (7 strands) may be used in lieu of solid conductor in below grade applications and in mildly corrosive environments, and where conductor flexibility is a consideration.

.3.5.3 4/0 bare high stranding (up to 19 strands) is permitted in all above grade applications where exposure to corrosives is not a concern.

.3.6 All 4/0 bare copper ground cables shall be properly supported:

.3.6.1 Solid: supported at 4-foot maximum spacing

.3.6.2 Medium stranding: supported at 3-foot maximum spacing

.3.6.3 High stranding: supported at 2-foot maximum spacing

.3.7 Ground cables may be required to be insulated based on their use.

.3.7.1 Transformer and generator neutrals connected to neutral resistors or reactors to limit ground fault currents must be insulated. Cable insulation shall be line-to-line voltage rated. Ground cables running from the Grounding resistor/reactor and station ground shall be bare 4/0 copper unless specified differently in the design.

.3.7.2 Ground cables run in conduit or tray with feeder cables shall be insulated to avoid the possibility of arcing from stray ground currents during a power system ground fault. The insulation system required in this application is 600-volt class.

.4 EQUIPMENT GROUNDING

.4.1 All electrical equipment, enclosures and skids are to be provided with safety grounding.

.4.1.1 Equipment case grounding shall be via 4/0 bare copper solid conductor. It shall be attached to the grounded equipment via Cadweld® or bolted connection where required to facilitate removal for equipment maintenance. It shall be bonded to an established ground grid, ground system, or grounded building steel.

.4.1.2 Each design should have a detailed grounding plan that adequately describes the grounding requirements for the enclosure/skid and also the grounding requirements for major powered electrical components contained therein.

.4.2 Equipment skids and multiple equipment enclosure line-up shall have two independent 4/0 ground points. For one of these ground points, individual cabinets and small enclosures (e.g. lighting transformers) can utilize the ground carried back to the supply panel with the power cable as long as this conductor carries no load current and is properly identified as a grounding conductor. Multiple groupings of enclosures can have their equipment grounds daisy chained and do not require that both ground paths be direct to

building or station ground so long as the maximum ground resistance limitation is observed.

.4.3 Portions of equipment skid may require separate grounding accommodations where vibration eliminators, non-conductive expansion joints or galvanic protection (isolation points) have been installed. These applications must be referred to the Design authority, UTHVS or the equipment manufacturer to establish the proper grounding design.

.4.4 Substation buildings and electrical equipment enclosures shall be provided with a continuous ground bus that runs the perimeter of the basement (or lowest) elevation. This ground bus shall be tied to adjacent structures and to the station grounding system at multiple points. As a preferred practice, all grounds should be run to this bus. An acceptable alternative, equipment and enclosure grounds can be run and bonded to adequately grounded pre-existing equipment skids or building structural steel so long as the maximum ground resistance limitation is observed.

.4.5 Control and Relay panels:

In addition to the required provisions for equipment grounding, control panels shall be provided with an internal ground bus made up of a minimum 2" by ¼" inch copper bar. This bus shall be placed at the bottom or top of the panel front on the interior side and brought to substation ground. Where panels are arranged in multiple panel configurations, the ground bus shall have provisions to connect or jumper between panel sections via a bolted or Cad welded connector. All equipment case grounds, CT grounds, instrument transformer grounds and shielded control and instrument cable grounds shall be brought to this ground bus and connected via ¼" bolted fasteners.

.4.6 Buried control cable and ducts:

Control cables run to locations in the substation below grade in conduit, or where permitted direct buried, shall have all spare conductors grounded at the control panel end of the cable run. In addition, a bare copper ground wire shall be placed below the duct bank running the length of the cable run and snaked at roughly 45 degree angle to the control cable. This ground cable shall be attached to substation ground at both ends of the run.

.4.7 Buried Power cable and ducts:

Feeders with each phase contained in a separate conduit in a three-phase duct bank array shall be provided with un-insulated ground cables run external to the conduit. The conductors shall be run below the duct bank and bonded to substation ground at both ends of the conduit run. There shall be a minimum of one 4/0 bare copper cable per vertical duct bank column. Three

phase arrays with only three ducts arranged in a single vertical column shall be provided with a minimum of two 4/0 bare copper ground cables. Feeders with all three phases and an insulated 4/0 ground cable contained within a conduit require no external ground conductor.

.4.8 Fences (perimeter grounding):

Substation fences shall be provided with continuous buried 4/0 bare copper ground cable run a nominal three to six feet on both sides of the fence and bonded to the fence at fifty foot intervals or less. These cables shall be attached to the substation ground mat at regular intervals. Gates shall be bonded via extra flexible ground leads and the gate opening area shall be ringed with buried 4/0 bare copper ground cables.

.4.9 Yard Operator stations, pads:

Operating positions and step-off pads shall be grounded to the adjacent strictures with 4/0 bare copper cable via two independent paths.

.4.10 Primary Switch Enclosure Grounding:

Primary switches mounted inside buildings or in vaults shall be grounded at two points in conformance with the general requirements for grounding stated in sub-section .2.4 of this section. Enclosures, where provided, are to be grounded to the switch grounding system providing two paths to ground for the enclosure in accordance with Section .4.3. Ground connections to enclosure are to be bolted onto the inside of the enclosure. The bolting is to facilitate removal of the enclosure for switch maintenance or replacement.

.4.10.1 Primary switches mounted external to buildings on manholes, vaults or housekeeping pads or slabs shall be provided with enclosure touch potential grounding in addition to switch grounding. Grounding rods shall be driven at all four corners of the pad at a distance of 4’ 3” from the pad. A single 4/0 bare copper conductor shall be bonded to and run between the four rods at a distance of 3’ from the edge of the concrete, forming a loop. Two 4/0 copper conductors shall be bonded to the 4/0 loop at opposite corners and bolted to the switch enclosure. These conductors may be bare copper if run exposed or may be insulated. Ground connections to enclosures are to be bolted onto the inside of the enclosure.

.4.10.2 Primary switches with enclosures mounted external to buildings on pavement or a slab extending three feet or more beyond the extremities of the switch enclosure shall be grounded at two points in conformance with the general requirements for grounding stated in sub-section .2.4 of this section. Enclosures are to be grounded to

the switch grounding system providing two paths to ground for the enclosure in accordance with Section .4.3. Ground connections to enclosure are to be bolted onto the inside of the enclosure. The bolting is to facilitate removal of the enclosure for switch maintenance or replacement.

.4.10.3 All remote electrical equipment, portable equipment or temporary service switches and outlets are to be grounded. Power panel branch circuits powering duplex outlets shall not be powered through a GFI or ACFI at the source but, if a GFI outlet is required, have the GFI local to, or integral with, the local service connection or outlet.

33 79 93. SITE LIGHTNING PROTECTION

.1 LIGHTNING PROTECTION

.1.1 Buildings and structures shall have lightning protection. This protection shall be designed to effectively protect not only the building but associated electrical structures and major electrical power equipment including transformers and cables.

.1.2 Protection may be afforded through the selective placement of air terminals on the buildings or structures or by shielding through the use of aerial ground wires placed to afford a 30-degree cone of protection.

.1.3 Protection from lightning induced voltage transients and large changes in local ground potential shall be afforded by properly applied lightning arrestors, spark gaps, and surge suppressors.

.1.4 Design and installation shall follow NFPA 780 Standard for the Installation of Lightning Protection Systems, most current edition.

.1.5 See DIVISION 26 for requirements for building/structure lightning protection.

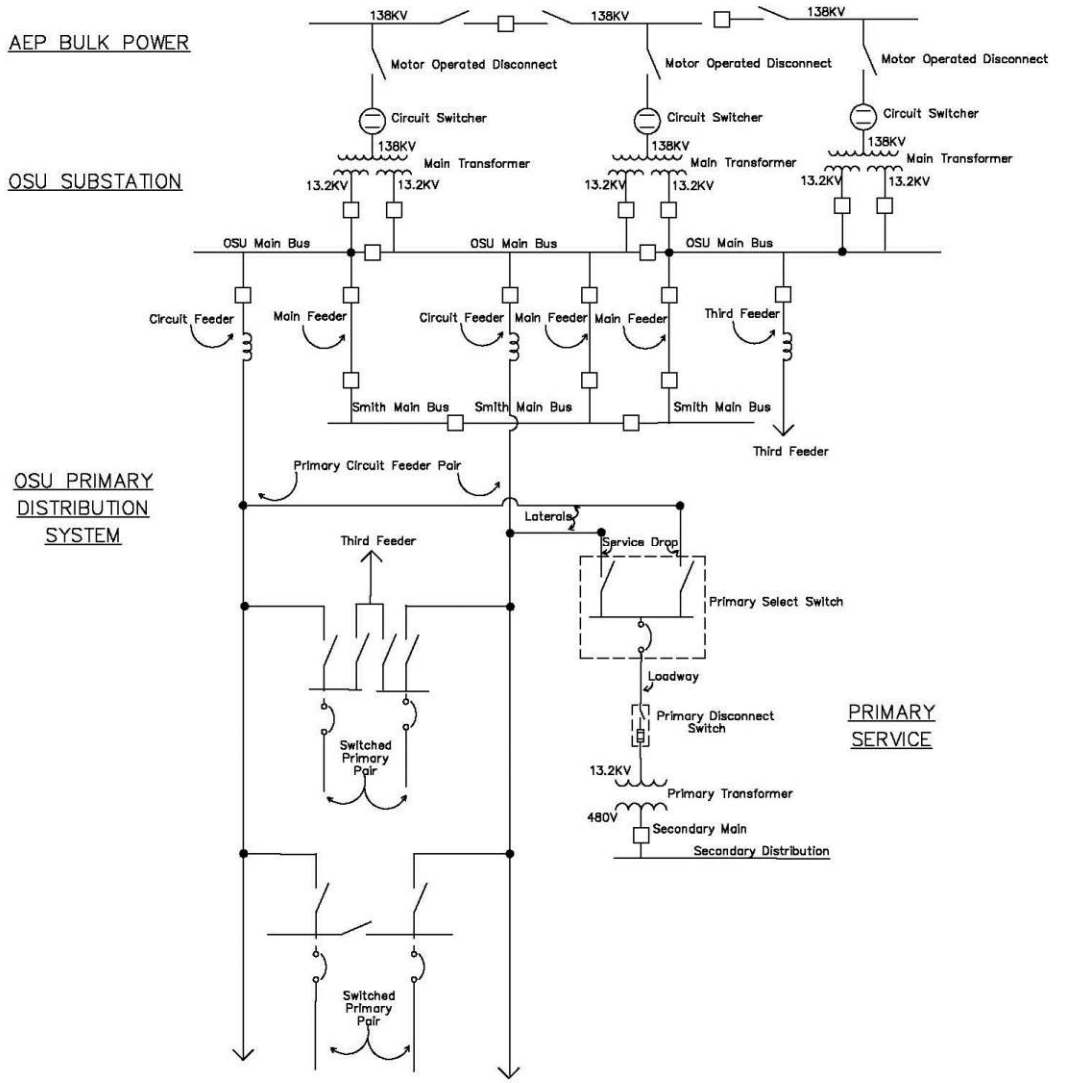


Fig. 1 Electrical One Line

Figure 1

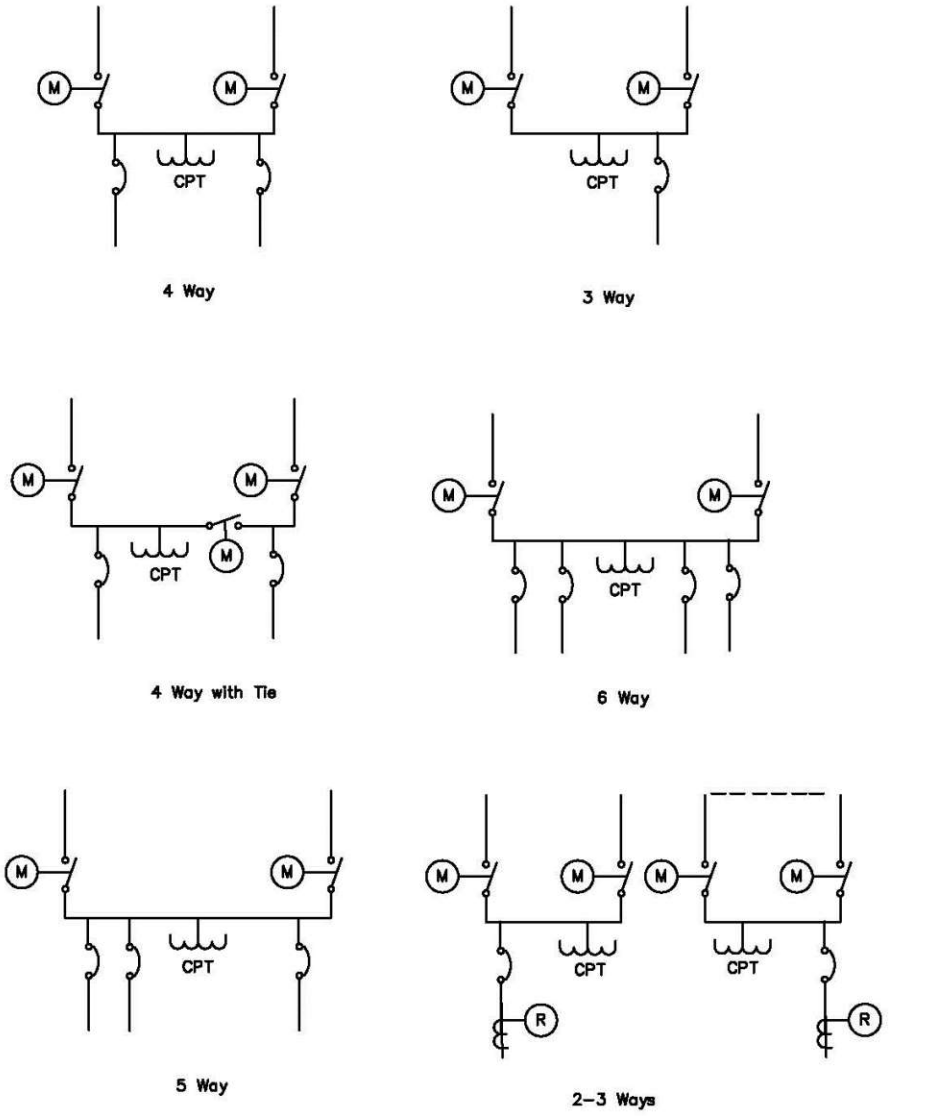

M
CPT
4 Way
3 Way
4 Way with Tie
6 Way
5 Way
2–3 Ways
R
M Motor Operated Disconnect Switch
Resettable Fault Interrupter or Switch and Fuse
See Fig. 3 for other Switch Configurations
Fig. 2 Standard 13.2KV Switch Configurations Two Feeders

Figure 2

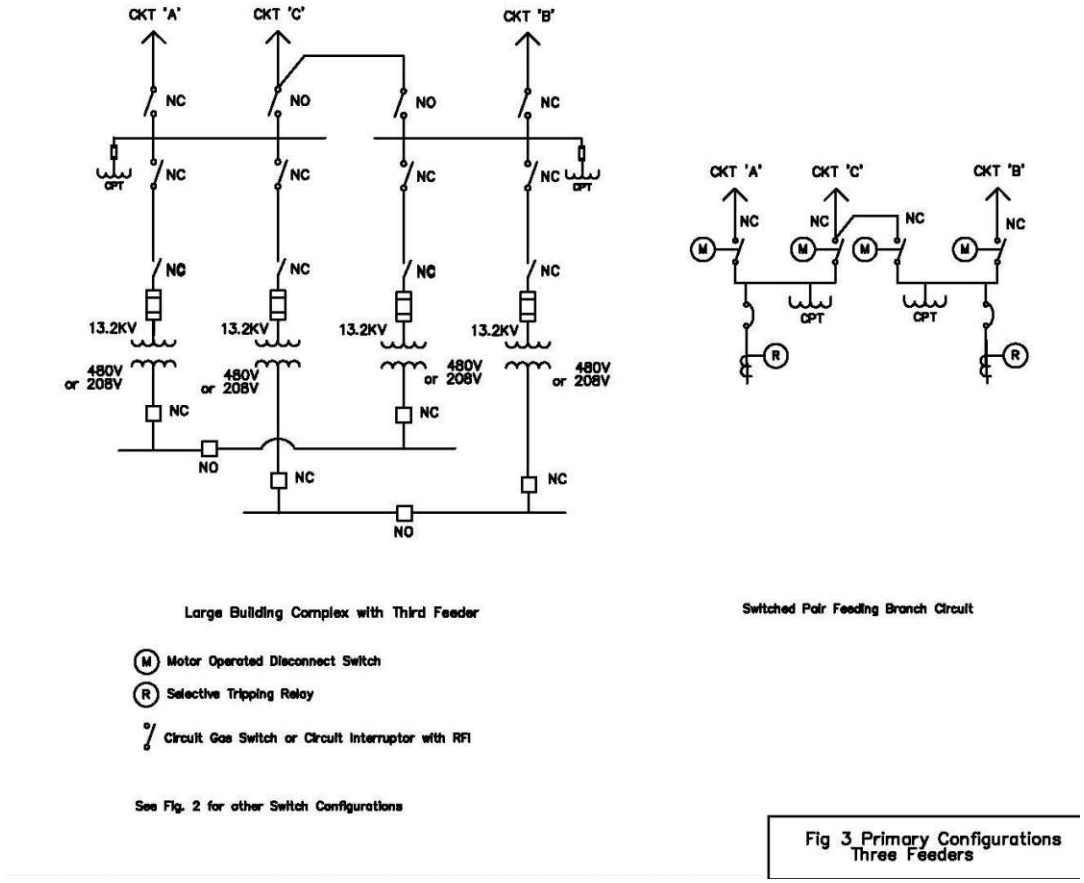


Fig 3 Primary Configurations Three Feeders

Figure 3

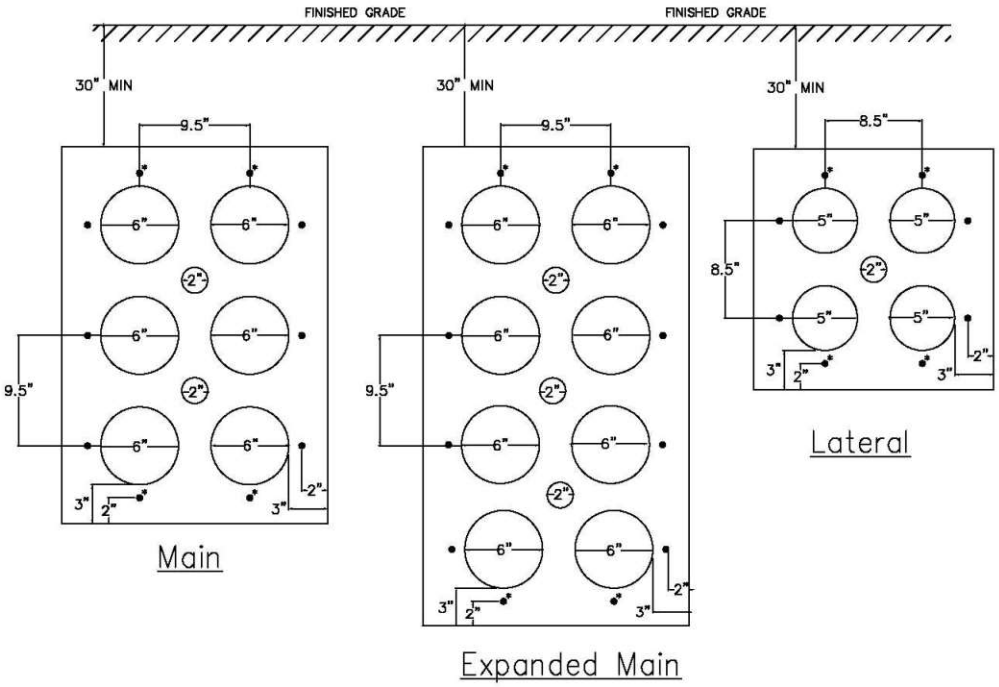


Fig 4 Primary Duct Bank Configurations

Figure 4

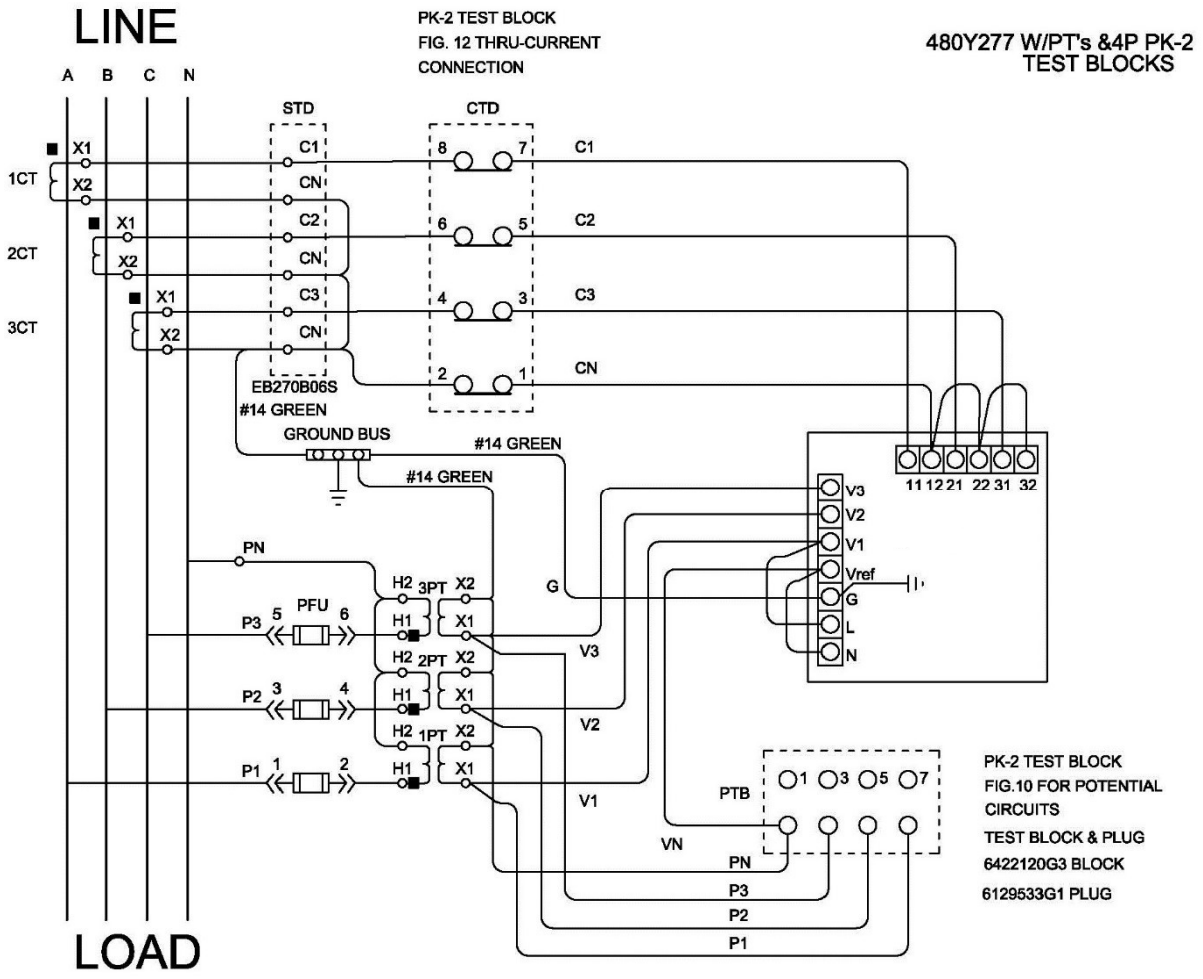
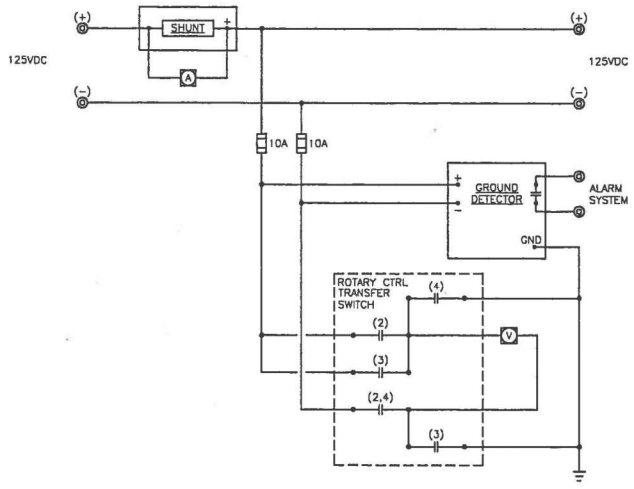

LINE
A B C N
PK-2 TEST BLOCK
FIG. 12 THRU-CURRENT
CONNECTION
480Y277 W/PT's &4P PK-2
TEST BLOCKS
STD
CTD
1CT
2CT
3CT
X1
X2
C1
CN
C2
C3
EB270B06S
#14 GREEN
GROUND BUS
#14 GREEN
#14 GREEN
11 12 21 22 31 32
V3
V2
V1
Vref
G
L
N
PN
PFU
P3
P2
P1
H2
H1
3PT
2PT
1PT
G
V3
V2
V1
VN
PTB
PK-2 TEST BLOCK
FIG.10 FOR POTENTIAL
CIRCUITS
TEST BLOCK & PLUG
6422120G3 BLOCK
6129533G1 PLUG
LOAD

Figure 5



GROUND DETECTOR PANEL DETAIL

GROUND DETECTOR PANEL PARTS LIST:

WESCHLER DC VOLTMETER
STYLE # 691B6712A15
0-150VDC

WESCHLER K241 DC AMMETER
STYLE # 691B671A15
INPUT RANGE 0-50mV
INDICATION RANGE 0-50 AMPS DC

WESCHLER SHUNT
MODEL # HA-50-50
50mV DC AMMETER SHUNT

HOFFMAN ENCLOSURE
161410CH, 16" X 14"

HOFFMAN PANEL
FOR 16" X 14" ENCLOSURE

BUSSMAN FUSE BLOCK
BUSSMAN # R600301CR

BUSSMAN 10AMP FUSES
BUSSMAN # LPSRK10 SP LPS-RI

BENDER GROUND FAULT DETECTOR
BENDER # UG140P

BENDER MOUNTING PLATE
SERIES X140

GE TERMINAL BLOCKS
GE # EB26B06C

GE MULTILIN CONTROL TRANSFER SWITCH
2 STAGE, 4 POSITION
GE # 16SB1BB438SSM2P

Figure 6

Figure 7

END OF DIVISION 33 - UTILITIES

THE OHIO STATE UNIVERSITY COMMUNICATIONS CABLING STANDARD

For all Wexner Medical Center projects, replace Office of the Chief Information Officer (OCIO) with Wexner Medical Center Network Infrastructure (WMCNI). This variance is highlighted in yellow.
For items that vary from the standards and apply only to Wexner Medical Center, note yellow highlighted text.

General

OCIO [WMCNI] personnel will be consulted during the planning stages of any building construction or building renovation. In some cases, current Entrance Facilities (EF), Equipment Rooms (ER), Main Technology Room and Technology Rooms (TR) may need to be enlarged or redesigned to accommodate changes in the use of building space.

OCIO [WMCNI] will review drawings and specifications on construction and renovation projects for compliance with the University Communications Cabling Standard. OCIO [WMCNI] will approve drawings and specifications through the Architects Office.

The project will request OCIO [WMCIT] to connect, disconnect, and/or move communication cables connected to the campus communication network, in the EF, MTR and TR(s), following established guidelines before project commencement. OCIO [WMCIT] will be responsible to perform the work once the request is received. The project will be responsible to remove all cabling back to the EF/MTR/TR once disconnected.

The project contractor shall contact OCIO six weeks prior to installation of any new facilities needing placed (if temporary service must placed it will be done at the cost of the project). Contractors must submit a request to 8-HELP (614.688.HELP) or via the web site https://osuitsm.service-now.com/selfservice/help_splash , for both installation and removals. Questions can be directed to 614.688.HELP. Outside Plant, services must be installed into the building prior to being able to install service.

Medical Center: The project contractor must contact WMCIT twelve weeks prior to installation of any new facilities needing placed (if temporary service must placed it will be done at the cost of the project). Contractors must submit a request to WMC Help Desk at (614)293-3861 or via the web site https://osumc.service-now.com/wmc/main.do , for both installation and removals. Questions can be directed to (614)293-3861. Outside Plant, services must be installed into the building prior to being able to install service.

Any project that requires moving or rerouting of telecommunications and networking cables will bear the cost of said moves.

All pathway work will be paid by project funding. The Project will be responsible for pathway to new/renovated building from the nearest manhole/tunnel or point of feed designated by OCIO Outside Plant Department. These pathways shall meet OCIO standards and meet all applicable codes. These pathways are for low voltage cables only. It will the responsibility of the project to coordinate with OSU Campus Mapping System to schedule site visits to obtain GPS locates. OCIO will provide main feed cables to each new building, including placement and terminations of each cabling medium (voice, data, and video).

Medical Center: The Project will be responsible for pathway to new/renovated building from the nearest Point of Service (POS) designated by approved service provider working with WMCNI. These pathways shall meet WMC standards and meet all applicable codes. These pathways are for low voltage cables only.

For on campus work, it will be the responsibility of the project to coordinate with OSU Campus Mapping System to schedule site visits to obtain GPS locates. Working through the WMCNI department it will also be required to coordinate any outside plant work for POS with the Office of the Chief Information Officer (OCIO). OCIO department will provide main feed cables to each new building, including placement and terminations of each cabling medium (voice, data, and video) and covered by project funding.

All work specified shall be UL listed and in accordance with the most current versions of the following codes and agencies:

The National Electrical Code, Article 800
National Fire Code (N.F.P.A. 72A)
Life Safety Code (N.F.P.A. 101)
National Electronic Manufacturer's Association (NEMA)
Institute of Electronic and Electrical Engineers (IEEE)
EIA/TIA 568, Commercial Building Telecommunications Wiring Standard which includes EIA/TIA 568C series, 569, 598, 606, 607, 758-B.
Medical Center: Americans with Disabilities Act (ADA)
ANSI/TIA-1179 "Healthcare Facility Telecommunications Infrastructure"
Occupational Safety and Health Administration (OSHA) – all applicable
Local Codes and Standards - all applicable

Marked up field drawings will be turned over to the OCIO [WMCNI] Outside Plant Department at first Life Safety Inspection. The marked up field drawings will contain all riser diagrams and cable counts along with all technology outlets and their associated. An additional electronic set will be turned over to the Manager–Data Storage & Retrieval.

To enable OCIO to inspect telecommunications and networking facilities work, the contractor must:

- Provide a progress schedule with the installation of telecommunications and networking raceways and spaces shown as a separate item.
- Immediately notify University Project Manager and OCIO [WMCNI] of any change in architectural drawings and/or plans affecting OCIO [WMC] facilities.
- Allow that all underground work be approved by OCIO [WMCNI] and Facilities Operations and Development before the site is covered with dirt or concrete. Failure to have the work inspected shall result in uncovering the area at the contractor's expense.
- Provide proper access and facilities for inspections.

With the Wireless initiative at The Ohio State University each remodel and new build will need to assess the wired versus wireless connection, and IPTV versus CATV needs. Specific requirements for each room and each project shall be collected during the Program of Requirement (POR) stage and the Design Development stage. The design team will coordinate with the department and OCIO [WMCNI] in the planning stages of any project, to better understand and plan for the best method of deployment of connectivity.

All projects will have a minimum 20-year warranty offered by the connectivity solution. Warranties provided by cabling partners to cover the system will not be accepted.

For questions concerning this document, please email ocio.osp@osu.edu
Medical Center: For questions concerning this document, please email ITNetworkInfrastructure@osumc.edu

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S. Wireless Access Point Detail – Drywall/Hard Ceiling

Medical Center:
ABBREVIATION REFERENCES

WMC	Wexner Medical Center
WMCIT	Wexner Medical Center Information Technology
EF	Entrance Facilities
MTR	Main Technology Room
TR	Technology Rooms
WMCNI	Wexner Medical Center Network Infrastructure
POS	Point of Service
OCIO	Office of the Chief Information Officer
POR	Program of Requirement
TO	Technology Outlets
OSP	Outside Plant
CCTT	Certified Cable Testing Technician
MPOE	Main Point of Entry

SECTION I
Cabling Contractor Qualifications:

1) A BICSI certified RCDD, listed on the BICSI website with current credentialing. Contractor submittals shall include copies of all certificates of staff to work on the project.

2) The Contractor must hold a current certification from the manufacturer of the proposed connectivity solution. This certification must be valid for both installation and testing and shall enable the Contractor to offer the full manufacturer's product and applications warranties as specified. All technicians working on the project will have manufacturers training and training certificates.

3) The cabling contractor must have a minimum of five (5) years of documented experience installing structured cabling systems.

4) Installation personnel shall consist of 100% BICSI certified staff and listed on the BICSI website. There shall be at least one BICSI certified Technician during all cable installation work.

5) A Fluke Certified Cabling Test Technician (CCTT) will perform all testing on the project.

6) Ohio State may approve or deny contractor based on contractor qualifications and work history at The Ohio State University.

SECTION II Submittals Guidelines

1. Contractor submittals will include the entire contractor qualifications based on Section 1 of this document, if these qualifications are incomplete or do not meet the standard the contractor will not be approved.

2. Product submittals must be received by the university OCIO [WMCNI] no more than 10 days after the award of the company's contract. Prior to start of any project or ordering of materials selected contractor shall turn in submittals with an adequate amount of time to allow for review in advance for the university to review and comment. Submittals are to include the following at a minimum:

    A. Division 27 contractor
        I. All product material for a complete and operable system to include but not limited to:
            - Cable
            - Ladder rack (within the TR)
            - Support systems
            - Jacks
            - Faceplates
            - Patch cords
            - Patch panels
            - Fiber patch cords
            - Fiber termination housings
            - Fiber panels and types
            - Firestop and UL systems being used
            - Racks/Cabinets
        II. All BICSI certificates for installation technicians.
        III. If installation staff change, the contractor shall inform the university and provide updated documentation.
        IV. Manufacturers training certificates for each technician
        V. RCDD certificate
        VI. Fluke CCTT certificate
        VII. Factory calibration sheets for all testers being used on project

    B. Division 26 contractor to include but not limited to:
        I. Cable tray (outside the TR)
        II. Backbone pathway
        III. Conduit
        IV. Firestop and UL systems being used for project.
        V. Any ancillary support items for the Division 27 contractor
        VI. Ground bars for both the ER and TR.

SECTION III TECHNOLOGY PATHWAYS

GENERAL

Cable facilities (conduit, cable trays, raceways etc.) are required for connecting laboratory, classroom, office areas, Entrance Facilities (EF) and Technology Rooms (TR). Cable facilities are furnished by project funding.

Medical Center: Cable facilities (conduit, cable trays, raceways etc.) are required for interbuilding horizontal cabling installations. This includes clinical, laboratory, pharmacy, retail, classroom, office areas, Entrance Facilities (EF), Main Technology Rooms (MTR), and Technology Rooms (TR). Cable facilities are furnished by project funding.

Upon completion, riser pathway (conduits/sleeves) shall have one additional empty conduit/sleeve in place for future.

Medical Center: A primary and secondary backbone riser pathway for copper and optical fiber cabling is required for all projects to every TR. Provide minimum of 8 sleeves.

OCIO [WMCNI] should be consulted before removal of telephone wire and equipment, i.e., when office partitions are relocated. All wiring must be removed back to the source by the contractor.

The electrical contractor shall provide a pull string in all empty conduits.

Conduit will be used in inaccessible environments such as: drywall ceilings/walls or any location where pathway is not readily accessible. This includes but not limited to: above HVAC ductwork, fume hoods, lab counters, cabinets and height issues not being able to safely access pathway from a stepladder.

Conduit types can vary per building the use of PVC or metallic conduits are acceptable as long as they meet code. If at any time metallic flex or non-metallic flex is used it shall be sized ½" larger than what is required to meet finished fill at 40%.

J-Hooks and/or cable tray will not be placed above hard ceiling or areas where there is no access or limited access (HVAC ducts or piping) Pull boxes, if needed, must be accessible. (See Exhibit A).

J-hooks will be placed only above drop tile ceiling with a minimum clearance of 6" between T-bar and j-hook; at no time will the cable clearance be less than 3" to the T-bar. J-hooks will be placed at intervals no longer than 4'. At no point, will the cable contact the ceiling or any other trades work.

Any cable pathway, shall be at 40% fill rate or less at project completion, if cable pathway is greater than 40% additional pathway will be added by the project.

At no time is it acceptable to place any other low voltage cabling within any pathway intended for voice and data cabling.

Plastic "zip-ties" are strictly prohibited for use of cable support.

All cable pathway shall be placed parallel and perpendicular to building lines.

ALL CABLE PATHWAYS:

A) Shall maintain the following clearances from possible sources of Electromagnetic Interference exceeding 5 kVA:
   i. Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to grounded metal conduit pathway: 6”
   ii. Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway: 12”
   iii. Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways: 24”
   iv. Electrical motors and transformers: 47”

1) Technology Outlet Pathway

A) Open Air (low voltage cabling with j-hooks and no conduit stub ups within walls- fishable walls)

i) J-hooks

(1) Only acceptable if walls are fishable, if any of the conditions below exist conduit “stub ups” shall be placed:

(a) Fixed casework
(b) lab counters
(c) fume hoods
(d) horizontal bracing in walls
(e) firewall

ii) J-hooks shall not be routed along walls, pathway will run to center of room and out to hallway if drywall is extended to ceiling a sleeved hole will be placed. Pathway fill ratios shall be adhered too.

iii) J-hooks shall not be placed more than 18” above drop ceiling.

B) Conduit stub ups & J-hooks

i) J-Hooks are an acceptable method of installation from the cable tray to the communications stub up with spacing 4’ on center or less to the “stub ups” located within the rooms.

ii) Conduits to the technology outlets are to be a minimum of one inch based on fill. A dedicated conduit will serve each outlet box. Conduit “stub ups” will extend 2’ from the wall, angle to the center of the room which it feeds, and must have conduit bushings on the ends.

iii) Conduit will be used in any open ceiling environment, unless the University Project Manager/OCIO has approved an alternate method of delivery.
Medical Center: Conduit will be used in any open ceiling environment, unless the WMC Project Manager/Network Infrastructure has approved an alternate method of delivery.

iv) Do not support cable from designated ceiling system or system tie wires or grid in fire rated systems. Tie wires installed specifically for IT with breakaway grid clips are acceptable upon approval.

C) Technology Outlet boxes/low voltage mounting brackets

i) Technology outlet boxes will be H-4 11/16" X W-4 11/16" X D-2 1/8", equipped with a 2-gang cover/plaster ring when installed with conduit.

ii) Wall-phone outlets will be equipped with a single-gang cover/plaster ring. The height of these boxes will be determined by the use of the box.

iii) For wireless AP installs in the ceiling requiring conduit, basis of design is: Randall Product # T-55017 with a single gang mud ring or University Project Manager/OCIO approved equal.

iv) Low voltage mounting brackets for "open air" installs Basis for Design and Performance:

(1) Double gang new construction attaches to stud: Caddy MP2S
(2) Single gang new construction attaches to stud: Caddy MP1S
(3) Double gang existing walls: MPLS2
(4) Single gang existing walls: MPLS

2) Conduit

A) No conduit run, without a pull box, is to exceed 100 feet with no more than 180 degrees bends.

B) No LB(s) are to be used in lieu of pull boxes for communications.

C) See D rating chart. (See Exhibit H). This includes all conduits, 40% fill at turnover and one additional conduit if fill ratio is at 40% or greater within that pathway.

D) All riser pathway will have at a minimum one empty conduit upon project completion.

E) All conduits that extend more than 25' will be required to be bonded/grounded per the NEC.

F) All conduit will have bushings installed.

G) Do not place pull boxes above fixed ceilings, HVAC ducts or piping

H) Electrical Non-Metallic (ENT) conduit is acceptable.

i) ENT is only to be used for TOs (technology outlet) not main pathway.
ii) When ENT style conduit is used size shall be increased by ½".
iii) ENT will be securely fastened to tray and TOs.
iv) Bushings shall be installed at each end.
v) Not acceptable in exposed conditions

3) Basket Tray

A) A basket tray will be placed above drop ceilings in the hallways/corridors; it will not be placed above offices or classrooms. At no time is it acceptable to have basket tray above a hard ceiling or HVAC ducts. At no time does an access panel constitute an accessible space.
Medical Center: In addition, a basket tray will be placed above drop ceilings in hallways and corridors; it shall not be placed above patient/treatment rooms, procedure rooms, conference rooms, and offices.

B) This tray will provide a path back to the Technology Room (TR). Cable trays and conduits must be properly grounded. All NEC codes for grounding of cable trays will be adhered to. Tray supports will be installed per the heaviest load rating per the manufacturer and NEMA Standards Publication VE-2000.

Medical Center: Supports shall not exceed 5' spans, 4' if secondary j-hook pathways are installed in them.

C) If basket tray changes elevations and travels above other mechanicals for more than 5', conduit must be placed in lieu of tray. The conduit will be sized per the max fill on the tray.

D) Basis for Design and Performance: Cablofil part number CF-XXX or approved equal through the University Project Manager/OCIO [WMC Project Manager/Network Infrastructure]

E) Center Support Hangers shall only be used due to space restrictions and must be approved by owner.

F) Conduit sleeves shall be installed over rod and extend 8" above tray wall to protect cabling from damage during installation.

G) Tray may not be altered or notched to allow structural or other mechanicals passage.

4) Fire stopping

A) An approved UL fire stop system must be used when penetrating fire rated walls or floors. All firestopping devices will be of the mechanical type, if for some reason a mechanical firestop solution is not available firestop will be a non-hardening pliable putty. All firestop penetrations will be an UL listed system, with labels adjacent to each penetration. Close out documents will include pictures of each penetration and the label affixed to the wall. Basis for Design and Performance: Hilti CP653BA, CP653, CP618 IFP26TI or equal approved by the University Project Manager/OCIO.
Medical Center: All firestopping devices will be of the mechanical type, if for some reason a mechanical firestop solution is not available, consult with WMCNI for a solution. All firestop penetrations will be an UL listed system, with labels adjacent to each penetration. Close out documents will include pictures of each penetration and the label affixed to the wall.

Basis for Design and Performance: Hilti CP653BA, CP653, and CFS-PL or approved equal through the WMC Project Manager/Network Infrastructure.

SECTION IV ENTRANCE FACILITIES (EF), AND TECHNOLOGY ROOMS (TR) *(see exhibit C)*

MEDICAL CENTER: All new EF(s) / MTR(s), or TR(s) will utilize modular Keystone patch mounted racks for connectivity of all category 6 cabling. (Exhibit N and O)

1) **All new EF(s)/MTS(s), or TR(s) will utilize modular patch panels mounted on racks for connectivity of all category 6/6A cabling.**

   A) Basis of Design and Performance: Hubbell HPJ24 and HPJ48

   MEDICAL CENTER: All new EF(s) / MTR(s), or TR(s) will utilize modular Keystone patch panels mounted on racks for connectivity of all category 6/6A cabling.

      i) Basis for Design Performance: Standard TO CAT6 – Commscope 2111528-1
      ii) Basis for Design Performance: Wireless CAT6A – Commscope 760207274

   B) All EF(s)/MTR(s)/TR(s) will be connected via cable pathway that shall consist of basket tray or conduit.

   C) In the EF, only Cat 3 riser cables will be placed on 110 blocks, next to the entrance cables. Cat 3 riser cables will be a minimum of 25 pair to each TR. In the TR, riser cables will be terminated on the racks in patch panels with one pair per port except for the last RJ45, which will terminate with two pair (V/BR-V/SL) on pins 4/5 and 3/6. Within the EF, a minimum of 25 pair cable will be run to the riser wall field to the termination rack. Basis for Design and Performance: Hubbell® 110BLK300FTK5
   Medical Center: Within the EF, a minimum of 25 pair cable will be run to the riser wall field to the termination rack. Basis for Design and Performance: COMMSCOPE® 110AB2-100FT

   D) Cable tray will be sized in each EF/TR so that no cable will hang over the edge and that all bend radius' are met per the cabling manufacturer's specifications. The minimum size shall be an 18" cable tray (basket tray is not acceptable within any EF/TR). Basis for Design and Performance: Hubbell HLS06**B
   Medical Center: Basket tray basis for Design Performance: Legrand CF105/450EZ

   E) When using 110 blocks, all riser cable will be routed at the bottom of all boards and will feed up into the bottom of the 110 blocks. At no time will cable be placed down the center of a board, all cables will be routed down the corner of the TR.

   F) In existing buildings, the new installation will match the existing EF/MTR/TR (blocks, patch panels) installation. New EF/MTR/TR installs will be built according to the new guidelines

   G) All cables will be secured with Velcro style ties; plastic cable ties of any type are not acceptable.

   H) **Medical Center:** All EF(s)/MTR(s)/TR(s) should be considered critical path and ready for commissioning at the same time electrical rooms are.

I) All TRs should be vertically stacked above and below each other to reduce cost and impact to business for new and future technology installations.

J) There must be at least one EF, MTR, or TR per floor. One EF is required per building and shall not be placed above the second floor of any building. An MTR is required if the building exceed five floors and shall not be placed below the 5th floor of any building. A TR should be placed centrally. If any cable length exceeds 90m (295 ft), including slack, from the TR an additional TR is required to support the total area.

2) Spaces for connection of the building communication cable to equipment will be provided in a separate room and not shared with other utility services, particularly the electrical service. When possible, this room will not be adjacent to the electrical distribution room. EF(s)/MTR(s)/TR(s) will be a secure room directly accessible from a hallway, public access space, or within a mechanical room built out to meet Campus Cabling Standards. All TR(s) require the design, installation, and commissioning of an appropriately sized HVAC system. Room temperature must be maintained between 65 to 85 degrees Fahrenheit, with a relative humidity range of 20 to 60 percent. System should be designed to allow a 30% increase to the overall British Thermal Unit count of the finalized design.

3) Janitor's closets and electrical closets are not considered appropriate EF/MTR/TR spaces.

4) Unless approved otherwise by the University Project Manager/OCIO the EF/MTR room size shall be a minimum 10'x14' and located not more than 50' from the outside plant cable main point of entry (MPOE). Threaded rigid metallic conduit shall be placed from the MPOE to the EF. TR(s) minimum room size shall be 10'x10'. Larger EF/TR(s) mat be required based on the number of Work Areas that will feed from the EF/TR(s). EF/TR(s) will be environmentally controlled to insure proper reliability of electronic equipment.
Medical Center: Unless approved otherwise by the University WMCNI the EF/MTR room size shall be a minimum 14'-8"x21' and located not more than 50' from the outside plant cable main point of entry (MPOE). Threaded rigid metallic conduit shall be placed from the MPOE to the EF. A TR(s) minimum room size shall be 12'-6"x14'-8". EF(s)/MTR(s)/TR(s) will be environmentally controlled to insure proper reliability of electronic equipment.

5) All walls of EF(s)/MTR(s)/TR(s) shall have backboards. Backboards for EF(s)/MTR(s)/TR(s) are to be ¾"x48"x96" fire retardant treated plywood with the A side facing the room, mounted vertically, and placed within 12" of floor. At no time is it acceptable to run/mount anything on backboard within any ER/MTR/TR other than communications cabling or equipment. All electrical outlets and switches will be installed within wall cavities. Backboards are to remain unpainted or they will have to be replaced at projects expense.

6) At no time will any water or sanitary pipes be run through an EF/MTR/TR, unless these items are needed for equipment within this room. If required, drip pans shall be installed to minimize damage to equipment below the pipes in the event of a leak. Sprinkler heads will be provided with guards.

7) At no time is it acceptable to have a transformer within the EF/MTR/TR, the only time an electrical panel is acceptable is if feeds equipment within the EF/MTR/TR. At no time shall any liquid or sanitary pipes be run through an EF/MTR/TR, unless required for equipment directly serving the room. If required, drip pans shall be installed to minimize damage to equipment below the pipes in the event of a leak.

8) EF(s)/TR(s) can house ~~NetShelter~~/Lenel/ACAMS equipment, BUCKID, AV, and Fire Alarm controls as long as clearances are maintained for all racks and wall mount equipment and all codes are met for equipment. ~~For the NetShelter layout, refer to *exhibit I.*~~
Medical Center: EF(s)/MTR(s)/TR(s) can house Security equipment, Nursecall, Facilities, Clinical Engineering, AV, and Fire Alarm controls as long as clearances are maintained for all racks and wall mount equipment and all codes are met for equipment.

9) EF(s)/MTR(s)/TR(s) will be designed as to allow 3' of room at the back of the racks (measured from the back of installed switches) and 3' on the front and side (one) of the racks.

10) All EF(s)/MTR(s)/TR(s) will be secured with a card swipe whether a remodel or new. The door will swing out. There will be no ceiling, and walls finished to deck.

11) At all EF/MTR/TR locations a double duplex electric outlet will be **provided on a dedicated circuit placement of these circuits shall be at the top of each data rack (**on the outside of the cable tray)**.** A 20-amp courtesy outlet will be placed on each usable wall of the room.
Medical Center: In all EF/MTR/TR locations, double duplex electric outlets shall be **provided on dedicated emergency circuits at the top of the data racks between every other rack (**attached on the outside of the basket tray)**.** A 20-amp courtesy outlet will be placed on each usable wall of the room. Additional power at specific racks will need to be determined, designed, and installed by the project. These requirements will have to be determined during the Design Document phase of the project. These outlets are to directly support UPS systems and network gear deployed by WMCNI and WMCNE once capacity is determined.

12) Lighting for all EF/MTR/TRs will be 50 foot candles 3' off finished floor, including behind and in front of racks.

13) In large buildings, more than one TR per floor may be required. A large building is defined as any building in which the physical layout of a floor would require cable "runs" (EF/TR to Telecommunications Outlet (TO)) in excess of 90 meters.

14) The floor of the EF/MTR/TR can be tile or sealed concrete.

15) A "ring run" will be provided at all Entrance Facilities to keep jumper (crosscut) wire organized. This will be accomplished by the use of 4-inch wide aluminum "D" rings screw-mounted above the top of the 110 Cat 3 riser blocks. The bottom of the "D" ring will be mounted two inches above and centered over the space between each vertical row of blocks. "D" rings should be open or split to allow placement of crosscut wire.
Medical Center: Wire management shall be provided at all Entrance Facilities to keep jumper (crosscut) wire organized. This will be accomplished by the use of cable trough with legs screw-mounted above the top of the 110 Cat 3 riser blocks and verticaly on each side. Basis for Design and Performance: COMMSCOPE 107831133.

16) Equipment Racks:

A. Basis for Design and Performance; Hubbell® HPW84RR19D or OCIO approved equal through the University Project Manager/OCIO
Medical Center: Basis for Design and Performance; Eaton® SB55609619U6AL or approved equal through the WMC Project Manager/Network Infrastructure.

i. Any racks that are floor mounted will be supported at the top by the cable tray system. The cable tray system will be engineered at such a height that cable water falls work properly.
Medical Center: Standard 8 foot high by 19 inch wide by 6" deep aluminum/metallic unpainted.

ii. All racks must be grounded to the Telecommunications Main Ground Bar (inside the EF) or the Telecommunications Ground Bar (TGB) in each MTR/TR. The connection in the rack must be connected by a rack grounding busbur with no less than fourteen mounting holes.

iii. Provide a multi-outlet AC plug strip. Provide enough outlets to accommodate all electronic devices in the relay rack. The strips shall be mounted on standoff brackets to provide 6 inches of separation from the cable management system. Strips shall be mounted on the rear of the rack. If UPS systems are being used, AC power must be evenly distributed between UPS and other source of AC power. Basis for Design and Performance: Hubbell® PR10420 with PRSLB4 or approved equal through the University Project Manager/OCIO

iv. For rack layouts refer to Exhibits D and E.
Medical Center: For rack layouts refer to Exhibits P and Q.

17) Wire Managers:

A. Vertical Wire Managers (2 per rack-black)

i. The wire manager shall be sized to match cabling requirements.
Medical Center: The wire manager shall be a sized at 10" unless otherwise specified and agreed upon by WMCNI.

THE FOLLOWING PARAGRAPHS (ii AND iii) OCIO ONLY

ii. A single vertical wire manager may be used in between bayed racks/frames if it is sized to match cable requirements for both racks/frames.

iii. Finish shall be powder coat paint in the color as specified.

(1) 1-Hubbell®® EA ICKSS6 (spindles pack of 50) will be included with each rack, or approved equal through the University Project Manager/OCIO

B. Basis for Design and Performance; Hubbell®® VM610 (2-each) or approved equal through the University Project Manager/OCIO
Medical Center: Basis for Design and Performance; Eaton® SB860810D096FB or approved equal through the WMC Project Manager/Network Infrastructure.

C. Horizontal Wire Managers (3 per rack-black)

i. Horizontal wire managers will be 2 rack units and be the same depth as vertical wire managers.

ii. Basis for Design and Performance: Hubbell® HM27C or approved equal through the University Project Manager/OCIO
Medical Center: Basis for Design and Performance: Panduit® WMP1E or approved equal through the WMC Project Manager/Network Infrastructure.

18) Patch panels

A. Patch Panels shall be sized to accommodate current project requirements plus 30% growth capacity. Patch panels shall not exceed 5 x 48 port (maximum total of 240 connections) in a rack.
Medical Center: Patch Panels shall be sized to accommodate current project requirements plus 30% growth capacity. Patch panels shall not exceed 6 x 48 port (maximum total of 288 connections) in a rack. Must be unloaded keystone panels.

i. Basis for Design and Performance: Hubbell® HPJ48 or approved equal through the University Project Manager/OCIO
Medical Center: Basis for Design and Performance: COMMSCOPE® 2111528-1 or approved equal through the WMC Project Manager/Network Infrastructure.

ii. Rear cable management bars for patch panel are required (2 per patch panel)

iii. Basis for Design and Performance: Hubbell® HPRCMB or OICO approved equal through the University Project Manager/OCIO

19) Enclosed cabinets:

A. Enclosed cabinets shall have a roof mounted cable fan and cable entry

B. Enclosed cabinets must be at least 32 inches deep to accommodate a rack mounted UPS.

C. Basis for Design and Performance is: Hubbell® part #H2N8032 or approved equal through the University Project Manager/OCIO

THE PREVIOUS SECTION 19) DOES NOT APPLY TO WEXNER MEDICAL CENTER

20) Wall mounted racks:

A. All wall mounted racks will be mounted on ¾ inch" type APA A-D Group 1 plywood, fire retardant treated, with the A side facing the room.

B. Basis for design: Hubbell® part # HSQ2426 or approved equal through the University Project Manager/OCIO

THE PREVIOUS SECTION 20) DOES NOT APPLY TO WEXNER MEDICAL CENTER

21) For each Work Area Outlet the project is to provide one 1' and one 10' Cat 6 patch cord of the same manufacturer and level of the Structured Cabling System being installed. Basis for design: Hubbell part #HC6xx01 and #HC6xx10

THE PREVIOUS SECTION 21) DOES NOT APPLY TO WEXNER MEDICAL CENTER

22) All terminations will be labeled left to right in sequential/alpha order.

THE PREVIOUS SECTION 22) DOES NOT APPLY TO WEXNER MEDICAL CENTER

23) Build out of terminations will be left to right.

THE PREVIOUS SECTION 23) DOES NOT APPLY TO WEXNER MEDICAL CENTER

24) Technology Rooms must be periodically cleaned after being turned over for equipment installs and construction in the room is completed to ensure a clean environment during the rest of the construction process.

GROUNDING

1. All grounding and bonding is to be done in Accordance with the NFPA/NEC codes and ANSI/TIA/EIA standards, for new construction and renovations.

2. At each EF there will be one TMGB grounded and bonded to the buildings main ground. The gauge of the grounding conductor will be a minimum of a 3/0 AWG. This conductor shall be in conduit to each TR.

3. At each MTR/TR, there will be one TGB (size based on the number of grounds within TR and backbone needs). Size of ground/bonding conductor to each TR is based on footage and can be found in Exhibit J. This conductor will be in a separate conduit from the EF to each MTR/TR.

4. All grounding/bonding connectors will be 2-hole compression style connectors or Cad welded. Each connector will be secured to the TMGB/TGB with a minimum of two bolts and antioxidant inhibitor applied.

5. Each rack will contain a horizontal ground bar and will be grounded/bonded to the TMGB/TGB.

    a. Basis for Design and Performance: Hubbell® part # HGRKTHC or approved equal through the University Project Manager/OCIO.
    Medical Center: Basis for Design and Performance: Panduit® part # RGRB19Y or approved equal through the WMC Project Manager/Network Infrastructure.

6. All tray will be bonded with a bonding jumper and bonded to the ground bar within each EF/MTR/TR.

7. Install Bonding Equalizer where required per ANSI/TIA/EIA-607.

8. For TBB/GE size, see Exhibit J.

9. All TBB/GE will be run in conduit between EFs/MTRs/TRs.

10. Daisy chaining or serial connections from one rack or cabinet to another will not be accepted.

11. Each individual patch panel shall be installed with at least one green thread-forming bonding screw.

12. All TMGB(s) and TGB(s) will be pre drilled and the wall mounting brackets shall provide a minimum of 2” separation from the wall to the back of the busbar.

13. All Equipment shall be bonded to the rack groundbar.

SECTION V LIFE SAFETY CIRCUITS WIRELESS ACCESS POINTS ~~AND NETSHELTER~~

1) **ELEVATOR PHONES** *(Exhibit B)*
Medical Center: (Exhibit M)

A) It shall be written into the contract documents that the Electrical Contractor is responsible for the installation costs of the elevator phone line(s).

i) The Electrical Contractor shall send OCIO [WMCNI] a letter on company letterhead/company email requesting service be activated to the specific elevator equipment room(s). Indicating the date of service is also required.
NOTE: Normal installation time for OCIO is 5 working days from the date of receipt of the request. OCIO email for service requests: ocio-request@osu.edu.
Medical Center: NOTE: Normal installation time is 12 weeks from the date of receipt of the request. WMCIT email for service requests: ITNetworkInfrastructure@osumc.edu.

ii) The University Architects Project Manager shall send the OCIO an E-Request requesting that monthly service fees for the elevator phone lines at the specific location be charged to them on the account number provided.

iii) The University Project Manager/OCIO will solicit the above documents from the Electrical Contractor and Facilities, Operation and Development, attach them together and forward them to OCIO [WMCNI].

iv) Before request for elevator, lines are submitted the OCIO shall have been notified to place the main feeds coming into the building. If any temporary cabling is needed the project will be responsible for this cost.

v) See exhibit B for details
Medical Center: See exhibit M for details

vi) Medical Center: WMCNI will have to engage a vendor to have the proper lines installed, so advanced notification is encouraged.

vii) Phones will be patched with a red patch cable.

THE PREVIOUS SECTION vii) DOES NOT APPLY TO WEXNER MEDICAL CENTER

viii) D-marc will be placed at wall phone height.

THE PREVIOUS SECTION viii) DOES NOT APPLY TO WEXNER MEDICAL CENTER

2) **EMERGENCY PHONES**

A) Cable will be an outdoor rated 6 pair Category 3 cable with water blocking compounds to prevent moisture intrusion, have an operating range suitable for -40oC to +80oC, and meet Category 3 transmission requirements. Basis for design: Superior Essex part number 04-061-85

B) From the protection unit in the TR a 4 pair cable will be extended to the rack and terminated on a jack in the patch panel.

C) Overvoltage protection to be provided at both ends. Grounding will be provided at both ends and NEC codes and applicable standards will be met. Electrical contractor to provide ground at stanchion. Basis for design: Circa Telecom model # 502 equipped with two 1360-75 modules.

D) One 2" conduit will be placed for low voltage communications to each stanchion from the nearest building telecommunications room. Prior to entering the building the 2" conduit will transition to rigid metallic conduit to the nearest TR. The communication pathway will be separate from power pathway.

E) Meets Category 3 transmission requirements.

F) Pathway will meet Outside Plant standards.

THE PREVIOUS SECTION 2) DOES NOT APPLY TO WEXNER MEDICAL CENTER

3) **WIRELESS ACCESS POINTS**

GENERAL

Upon completion of the Design Development (DD) phase of documents AutoCAD prints will be submitted to the University Project manager. University Project Manager/OCIO will submit a request through Service Now for a virtual survey. OCIO Wireless Networking will design a solution and submit to the University Project Manager for inclusion into the bid documents.
Medical Center: Upon completion of the Design Development (DD) phase of documents AutoCAD prints shall be submitted to the OSUWMC Project manager. WMC Project Manager (WMCPM) will engage WMC Network Engineering (WMCNE) to do virtual survey. WMCNE will design a solution and submit to the WMCPM for inclusion into the bid documents. The design will include an additional allowance of locations to be determined by the project size and scope to augment any coverage shortfalls identified once the final certification is performed by WMCNE.

During this process it will be determined which option below the project would like to use for the installation of the Wireless Access Points. For installation instructions refer to Exhibits F and G.
Medical Center: For installation instructions refer to Exhibits R and S

There are three installation options available to construction projects:

A) Option A

OCIO [WMCIT] complete install, this includes the following:

i) Installation of Wireless Access Points including cabling and basic pathway by the OCIO [WMCIT]. Cable tray pathways are not included.
ii) If additional pathway is required it will be included in the estimate to the customer
iii) Full price no credits.

B) Option B

Project supplies pathway and cable terminations, OCIO [WMCIT] installs Wireless Access Points

i) Installation of pathway and cabling by project
ii) Project is responsible for all terminations, labeling and testing
iii) Prior to placement project will provide a mock-up of the installation and work with the University Project Manager/OCIO [WMCNE] for approval.
iv) OCIO [WMCNE] will place Wireless Access Points upon completion of all testing.

C) Option C

Project is responsible for pathway, cabling, terminations and Wireless Access Point installation.

i) Installation of pathway and cabling by project
ii) Project is responsible for all terminations, labeling and testing
iii) Prior to placement project will provide a mock-up of the installation and work with the University Project Manager/OCIO [WMCNE] for approval.
iv) Project will place Wireless Access Points upon completion of all testing.
v) OCIO [WMCIT] will provide all Wireless Access Points to the project for installation.

Medical Center: Once the wireless system is installed, a final verification and certification will be completed by WMCNE. If any shortfalls are discovered WMCNE will identify them to the project to have the appropriate vendor take action and install the identified additional locations from the allowance determined in the design. If the additions exceed the designed allowance, WMCIT will negotiate a resolution with the project.

Design considerations for wireless installations should include penetrations for roof access and any outside locations.

1. **Medical Center:** Ceiling tile installations will utilize the following:
   i) Basis for Design and Performance: VENTEV part # TW-CTEN-2X2-3802B or approved equal through the WMC Project Manager/Network Engineering.

2. Solid ceiling installations will utilize the following:
   i) Basis for Design and Performance: VENTEV part # TW-HCEN-3802 or approved equal through the WMC Project Manager/Network Engineering.

4) **CAMERAS**

A. Cameras will be placed on their own patch panels in the rack and follow Appendix M standards for cabling.

5) **Overvoltage/lightning Protection for data cabling (when required):**

Basis for Design and Performance ITWLinx part # 2090-192-30B or 2090-220-30B depending on installation environment. Or approved equal through the University Project Manager/OCIO. [WMCIT]

~~6) **NetShelter**~~

~~A) The project shall install a minimum of twelve Category 6 data link lines with the installation of the NetShelter. These will be placed from the NetShelter to the Rack within the EF/TR. These link lines shall be placed on their own patch panel and labeled as "NetShelter Link 1, NetShelter Link 2 and so on". Make and Model numbers for the Netshelter can be found in Division 28 of the BDS. Please see exhibit I for installation guidelines and required conduits.~~

~~B) The project will also install one additional CAT 6 line for a dial backup line from the technology outlet patch panels. Located in the racks to the NetShelter.~~

~~C) See Exhibit I for installation instructions.~~

~~**THE PREVIOUS SECTION 6) DOES NOT APPLY TO WEXNER MEDICAL CENTER**~~

SECTION VI TECHNOLOGY OUTLETS (TO), JACK, CABLE DESIGN & PERFORMANCE GUIDELINES

GENERAL

All components of the structured cabling system will be **Component Certified** to meet the appropriate category of cabling being installed. The manufacturer shall provide Category 6 component compliance certificates from a recognized third party testing organization upon request. All jacks, faceplates, patch panels, and patch cords will be of one manufacturer and supplied by the contractor. At no time are "modular plugs" for terminations acceptable.

1) Minimum Requirements for work area Technology Outlets (TOs), except for Wireless Access Points and wall phone outlets will be Category 6, black RJ45 jacks.

   A) Basis for Design and Performance: Hubbell® part # HXJ6BK or OCIO approved equal through the University Project Manager/OCIO

   Medical Center: Minimum Requirements for work area Technology Outlets (TOs), except for Wireless Access Points will be Category 6, black RJ45 jacks unless otherwise noted for below systems.

   A. Basis for Design and Performance: COMMSCOPE or approved equal through the WMC Project Manager/Network Infrastructure

      i) Black – Standard Data Outlet – part # 2291216-2
      ii) Orange – Dedicated Circuit - part # 2291216-5
      iii) Red – Security - part # 2291216-7
      iv) Grey – Facilities (Circuits for BAS and Nurse Call) - part # 2291216-4
      v) Green – Patient Phones/Dedicated Voice/POTS/T1 circuits - part # 2291216-9
      vi) Blue – Clinical Engineering (designated clinical on drawings) - part # 2291216-6
      vii) Yellow – Clinical Engineering, Time Clock, and Digital Clocks - part # 2291216-8
      viii) Purple/Violet – Special Circuits (MOXA(OBIX), PCI) - part # 2291216-0
      ix) White – In ceiling cameras and other devices – part # 760235588

2) Minimum Requirements for Wireless Access Point (Wireless Access Points) will be one Category 6A, gray RJ45 jack. The jack will be terminated within a single opening surface mount box. A 1' cat 6A patch cord will be supplied for each end and will be channel tested for Performance. Please see Exhibit F & G for installation guidelines.
   Medical Center: Minimum Requirements for Wireless Access Point (Wireless Access Points) will be one Category 6A, white RJ45 jack. The jack will be terminated within a single opening surface mount box. A white 5' Cat 6A patch cord will be supplied for the TR end and the installation shall be channel tested for Performance. See Exhibits R and S for WMC.

   A) Basis for Design and Performance: Hubbell® part # HJ6AGY or OCIO approved equal through the University Project Manager/OCIO
   Medical Center: Basis for Design and Performance: COMMSCOPE or approved equal through the WMC Project Manager/Network Infrastructure

      i) White – at TR for Wireless Access Points – part # 68301835-01

ii) White – at Wireless Access Points – part # 760235592

3) Wall phone outlets will be stainless steel, equipped with a flush Cat6 data jack, and designed for modular mounting of wall phones. Basis of design: Hubbell part #SP6F or equal approved by the University Project Manager/OCIO. The mounting must be ADA compliant.
Medical Center: Wall phone outlets must be ADA compliant and are a standard RJ45 outlet.

4) Patch cords:
A) For TOs two patch cords will be included, one 1' and one 10' for each outlet, for bid purposes, contractor will work with customer/project A/E/OCIO for sizing prior to ordering.
i) Basis for Design and Performance: Hubbell® part # HC6BXX (*XX=length)* or OCIO approved equal through the University Project Manager/OCIO

A) **Medical Center:** For TOs three patch cords shall be included, two 5' and one 7' for each Category 6 cable, for bid purposes, contractor will work with customer/project A/E/OCIO for sizing prior to ordering.

1. Standard Data Patch Cable Teal
   i. Basis for Design and Performance: COMMSCOPE part #UNC6-GRXX (XX=length) or approved equal through the WMC Project Manager/Network Infrastructure.

2. Standard Data Patch Cable Pink
   i. Basis for Design and Performance: COMMSCOPE part # UNC6-PKXX (*XX=length)* or approved equal through the WMC Project Manager/Network Infrastructure.

3. Standard Data Patch Cable Yellow
   i. Basis for Design and Performance: COMMSCOPE part # UNC6-YWXX (XX=length) or approved equal through the WMC Project Manager/Network Infrastructure.

Colors for patch cords:
i. Standard Cat 6A data- green
ii. Clinical Engineering – pink and yellow

B) For Wireless Access Point two patch cords will be included one 1' and one 1'.for each outlet.
i) Basis for Design and Performance: Hubbell® part # HC6AGY01 or OCIO approved equal through the University Project Manager/OCIO.
Colors for patch cords:
1) Standard Cat 6 data- blue
2) Wireless- gray
3) Cameras, Life Safety and Security- Red

B) **Medical Center:** For a Wireless Access Point one 5' patch cord will be included for each outlet unless another length is specified.
1) Basis for Design and Performance: COMMSCOPE part # UC1AAA2-08F0XX (*XX=length)* or approved equal through the WMC Project Manager/Network Infrastructure.
Colors for patch cords:
1.Wireless - white

5) Floor mounted outlets will be coordinated with the architect, user, and OCIO [WMCNI] during the planning stages of each project. All floor boxes and poke throughs must be approved by the OCIO [WMCNI].

Approval of any outlets (jacks) on shop drawings shall be approved by the OCIO [WMCNI] through the University [WMC] Project Manager.

6) The faceplate will be stainless steel or plastic in accordance with architectural design. The faceplate shall have four or six modular openings. Openings without jacks installed, will have blank inserts installed. Stainless steel covers shall be used in auditoriums, classrooms, and where frequent use or abuse is more likely.
   A) Plastic Faceplates basis for Design and Performance: Hubbell® IFP26TI or equal approved by the University Project Manager/OCIO
   B) Stainless Steel Faceplates Basis for Design and Performance: Hubbell® SSF206 or equal approved by the University Project Manager/OCIO
   C) Blanks for Faceplates Basis for Design and Performance: Hubbell® SFBI10 or equal approved by the University Project Manager/OCIO

6) **Medical Center**: The faceplate will be plastic and will be from the same manufacturer as the jacks. The faceplate shall have the required modular openings for the installation. Openings without jacks installed will have blank inserts installed.

   A) Faceplates basis for Design and Performance: COMMSCOPE part # 1-21110XX-3 (XX=openings style) or WMCNI approved equal by the University Project Manager/IT.
   B) Blanks for Faceplates Basis for Design and Performance: COMMSCOPE part # 1-2111486-3 or approved equal through the WMC Project Manager/Network Infrastructure.

7) Any configurations beyond this minimum standard will be handled on a per job basis.

TECHNOLOGY CABLE

1) CAT 6 CABLE- RISER RATED

   A) Basis for Design and Performance is Hubbell® part #: C6RRB or approved equal through the University Project Manager/OCIO

1) **Medical Center:** CAT 6 CABLE
   A) Teal Cable
      i) Basis for Design and Performance is COMMSCOPE part #: 4662504/10 or approved equal through the WMC Project Manager/Network Infrastructure.

2) CAT 6 CABLE- PLENUM

   A) Basis for Design and Performance is Hubbell® part #: C6RPB or approved equal through the University Project Manager/OCIO

2) **Medical Center:** CAT 6 CABLE
   A) White Cable
      i) Basis for Design and Performance is COMMSCOPE part #: 4763314/10 or approved equal through the WMC Project Manager/Network Infrastructure.

3) CAT 6A CABLE- RISER

A) Basis for Design and Performance is Hubbell® part #: C6ASRDSGY or approved equal through the University Project Manager/OCIO

3) **Medical Center:** CAT 6 CABLE
A) White Cable
i) Basis for Design and Performance is COMMSCOPE part #: UN884025514/10 or approved equal through the WMC Project Manager/Network Infrastructure.

4) CAT 6A CABLE- PLENUM

A) Basis for Design and Performance is Hubbell® part #: C6ASPDSGY or approved equal through the University Project Manager/OCIO

4) Medical Center: CAT 6/6A CABLE
A) Standard Data White Color
i) Basis for Design and Performance is COMMSCOPE part #: UN874026814/10 or approved equal through the WMC Project Manager/Network Infrastructure.

RISER CABLE

GENERAL

All riser cable pathways whether horizontal or vertical will be based upon on all sleeves with 40% fill plus as a minimum of 1 empty new pathway for future.

THE PREVIOUS SENTENCE DOES NOT APPLY TO WEXNER MEDICAL CENTER

There will be no splicing of riser cables in the pathway, all cables will be direct home runs from each EF to each MTR/TR. The only splicing allowed will be inside the EF/MTR/TR for fiber pigtails within each housing.

1) COPPER

A) Riser cables will be 24 gauge, Category 3, twisted solid annealed copper conductors, individually insulated and color coded in accordance with telephone industry standards. Cables having more than 25 pairs will be assembled in individual color-coded binders. All communications wire or cable installed in a building must meet requirements of Article 800 of the National Electrical Code.

B) During renovation, projects where an EF, MTR or TR is being created or relocated splicing the riser cables shall be reviewed by OCIO. Upon approval, splicing may be permitted in the copper riser cables only. Modular splicing devices that are to be used must also be approved.

C) Minimum size is 25 pairs.

D) Six copper Cat 6 cables will be placed for “link lines” from each EF/MTR to each TR if the distance is within 90 meters. These link lines will be terminated on separate patch panels in each EF/MTR/TR and labeled with TR number and patch panel position.

2) FIBER

A) Install one six-strand OM3 armored fiber cable. The cable will be placed from each EF to each TR and terminated with six strand fusion spliced pigtails, or factory preterm with LC/UPC style connectors. Sheath will be bonded and grounded on both ends.
   i) Basis of design and Performance: Corning 006T81-31180-A1 for riser rated or approved equal through the University Project Manager/OCIO

   ii) Basis of design and Performance: Corning 006T88-31180-A3 for plenum or approved equal through the University Project Manager/OCIO

B) Install one six-strand singlemode armored fiber cable. The cable will be placed from each EF to each TR and terminated with six strand fusion spliced pigtails, or factory preterm with SC/APC style connectors.

   i) Basis of design: Corning 006E81-31131-A1 for riser rated or approved equal through the University Project Manager/OCIO

   ii) Basis of design: Corning 006E88-31131-A3 for plenum or approved equal through the University Project Manager/OCIO

C) Fusion spliced cassettes will be used at each EF/TR for connectivity. LC/UPC shall be used for multimode and SC/APC will be used for singlemode.

   i) Basis of design: Corning CCH-CSXX-XX-XXXXX or WCH-XXP or OCIO approved equal through the University Project Manager/OCIO

D) All splice cassettes will be placed in appropriate sized fiber housings intended for that purpose.

E) For every six strands of fiber terminated there will be two duplex fiber patch cords supplied. Multimode will be LC/UPC-to-LC/UPC three meters in length. Singlemode will be SC/APC to LC/UPC 3 meters in length.

F) Jumpers will be of the same manufacturer/material as fiber.

G) There will be a 20’ service loop at each TR and the EF on each fiber. The 20’ service loop will be placed on the wall using Leviton 49800 FR for slack management (see Exhibit A) in a craftsmanship like manner.

H) All Fiber Optic cables shall be home run from the EF or MTR to each TR. The only allowable splicing is within the fiber termination housing for the final fusion spliced terminations. **All Fiber Optic Cable inside of buildings will be armored for protection and be bonded and grounded at each end if metallic armored.**

THE PREVIOUS SECTION 2) DOES NOT APPLY TO WEXNER MEDICAL CENTER

2) Medical Center: FIBER

GENERAL

Multi-Mode fiber is only allowed in data center applications. Multi-Mode is not allowed in building backbone applications. 62.5 Multi-Mode cable is prohibited unless approved by owner for any application.

A) Data Center
   i) 12 strand OM3 Multi-Mode MTP-MTP fiber cable. The cable will be placed from rack to rack and terminated in LC/UPC MTP adapter modules (Cassettes).
      (1) OM3 Cable basis of design and Performance: Corning Inc. A757512TPNBB (lengths to be determined) plenum rated only or approved equal through the WMC Project Manager/Network Infrastructure.

(2) Modules basis of design and Performance: Corning Inc. CCH-UM12-05-70T or approved equal through the WMC Project Manager/Network Infrastructure

B) ER/MTR/TR Backbones

i) Install one twelve strand singlemode plenum dielectric armored fiber cable. Cables will be placed one each from the EF and MTR to each TR and spliced to factory pretermed cassettes.
(1) OS2 Cable Basis of design: Corning Inc. part # 012E88-33131-D3 for plenum rated or approved equal through the WMC Project Manager/Network Infrastructure

ii) Fusion spliced cassettes will be used at each EF/MTR/TR for connectivity. LC/APC conectorized pigtails will be fusion spliced to the singlemode fiber cable.
(1) Basis of design: Corning Inc. part # CCH-CS12-A9-P00RE or approved equal through the WMC Project Manager/Network Infrastructure

iii) All splice cassettes will be placed in appropriate sized connector housings intended for that purpose.
(1) 2RU Housing basis of design: Corning Inc. part # CCH-02U or approved equal through the WMC Project Manager/Network Infrastructure
(2) 4RU Housing basis of design: Corning Inc. part # CCH-04U or approved equal through the WMC Project Manager/Network Infrastructure

iv) There will be a 20’ service loop at each MTR/TR and the EF on each fiber. The 20’ service loop will be placed on the wall using Leviton 49800 FR for slack management in a craftsmanship like manner.

v) All Fiber Optic cables shall be home run from the EF or MTR to each TR. The only allowable splicing is within the fiber termination housing for the final fusion spliced terminations. All Fiber Optic Cable inside of buildings will be dielectric armored for protection.

C) Optical Fiber Labeling

i) Each fiber optic enclosure shall be uniquely labeled with a numerical and alphabetical combination to create a unique identifier. This unique code applies to newly installed Corning systems; existing systems are not covered by this labeling standard currently. New enclosures in technology rooms shall be identified beginning with **1A**, sequential labeling shall advance alphabetically through Z before advancing numerically (e.g., 1A through 1Z and then 2A). See *Exhibit L* 2 for label placements.

ii) Each fiber optic backbone cable shall be uniquely identified. This identifier consists of the cables source, enclosure ID, strand enclosure position, strand count, destination, enclosure ID, strand enclosure position and strand count. The label shall be 1.500" W x 0.750" H (38.100 mm W x 19.050 mm H) in size and shall contain two rows of text per label. See *Exhibit L.*

iii) A fiber optic cable sheath label shall be placed on the cable itself in strategically placed areas or points of interest based upon the footage, floor changes, building changes, within pull boxes, splice points, and the entry and exit of conduits as defined below in diagram 3. The cable shall also be identified within the source and destination at least 12 inches and no more than 3 feet from the point of jacket removal. The fiber optic cable shall also be labeled at a minimum of every one hundred (100ft.) feet over the entire span of the run. This label will be placed directly on the cable wrapped so all information can be easily identified. The label shall be sized based upon the cable diameter and shall contain two rows of text per label. The label shall completely wrap the cable one time and shall be a self-laminating label. The label shall be 1.500" W x 0.750" H (38.100 mm W x 19.050 mm H) in size and shall contain two rows of text per label.

SECTION VII CABLE INSTALLATION & TERMINATION GUIDLINES

General:

During the POR and DD phase, it shall be decided on the quantity of cables needed at each Technology Outlet (TO). Each wall phone outlet will be cabled with one 4 pair unshielded (**Category 6**) cable. All communication cable installed in a building must meet the requirements of ARTICLE 800 of the National Electrical Code. Splicing in station cable is not permitted cable must be continuous from the nearest TR to the Telecommunications Outlet (TO). Mutoas or Consolidation Points shall not to be used on Campus [at the Wexner Medical Center].

1) Each Wireless Access Point (WIRELESS ACCESS POINT) will be cabled with one unshielded Cat 6A cable, gray in color and terminated on a gray Cat 6A jack. All WIRELESS ACCESS POINT terminations will be on their own patch panel. These will be continuous runs from the nearest TR to the TO. These will be Cat6A channel tested.
   Medical Center: Each Wireless Access Point (WIRELESS ACCESS POINT) will be cabled with one unshielded Cat 6A cable, white in color and terminated on a white Cat 6A jack. All WIRELESS ACCESS POINT terminations will be on their own patch panel. These will be continuous runs from the nearest TR to the TO. These will be Cat6A channel tested.

2) Any cabling that is kinked, stretched, punctured, ripped, twisted, discolored, deformed or painted (even overspray) will be removed and reinstalled at contractor/project cost, regardless if it passes testing.

3) No low voltage cabling will touch ceiling tile, ceiling grids, conduits, walls, or any other structure/trade. Cable will only rest in the pathway that it was designed to be installed in.

4) All cables from the TO will be terminated on the modular patch panels located in the EF/MTR/TR that the cables run to. All category cabling shall be terminated 568A.

5) The proper rated cable shall be used for its intended environment. Cable will be riser rated, plenum, or riser/filled for floor boxes/emergency phones. **If it is a plenum environment and floor boxes/emergency phones are installed, each run will be required to be placed in conduit to the nearest EF/MTR/TR**. The conduit will be placed from the technology outlet to the nearest EF/MTR/TR with a riser rated/filled cable application and meet the conduit specifications within this document.

6) In new building installations riser cables will terminate on the rack one pair per port except for the last jack and it will be terminated with both the violet/brown and violet/slate pair on pins 4/5 and 1/2.

7) Each Technology Outlet will be identified with a unique identifier. Each TO will be labeled with the TR room number which the cable terminates in, and a four digit number which the first number will identify the floor that the TO is on and a three digit following that.

   A) For example:: for cable number 21 on the 2nd floor terminating in room the second floor TR room 214 the unique identifier would be 214-2021 if the same cable was on the 3rd floor terminating in the same closet it would be labeled 214-3021.

   Medical Center: Each Technology Outlet will be identified with a unique identifier. Each TO will be labeled with the EF/MTR/TR room number which the cable terminates in, the room number of the room the TO is in and a three digit number which identifies the patch panel by alphabet and then the corresponding numeric port number on the patch panel. *Exhibit K*.

   (i) Example: 2202 (**TR**) / W326 (**Room**) / A26 (**Patch Panel and Port**)
   1. 2202 / W326M / A26

B) Each floor will be placed on its own patch panel.

C) All numbering will be sequential and flow left to right on patch panels. When TR(s) contain different floors there will be 3 rack units left blank for each floor for future adds.

THE PREVIOUS SECTIONS B) AND C) DO NOT APPLY TO WEXNER MEDICAL CENTER

D) **Medical Center:** Final space identifications for the building must be completed prior to TO labeling. If changed after final TO labeling, the project may be subject to additional cost to correct labeling if room identifications are altered after completion.

SECTION VIII IPTV & CATV OUTLET DESIGN & PERFORMANCE GUIDLINES

General:

During the POR gathering phase the OCIO will meet with the customer and project designers to determine if a CATV or IPTV is the required design and fits the needs for the project. During this phase, the locations will be determined and documented.

THE PREVIOUS PARAGRAPH DOES NOT APPLY TO WEXNER MEDICAL CENTER

Commentary: For all new buildings, IPTV is the preferred method of delivery.

IPTV

IPTV locations shall be treated as a Cat6 data drop and follow the standards for installation, labeling and testing within Appendix M.

Medical Center: Under no circumstances is CATV coax to remain or be re-used in renovation projects

CATV

If during the POR phase a CATV offering is required the OCIO shall design the cable TV distribution upon completion of the DD phase of the drawings. The project will submit a set of AutoCAD drawings to the OSU project manager, the project manager will open a request in Service Now for the OCIO to design the system.

Upon completion of the design OCIO will submit drawings and cost estimate for splicing, hardware, testing and activation to the University Project Manager for inclusion into the bid document.

Contractor will be required to place backbone hardline and cable drops to OCIO standards. The contractor will be responsible for work area coax terminations. The OCIO will terminate the backbone and CATV drops within each TR.

Should OCIO find damaged CATV cable, OCIO will notify the contractor. The contractor will have first opportunity to replace damaged coax at contractor's expense. Should contractor not be able to replace damaged coax in a timely manner, OCIO will have the coax replaced and bill the construction project.

All cable TV runs will be routed directly from the TR to the outlet. Splitters and Amplifiers shall be mounted at the TR. There will be no splicing of station drop cables.

The CATV outlet shall be a 75-ohm female "F" to female "F" wall plate adaptor.

The connectors will be an "F" type compression type fitting. OCIO recommends a Ripley Cablemantic C.A.T. "All Series" compression assembly tool.

CATV CABLE & CONNECTORS

1) STATION CABLES

   A) RISER RATED
      i) For runs less than 200' cable shall be a 6 Series quad-shield 75-ohm coaxial cable.

(1) Basis for Design and Performance: Commscope 5781 or OCIO approved equal
(2) F connector for riser rated cable: Gilbert GF-URS-6 or OCIO approved equal

ii) For runs of 201-350' cable shall be 11 Series quad-shield 75-ohm coaxial cable
(1) Basis for Design and Performance: Commscope 5940 or OCIO approved equal
(2) F connector for riser rated cable: Gilbert GAF URS-11 MH or OCIO approved equal

B) PLENUM RATED
i) For runs less than 200' cable shall be 6 Series quad-shield 75-ohm coaxial cable
(1) Basis for Design and Performance: Commscope 2227V or OCIO approved equal
(2) F connector for plenum rated cable: Gilbert GF UR 6 PL or OCIO approved equal
ii) For runs of 201-350' cable shall be 11 Series quad-shield 75-ohm coaxial cable
(1) Basis for Design and Performance: Commscope 2287K or OCIO approved equal
(2) F connector for plenum rated cable: Gilbert GAF-UR-11 PL or OCIO approved equal

2) RISER CABLE FOR BUILDING DISTRIBUTION
A) Shall be 0.500" aluminum sheathed 75-ohm distribution cable
i) Basis for Design and Performance: Commscope P3 500 CA or OCIO approved equal
ii) Connector Basis and Design: GRS-500-CH-DU-03-T or OCIO approved equal

THE PREVIOUS SECTION CATV DOES NOT APPLY TO WEXNER MEDICAL CENTER

SECTION IX TESTING

GENERAL

Upon completion of installation and acceptance by the OCIO, the cabling contractor will contact the OCIO to witness testing. The OCIO will be given at least one week (5 working days) advanced notice for testing. This testing will be arranged through the University Project Manager/OCIO/WMCNI, at no time will contractor dictate the time/date for testing.

To be tested the system must be complete, this includes all pathway, cabling dressed, labeling, faceplates secured and fire stopping.

All testing will be done with a CCTT (Certified Cable Testing Technician); the CCTT shall perform all testing. The approved test instrument is the Fluke Versiv™ (DSX-5000) or OCIO approved equal.

MARGINALTESTS WILL NOT BE ACCEPTED.

Test instrument shall be within its 12-month calibration period and have the latest software and firmware versions installed. If the test instrument is not within calibration period testing will not take place.

Permanent Link test results, including individual frequency measurements, shall be recorded in the test instrument for subsequent uploading to a PC, using Fluke software, from which administrative documentation (testing reports) may be generated

Testing shall be performed on each cabling segment (connector to connector). Sampling is not acceptable.

OCIO [WMCNI] will witness all setup and referencing of test instruments prior to testing.

Permanent Link adapters made from 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.

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 Permanent Link test each day to ensure no degradation of the test instrument or its Permanent Link adapters.

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:

- The overall Pass/Fail evaluation of the link under test
- The date and time the test results were saved in the memory of the tester
- The identification of the customer site as specified by the end-user
- The name of the test limit selected to execute the stored test results
- The name of the personnel performing the test
- The version of the test software and the version of the test limit database held within the test instrument
- The manufacturer, model and serial number of the field-test instrument
- The adapters used
- The factory calibration date

Provide actual test results in Fluke software form and PDF copies to the OCIO upon completion of project.

TESTING

1) COPPER- Cat 3 riser

   A) Riser cable will be tested one pair at a time with the Fluke Versiv with a single pair block adapter.

   B) All tests will be saved and turned in upon completion of project with other test results.

2) COPPER- Cat 6

   A) All testing procedures and field-test instruments shall comply with applicable requirements of:

      i) ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
      ii) ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
      iii) ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard
      iv) ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
      v) ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.

   B) All cables will be tested for the following:
      i) Wire Map
      ii) Length
      iii) Propagation Delay
      iv) Delay Skew
      v) DC Loop Resistance – recorded for information only
      vi) DC Resistance Unbalance – recorded for information only
      vii) Insertion Loss
      viii) NEXT (Near-End Crosstalk)
      ix) PS NEXT (Power Sum Near-End Crosstalk)
      x) ACR-N (Attenuation to Crosstalk Ratio Near-End) – recorded for information only
      xi) PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) – recorded for information only
      xii) ACR-F (Attenuation to Crosstalk Ratio Far-End)
      xiii) PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
      xiv) Return Loss
      xv) TCL (Transverse Conversion Loss) – recorded for information only
      xvi) ELTCTL (Equal Level Transverse Conversion Transfer Loss) – recorded for information only

   C) All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis. Any Permanent Link 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 meets performance requirements. The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation.

   D) 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 OCIO.

3) COPPER CAT6A

   A) All testing procedures and field test instruments shall comply with applicable requirements of:

i) ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
ii) ANSI/TIA-568-0. D, Generic Telecommunications Cabling for Customer Premises.
iii) ANSI/TIA-568-1. D, Commercial Building Telecommunications Cabling Standard
iv) ANSI/TIA 568 C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.

B) All cables will be tested for the following:
i) Wire Map
ii) Length
iii) Propagation Delay
iv) Delay Skew
v) DC Loop Resistance
vi) DC Resistance Unbalance within a pair
vii) DC Resistance Unbalance between pairs
viii) Insertion Loss
ix) NEXT (Near-End Crosstalk)
x) PS NEXT (Power Sum Near-End Crosstalk)
xi) ACR-N (Attenuation to Crosstalk Ratio Near-End)
xii) PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
xiii) ACR-F (Attenuation to Crosstalk Ratio Far-End)
xiv) PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
xv) Return Loss
xvi) TCL (Transverse Conversion Loss)
xvii) ELTCTL (Equal Level Transverse Conversion Transfer Loss)
xviii) PS ANEXT (Power Sum Alien Near-End Crosstalk)
xix) Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk)
xx) PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
xxi) Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

C) All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis. Any Permanent Link 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 meets performance requirements. The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation. No Permanent Link will exceed 295'.

D) 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 OCIO

4) FIBER OPTIC

A) All testing procedures and field-test instruments shall comply with applicable requirements of:
i) ANSI Z136.2, ANS for Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources

ii) ANSI/EIA/TIA-455-50B, Light Launch Conditions for Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements

iii) ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR

iv) ANSI/TIA/EIA-455-60A, Measurement of Fiber or Cable Length Using an OTDR

B) Great care will be taken when testing fiber. All cleaning procedures will be adhered to during testing. At no time is it acceptable not to clean connectors when mating.

C) Each strand will be verified for continuity with a VFL prior to light meter testing.

D) All strands will have an end face connector test performed with a pass/fail automated result.

E) Riser cables will be tested with light source and power meter. Fiber will be tested at 850 nm and 1300 nm for multimode cable, 1310 nm and 1550 nm for singlemode cable. Factory calibration must be current for the fiber optic testers; factory documentation must be provided in submittals.

F) Each strand will be tested and results electronically stored. Once testing is complete results will be down loaded and turned over to the OCIO [WMCNI] Electronically with manufacturer viewing software accompanying results.

G) Multimode testing will be performed using TIA/EIA-526-14-B Method B for in building riser cables Encircled Flux testing is a requirement, proper mandrels must be used.

H) Single mode testing will be performed using TIA.EIA-526-7 Method A.1 for in building riser cables. For outside plant cables, TIA/EIA-52607 Method A.1 and Method B will be used. If issues arise in the building riser cables it will be the responsibility of the contractor to supply an OTDR for further testing and trouble shooting.

I) All fiber testing will be bidirectional

J) All installed cabling links and channels shall be field-tested and pass the test requirements and analysis. Any 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 link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation.

K) 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 OCIO. [WMCIT]

Section X OUTSIDE PLANT STANDARDS

GENERAL

Conduit sizing and quantities between buildings shall be determined by OCIO and will be communicated to the University Project Manager/OCIO [WMCIT] for inclusion in the project specifications. Minimum requirements are outlined in the following paragraphs.

Prior approval and coordination with OCIO, University Project Manager/OCIO [WMCIT], and other concerned parties is necessary when the situation requires any modification to the conduit system.

Repair or replacement of damaged conduit is the responsibility of the party involved in causing the damage. All damages shall be reported to OCIO [WMCIT], Construction Management and Facilities Management immediately.

Since communications and networking is vital to departments, redundant entrances to new, buildings/renovations will be looked at during the initial design phase to be included in the overall scope of the project.

It is the responsibility of the contractor to notify O.U.P.S. at 1-800-362-2764, 72 hours prior to start of construction, excluding holidays (recognized University holidays) and weekends, for all utility markings. Those utilities that are not listed with O.U.P.S. must also be notified by the contractor.

It will be the responsibility of the project to obtain the necessary permits involved in placing OCIO [WMCIT] conduit/cable through public right of ways. Costs for this process must be preapproved by the project prior to obtaining the permits.

When crossing privately owned properties with OCIO [WMCIT] facilities, easements shall be coordinated by OCIO Outside Plant Department and The Ohio State University's Property and Real Estate (PARE) Department.

It will be the responsibility of the contractor to inform the University mapping department to take shots of the installation throughout the installation. They can be reached at 614.292.HELP or service2facilities@osu.edu .

OSP REQUIREMENTS

1. All new facilities or renovations will be subject to meet minimum requirements. 2-4" (I.D.) PVC encased will be required for every new building for the placement of voice, data, and video. Conduit is to be placed at 36" below grade to top of encasement. Variances must be approved by OCIO, for each entrance.
   Medical Center: All new facilities or renovations will be subject to meet minimum requirements. A minimum of 4-4" (I.D.) PVC encased will be required, 2 each for each entrance for every new building for the placement of voice, data, and video. Conduit is to be placed at 36" below grade to top of encasement. Variances must be approved by OCIO, for each entrance.

2. Conduits will not feed building to building.

3. Duct banks will be placed as straight as possible, if turns or offsets need to be made, manhole/hand holes will used for this function. From manhole/handhole to the building entrance one 90-degree bend is acceptable. All runs will be proofed with a mandrel with the OCIO or OCIO representative in attendance. OCIO Outside Plant Department must approve all duct bank/manhole installations prior to start.

4. A Kevlar pull string or a measure tape shall be installed and tied off in each conduit. Pull wires used in outside conduit shall be stainless steel or copper; #12 AWG or strings shall be of the Kevlar type.

OCIO shall be contacted for final dimension approval. Each duct bank will have a locator wire installed after conduits have been "proofed".

5. All underground conduits and ducts, rigid or PVC, added to a project shall be added in groups of 2, 4, 6, 8, 10, 12 or more.

6. All underground conduit, duct bank and raceways shall be concrete encased (2500psi minimum).

7. The minimum separation for communications ducts and power ducts in a joint trench environment is 3" (8 cm) of concrete, 4" (10 cm) of masonry or 12" (30 cm) of well-tamped earth. All communications ducts shall also be a minimum of 48" from steam pipes and condensation lines when running parallel. If crossing perpendicular (min of 24" of clearance), Gillsulate insulation (or OCIO/FOD approved equal) must be placed over the top or underneath the encasement to reduce the risk of damage due to heat.

8. PVC schedule 40, encased in reinforced concrete with 5/8" rebar placed on 5" on center shall be used in any location subject to abuse, such as under roadways, slabs or foundations.

9. In new construction, all conduit duct banks will enter the lowest bottom bay of the manhole. In existing structures, ducts will be placed in the next available bay.

10. All necessary precautions shall be taken by the contractor during construction to prevent the lodging of dirt, plaster, concrete or trash in all conduit. All conduit in floors, concrete or below grade shall be swabbed free of debris and moisture before wires are pulled. All conduit shall have duct plugs (expandable mechanical) installed at both the manhole and building entrance to prevent water migration into the building. All building entrances will be sloped to drain back towards the manhole. Under no circumstances will a manhole be placed above the entrance to a building allowing it to drain towards the building. Off campus locations conduit shall be extended to the property line. A handhole shall be installed at the property line to receive WMCIT conduits and service providers conduits.

AERIAL

1. Most university low voltage cabling is underground. No aerial cabling shall be installed on campus unless approved by the University Project Manager/OCIO [WMCIT].

TUNNELS

1. Where conduit, ducts, or cable trays are in tunnels, they shall be kept as far away as possible from parallel runs of flues, steam pipes, hot gas pipes, hot water pipes, or any other utility line which is hot during normal operation of the facility it serves. It is the preference of OCIO Outside Plant Department that all communication cabling is placed opposite the steam side of tunnels. All conduit sections crossing steam lines shall be rigid and shall be provided with a means of insulation from the steam lines, unless a written exception is provided by the University Project Manager/OCIO and OCIO Outside Plant Department.

TRAPS

1. All conduit, tubing, raceways, ducts, and duct banks shall be installed in such manner to insure against collection of trapped condensation. Raceway runs shall be arranged to be void of traps.

2. When conduit passes through exterior concrete walls of any facility, the entrance shall be watertight. Pipe sleeves, at the conduit entrance, shall be sized large enough to place Link Seals between the sleeves and entrance conduit. Link Seals will be placed on both sides of the entrance.

TYPES

1. Abandoned gas, water, steam and any pipes that might contain asbestos insulation shall not be used as telecommunications and networking conduit under any circumstances.

2. Four types of conduit are accepted for underground conduit systems. Project specifications will detail the types of conduit to be used in the various locations covered by the project.
   A. Rigid galvanized steel conduit with threaded fittings. This conduit shall be installed with concrete casing in areas subject to abuse. This conduit will have an epoxy coating that has been applied by the manufacturer. Coating shall extend to 6" above ground level where conduit is installed by a pole, or side structure, or inside a pedestal.

   B. Schedule 40 PVC conduit. This conduit shall be installed with concrete encasement. No PVC conduit is acceptable without concrete, unless specified by OCIO Outside Plant Department.

   C. “C”-Duct conduit: This conduit shall be installed only with concrete encasement.

   D. HDPE SDR11 or Bore Guard schedule 40: To be used for only directional boring. Boring must be preapproved by OCIO/FOD

3. The duct encasement shall be rectangular in the cross section and have a minimum concrete thickness of 2" around any conduit. The duct encasement shall be sized and placed as shown on construction documents.

4. All conduit and ducts must be terminated with bell ends at the manhole, facility, or other termination point.

5. Duct spacers shall be provided at a maximum of 5' intervals. Conduit shall be anchored at 3'-6" intervals and at each spacer to prevent duct floating during concrete installation.

Entrance Facility

1. The Entrance Facility (EF) in the building must be placed within 50’of the Main Point of Entry (MPOE). At the MPOE of the building, rigid metallic conduit (number of rigid metallic conduits equal the number of conduits entering the building) must be placed to the EF. All unlisted OSP cables will be placed in rigid conduit.
2. Conduit will have expandable plugs installed at each end to prevent water intrusion.

MANHOLES

GENERAL

1. Manhole sizes may vary depending on space limitations. All manholes shall be placed in accordance with the manufacturer’s specifications and all required safety regulations. All manholes shall be placed with a collar height of 18” minimum. Locking lids are required and shall be 30” in diameter with “COMMUNICATIONS” engraved on the lid. Manhole lids will not have recessed handles that pull out. All manholes will be precast. See material list for acceptable manufacturer and part numbers.

2. The OCIO outside Plant Designer must approve Handholes on campus.

3. The maximum distance between manholes connected in any one run shall not exceed 500', unless approved by OCIO Outside Plant Department.

4. All telecommunication manholes/handholes must be placed in accordance with manufacturer’s specifications unless special conditions are approved by OCIO [WMCIT] Telecommunications and Networking Outside Plant Department.

5. All Telecommunication Precast manholes/handholes shall include the associated hardware package (for racking), ladder, frame, cover, and collar (neck) for the specific structure being placed. Note: Lids must be marked as Communications.

6. See below for approved product vendor or OCIO approved equal:

   Concrete Precast Manholes/Handholes:
   Oldcastle Hartford Concrete Products
   1400 North Wabash Avenue
   P.O. Box 660
   Hartford City, Indiana 47348-0660
   1-800-428-8110
   Telefax: 765-348-3121

Manhole Interior

1. All materials used in a manhole shall be resistant to corrosion. All steel shall be galvanized or zinc coated. All racking in manholes shall be in accordance with manufacturers' specifications.

2. Manholes shall have pulling rings opposite to the conduit entrance on each wall.

3. Each manhole will be grounded

Restoral

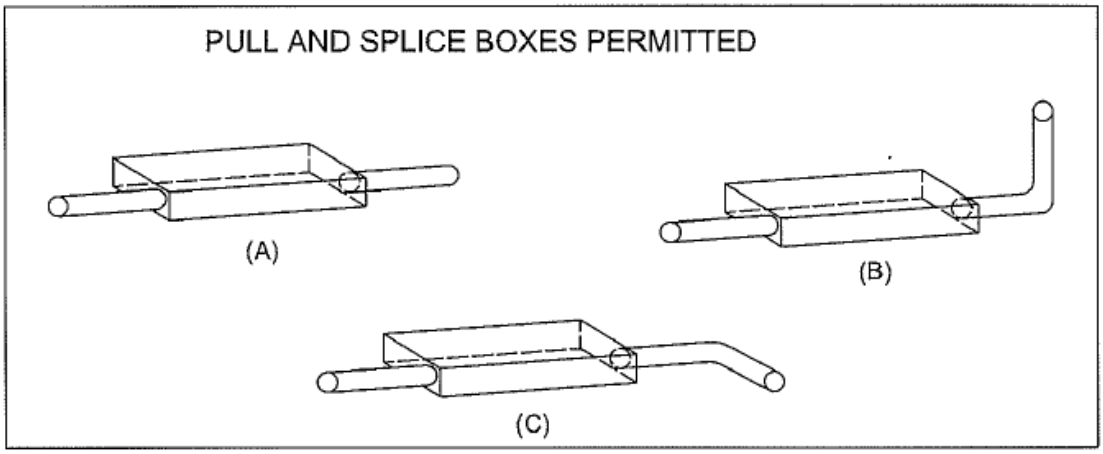
1. All surfaces must be restored to like or better condition as soon as possible. Where settling occurs, it is the responsibility of the contractor to correct the given area and take appropriate measures to reseed and regrade as necessary at no additional charge to the project or OCIO. The contractor is responsible for 1 year from project completion date.
2. All restoral must meet Division 31, 32 &33 of the Building Design Standards.

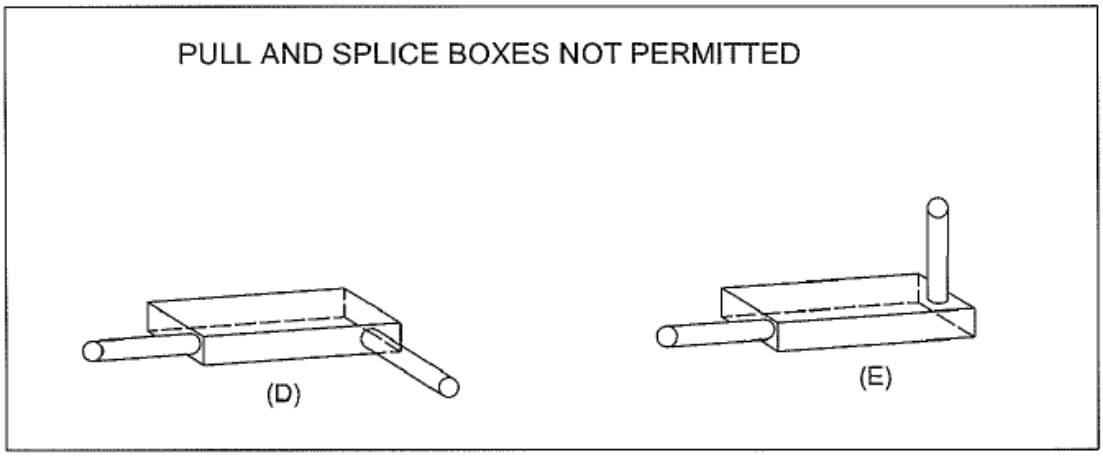
EXHIBIT A

PULL AND SPLICE BOXES

A PULL BOX SHOULD BE PLACED WHERE CONDUIT RUNS EXCEED 100 FEET IN LENGTH OR CONTAIN THE EQUIVALENT OF MORE THAN TWO (2) 90 DEGREE BENDS. CONDUIT SHOULD ENTER AND LEAVE THROUGH OPPOSITE ENDS OF THE BOX. NO BENDS SHOULD BE MADE INSIDE THE BOX. IF A 90 DEGREE TURN IS REQUIRED AT A BOX IT IS PREFERABLE TO PLACE IT ADJACENT TO THE BOX AS ILLUSTRATED IN (B) AND (C). DO NOT PLACE THEM AS ILLUSTRATED IN (D) AND (E).

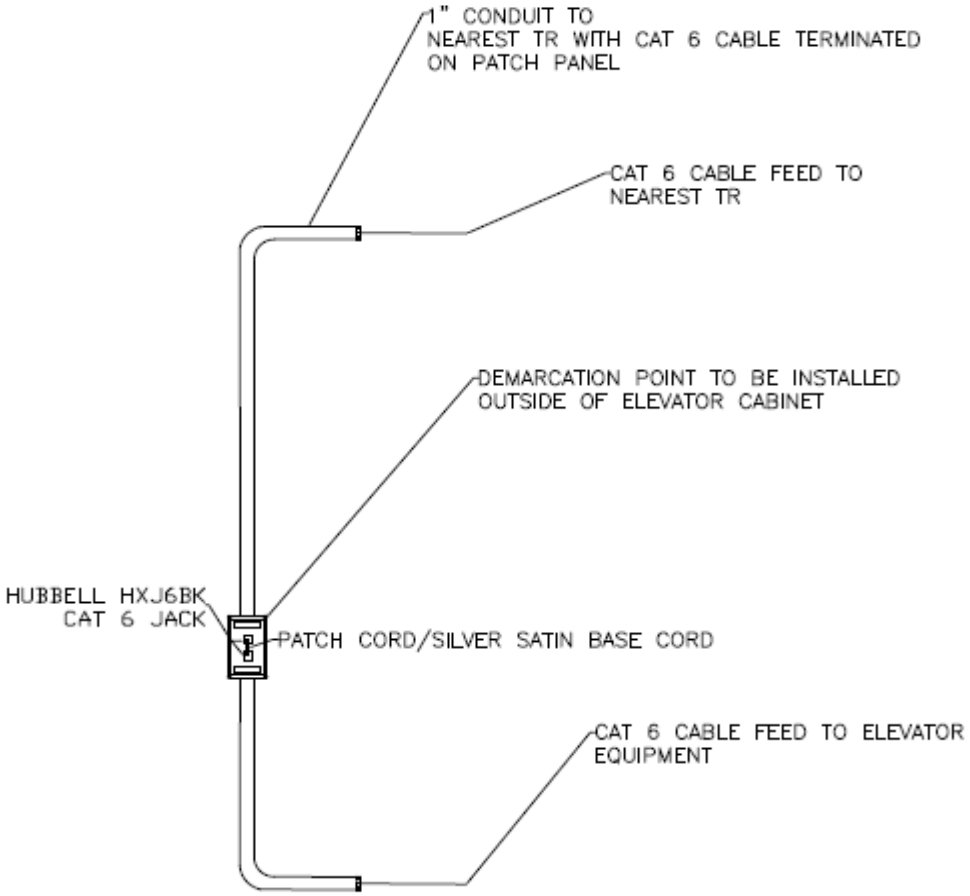
THESE SAME CONSIDERATIONS APPLY TO SPLICE BOXES PLACED AT TURNS.





SEE EXHIBIT M FOR WEXNER MEDICAL CENTER

EXHIBIT B



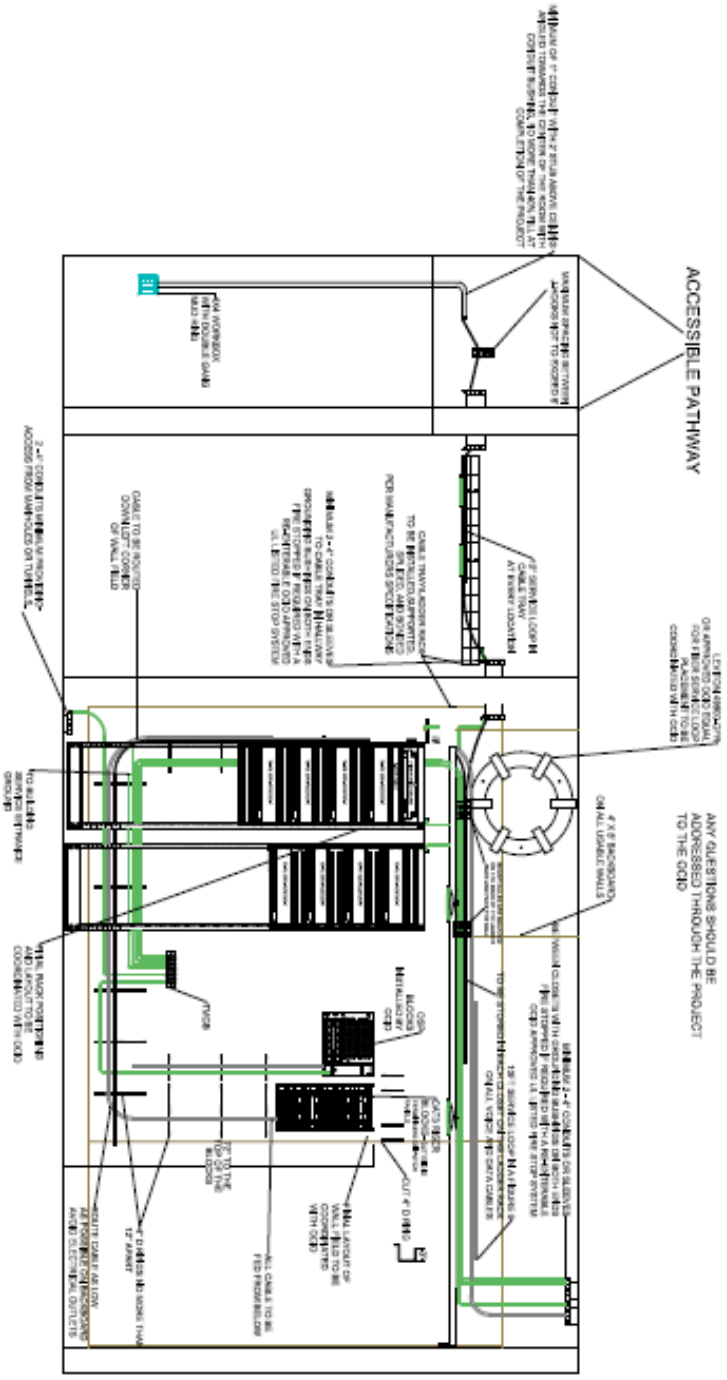
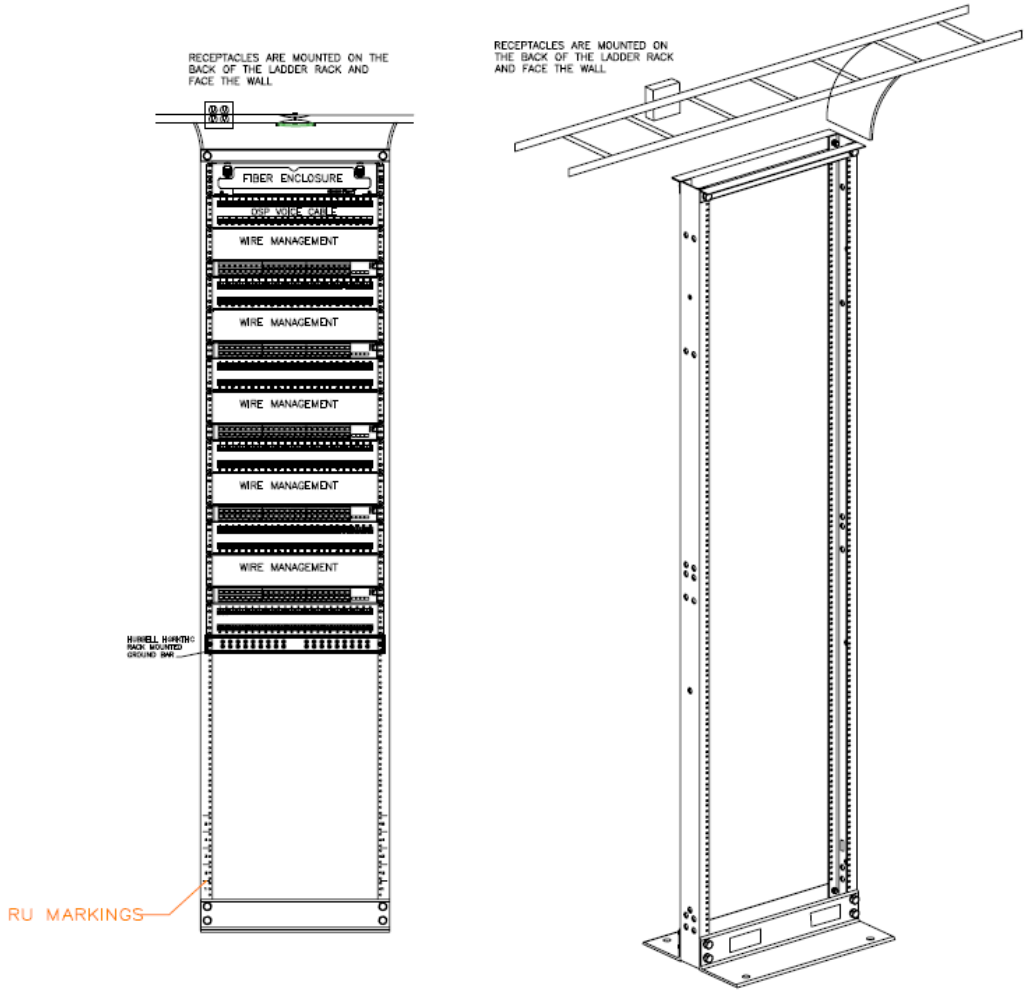


EXHIBIT C

SEE EXHIBIT N & O FOR WEXNER MEDICAL CENTER

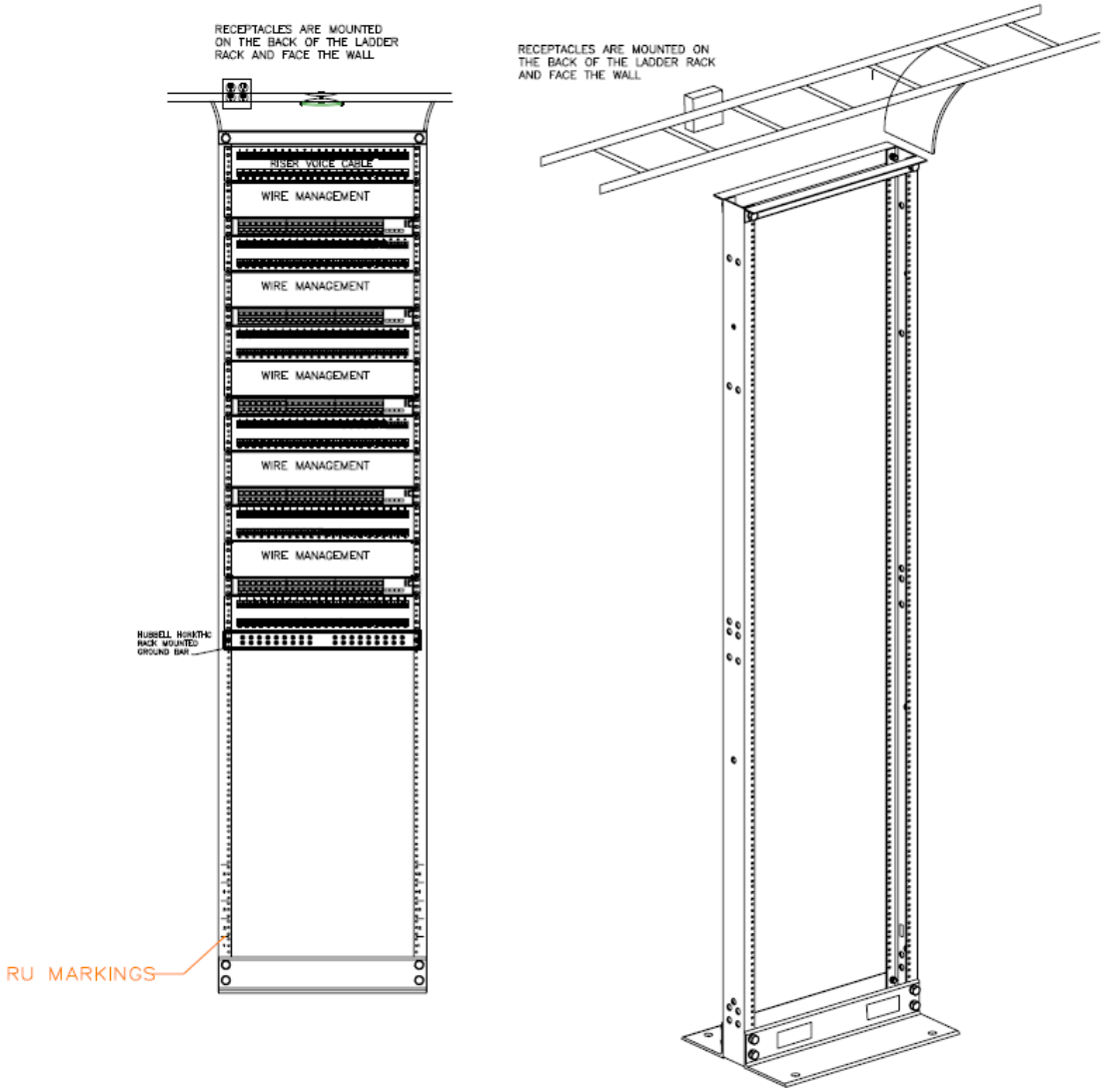
SEE EXHIBIT P FOR WEXNER MEDICAL CENTER

EXHIBIT D



SEE EXHIBIT Q FOR WEXNER MEDICAL CENTER

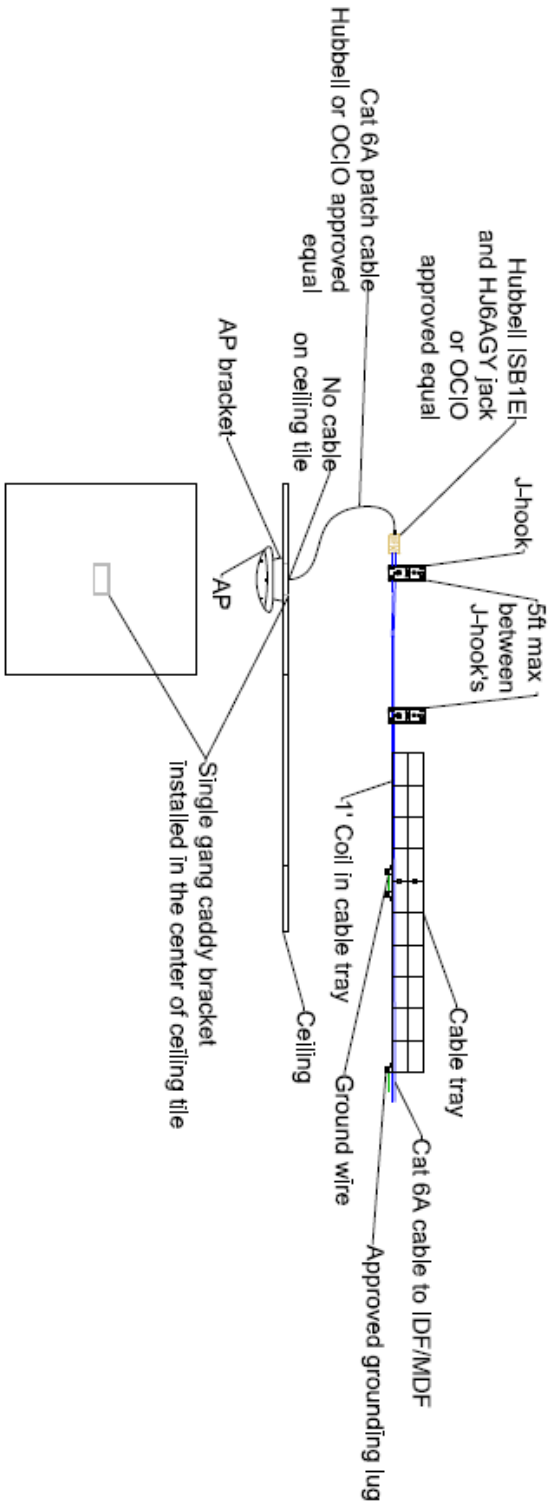
EXHIBIT E



SEE EXHIBIT R FOR WEXNER MEDICAL CENTER

EXHIBIT F

AP install in a drop ceiling



SEE EXHIBIT S FOR WEXNER MEDICAL CENTER

EXHIBIT G

AP install in a hard ceiling

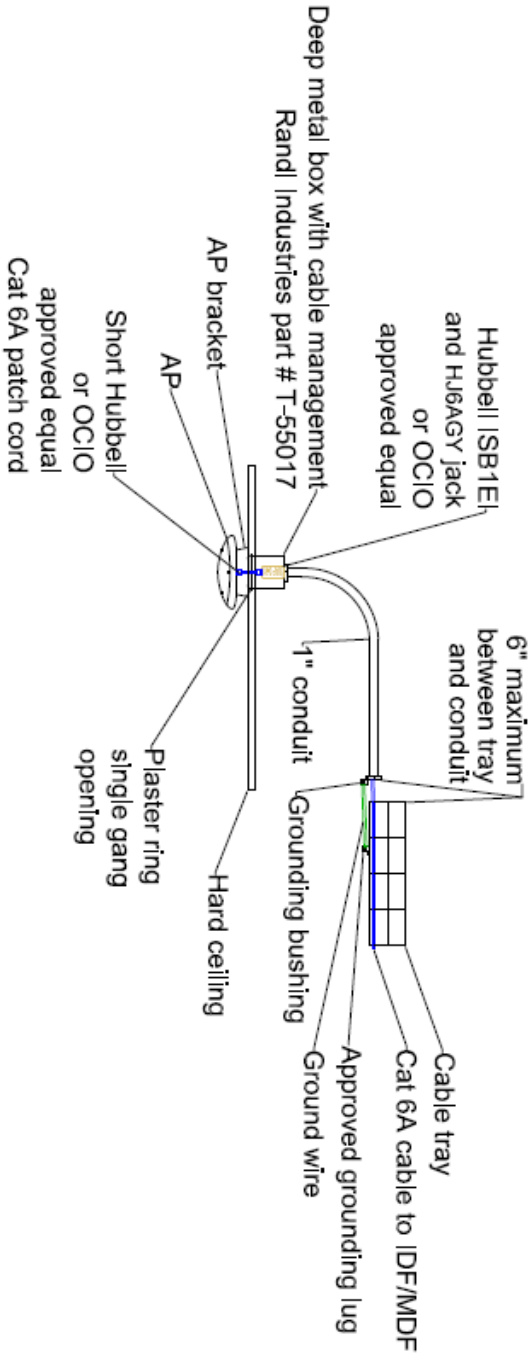


EXHIBIT H

CAT 6 CONDUIT CABLE FILL WITH 180 DEGREES OF BENDS

CONDUIT TRADE SIZE	# OF CABLES
1"	4
1.5"	9
2"	16
2.5"	30
3"	45
4"	75

CAT 6A CONDUIT CABLE FILL WITH 180 DEGREES OF BENDS

CONDUIT TRADE SIZE	# OF CABLES
1"	1
1.5"	3
2"	6
2.5"	11.9
3"	17
4"	29

CAT 6 CONDUIT CABLE FILL NO BENDS/OFFSETS

CONDUIT TRADE SIZE	# OF CABLES
1"	6
1.5"	14
2"	24
2.5"	42
3"	65

CAT 6A CONDUIT CABLE FILL NO BENDS/OFFSETS

CONDUIT TRADE SIZE	# OF CABLES
1"	2
1.5"	5
2"	9
2.5"	16
3"	25

4"	108	4"	42

EXHIBIT I No longer Applicable June 28, 2019

EXHIBIT I

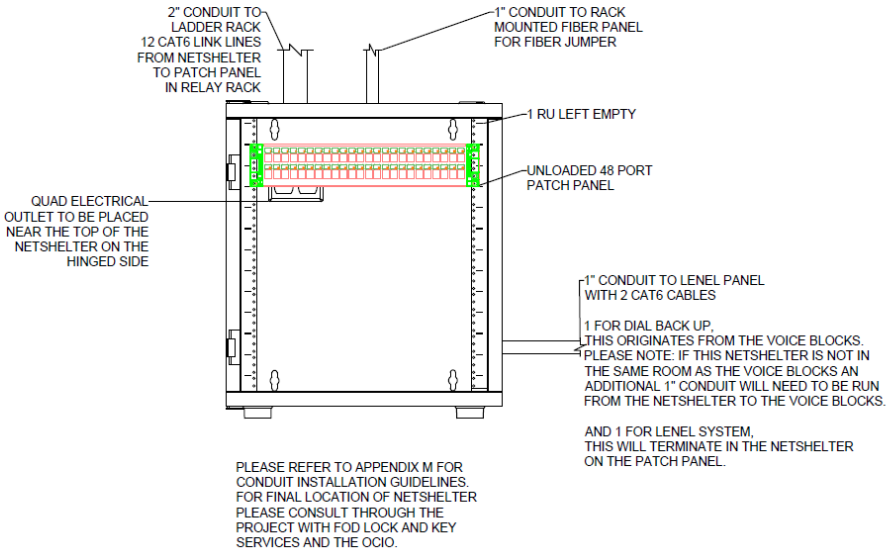


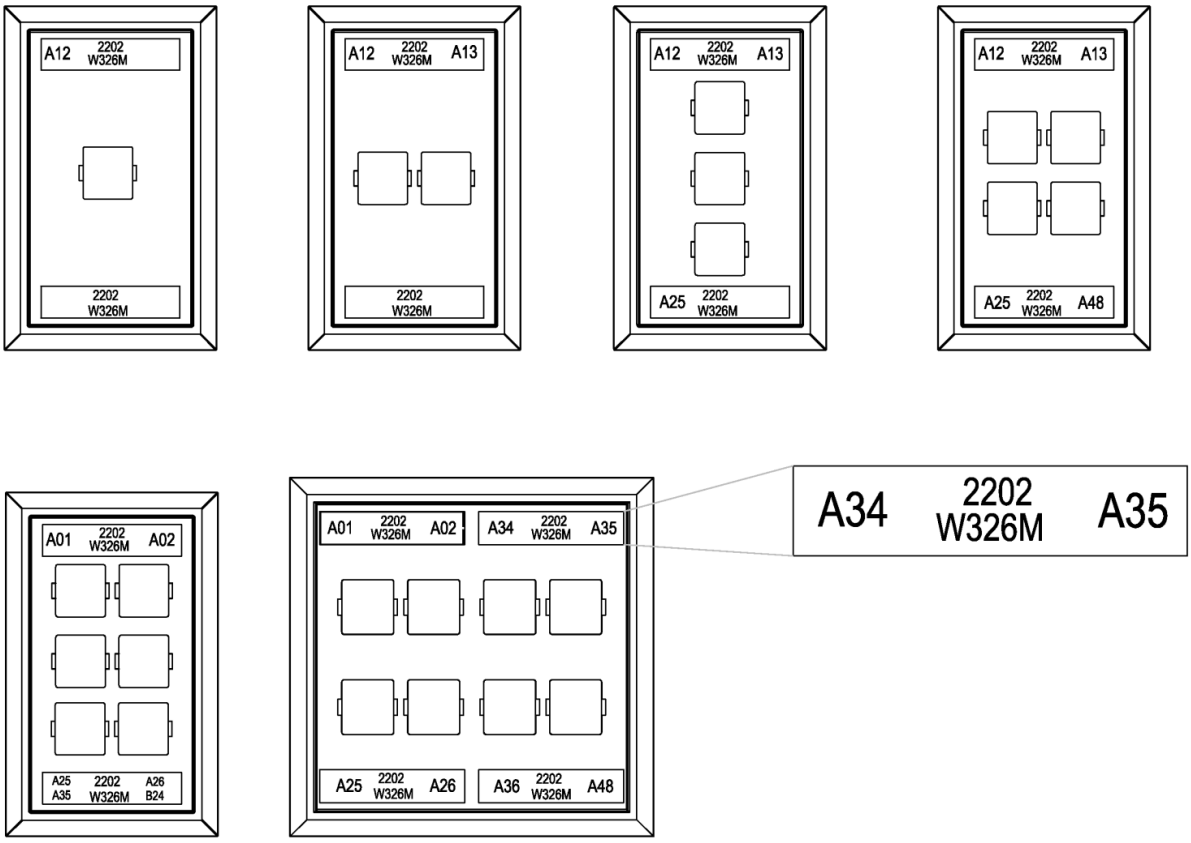
EXHIBIT J

TBB sizing chart

TBB/GE linear length m (ft)	TBB/GE size (AWG)
less than 4 (13)	6
4 – 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8 – 10 (27 – 33)	2
10 – 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20 – 26 (67 – 84)	3/0
26 – 32 (85 – 105)	4/0
32 – 38 (106 – 125)	250 kcmil
38 – 46 (126 – 150)	300 kcmil
46 – 53 (151 – 175)	350 kcmil
53 – 76 (176 – 250)	500 kcmil
76 – 91 (251 – 300)	600 kcmil
Greater than 91 (301)	750 kcmil

EXHIBIT K

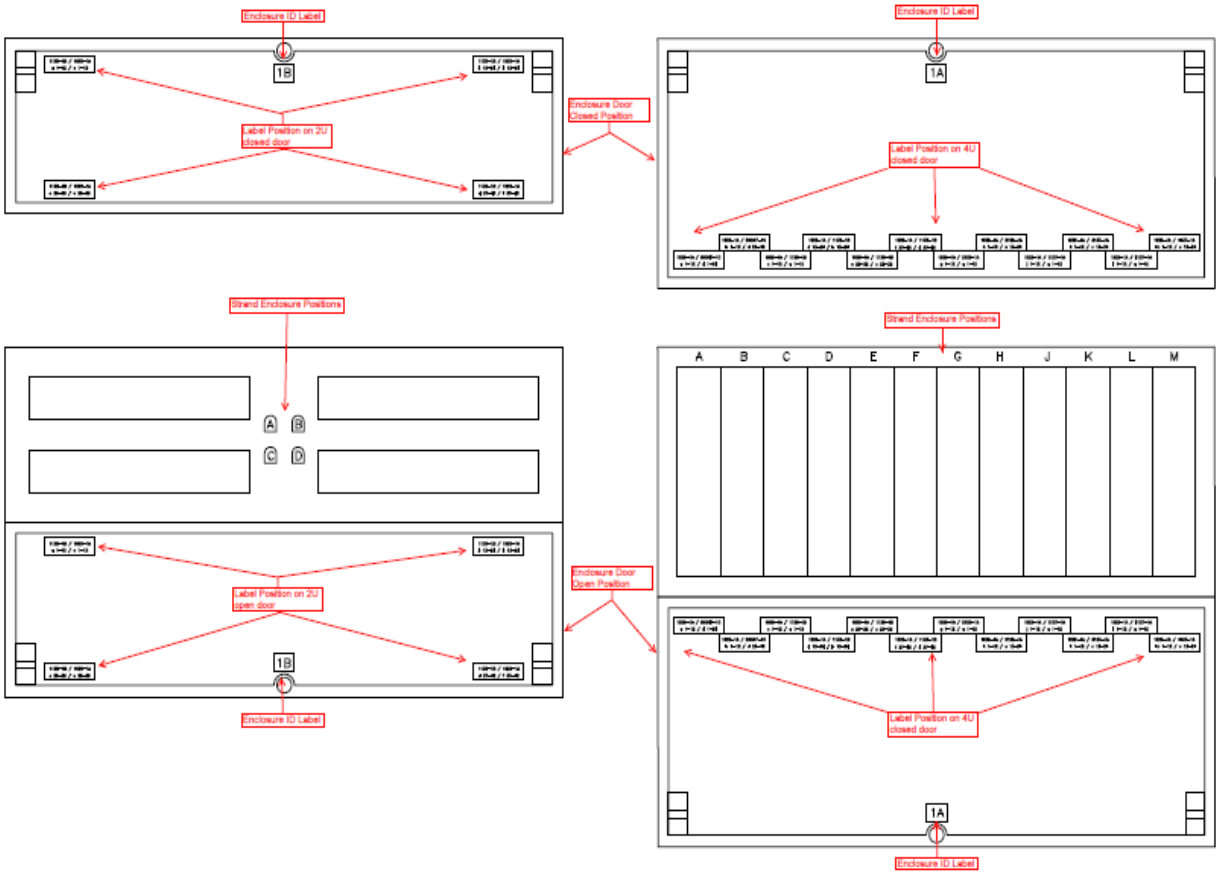
Technology Outlet Label



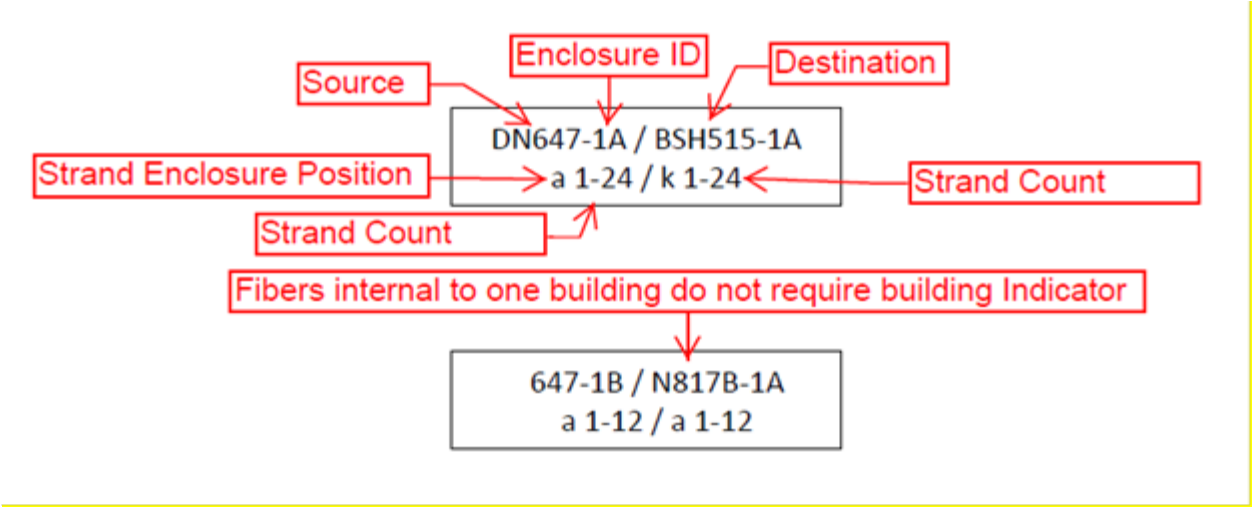
MEDICAL CENTER - EXHIBIT L

Optical Fiber Labeling

Fiber Enclosure

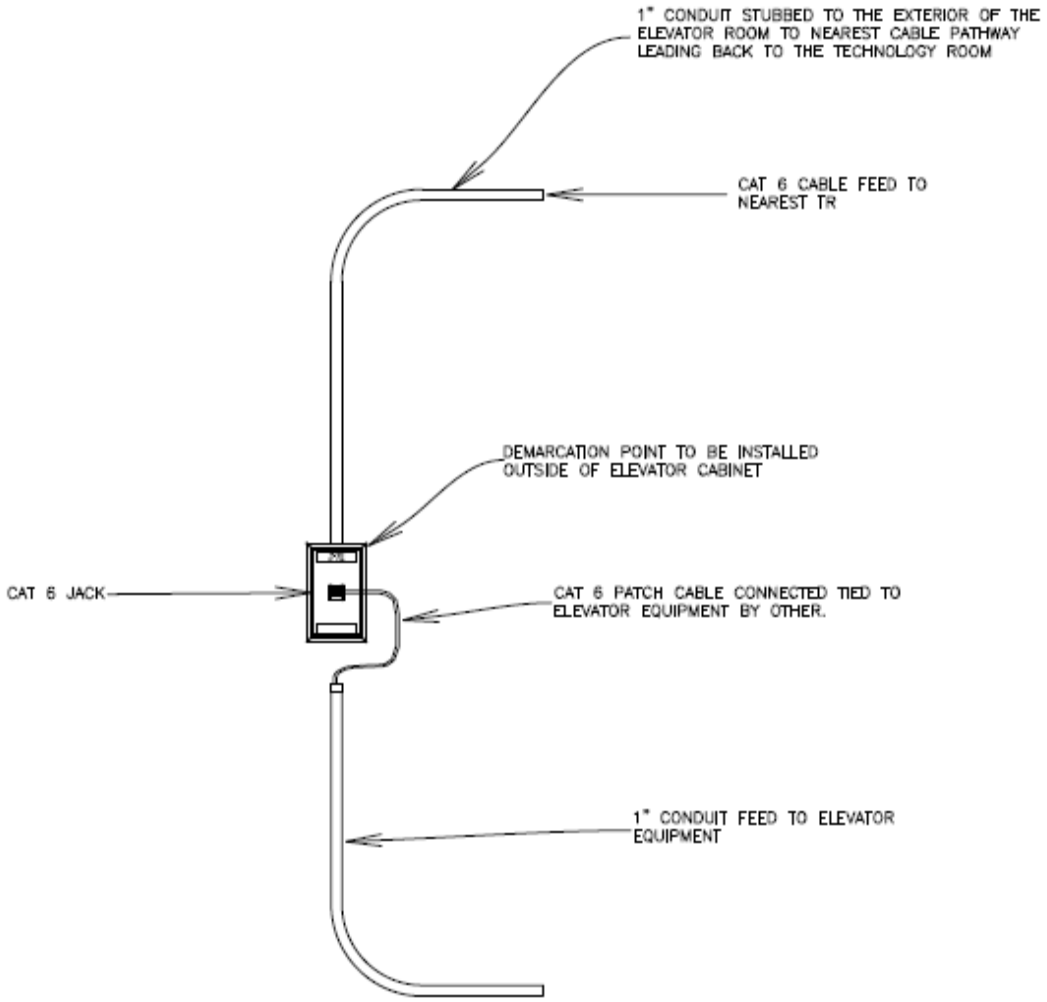


Fiber Optic Termination Label


Source
Enclosure ID
Destination
DN647-1A / BSH515-1A
a 1-24 / k 1-24
Strand Enclosure Position
Strand Count
Strand Count
Fibers internal to one building do not require building Indicator
647-1B / N817B-1A
a 1-12 / a 1-12

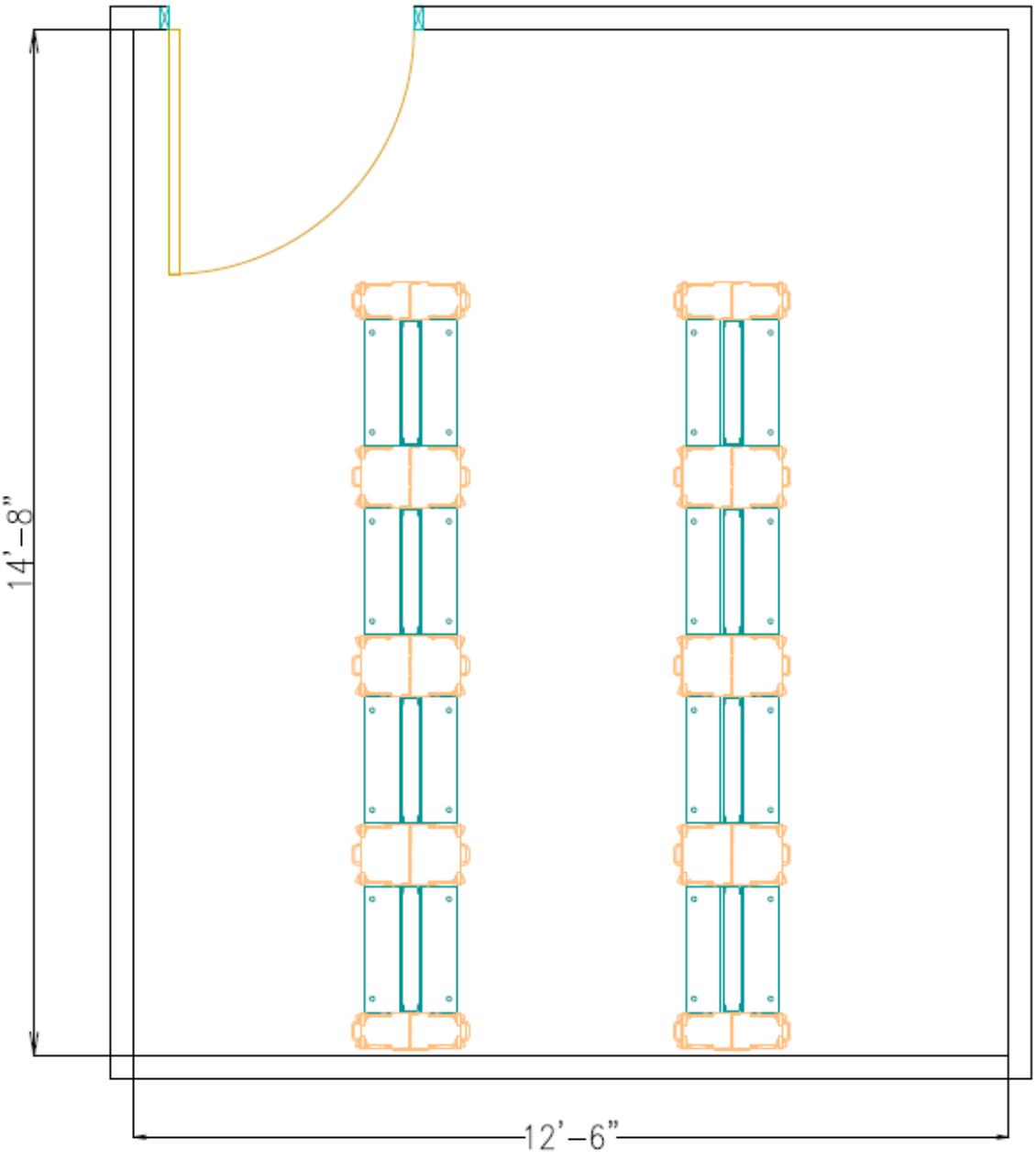
MEDICAL CENTER - EXHIBIT M

Elevator Phone Schematic



MEDICAL CENTER - EXHIBIT N

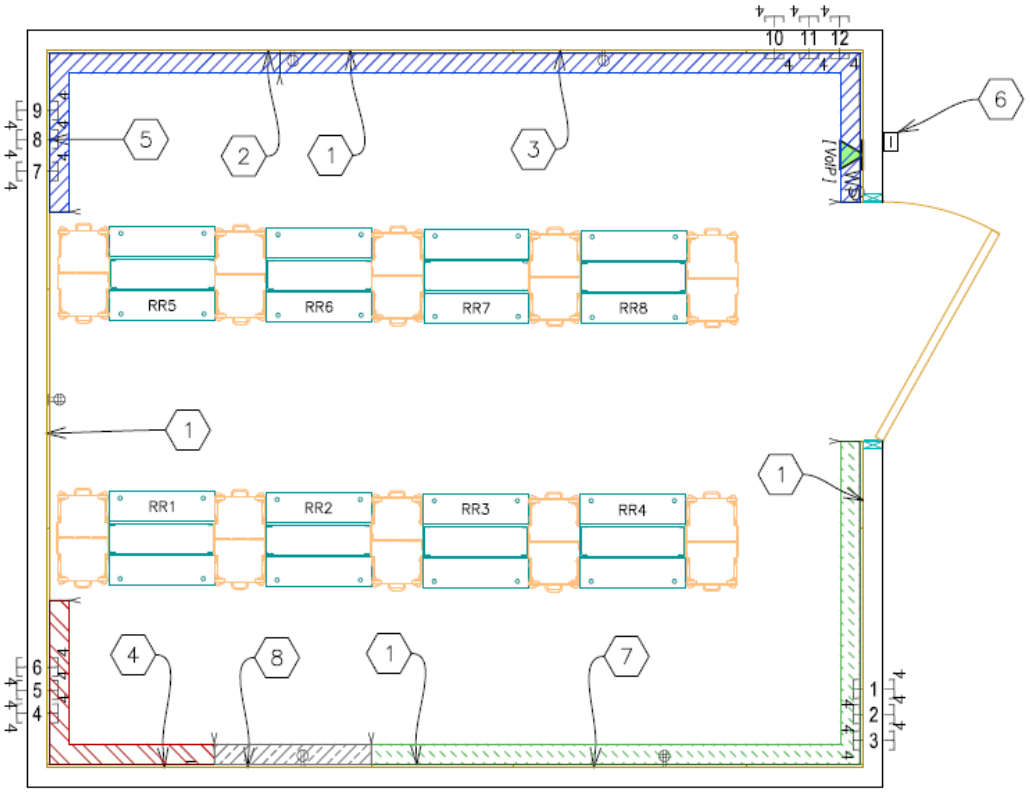
Technology Room (TR) Sizing



NOTE: Space should be free of all other building structural componants and beams.

MEDICAL CENTER - EXHIBIT O

Technology Room (TR) Layout



WALL SPACE KEY

- Information Technology
- Clinical Engineering
- Security
- Facilties Engineering

O Coded Notes:

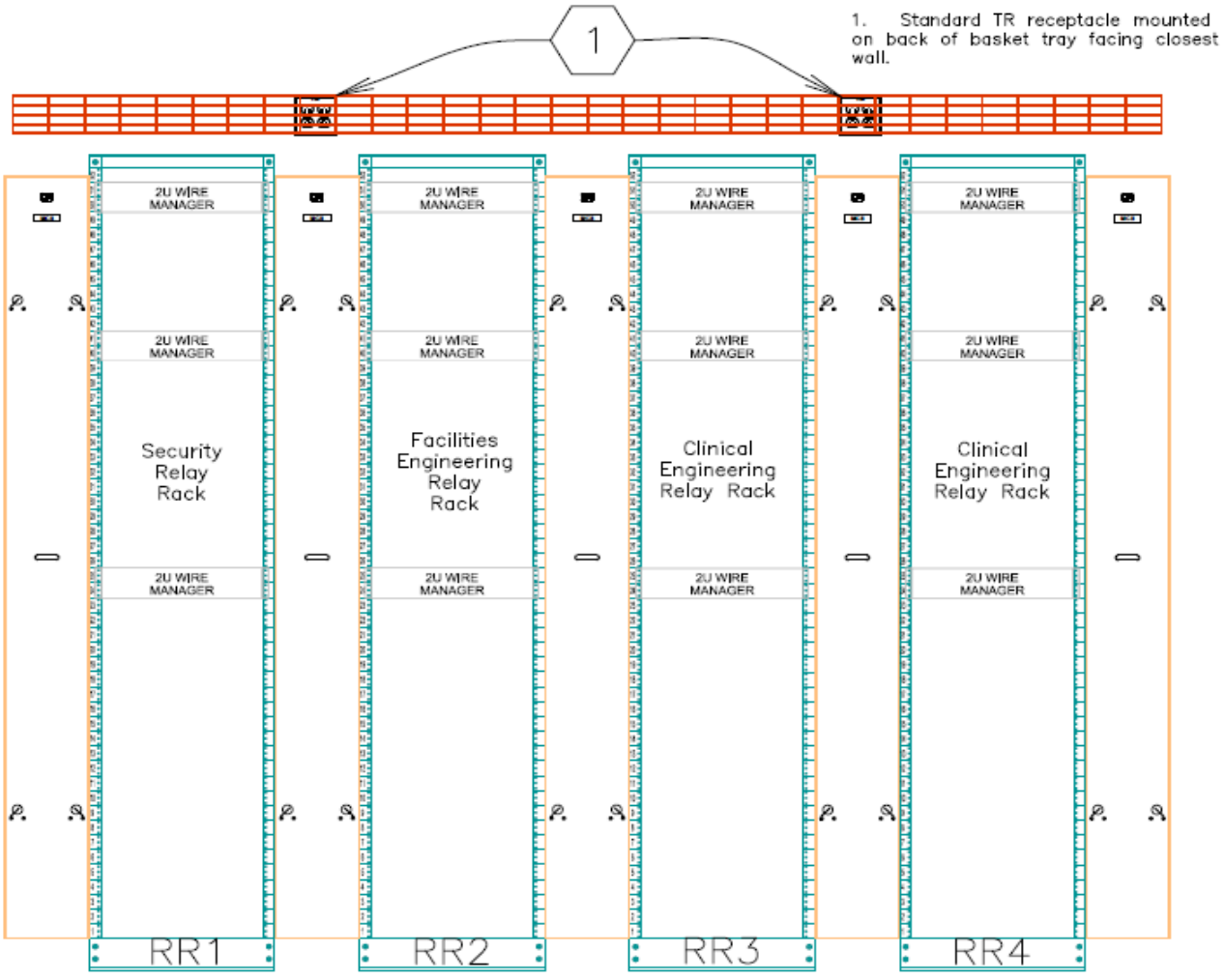
1. ¾" X 4' X 8' fire retardant plywood, Grade A–C on all walls. The A grade will be facing out (Unpainted).
2. 110 Wall Field
3. CATV Wall Field
4. Security
5. Telecommunications Ground Busbar (TGB)
6. Card Reader
7. Clinical Engineering
8. Facilities Engineering

General Notes:

1. 12'–6" X 14'–8" room
2. 168 square feet of continuous floor space
3. No drop ceiling
4. No windows
5. Door located on a 12'–6" wall, must open out and be 48" wide.
6. RR1: Relay rack 1 is Security
7. RR2: Relay rack 2 is Facilities Engineering
8. RR3: Relay rack 3 is Clinical Engineering
9. RR4: Relay rack 4 is Clinical Engineering
10. RR5: Relay rack 5 is Information Technology
11. RR6: Relay rack 6 is Information Technology
12. RR7: Relay rack 7 is Information Technology
13. RR8: Relay rack 8 is Information Technology

MEDICAL CENTER - EXHIBIT P

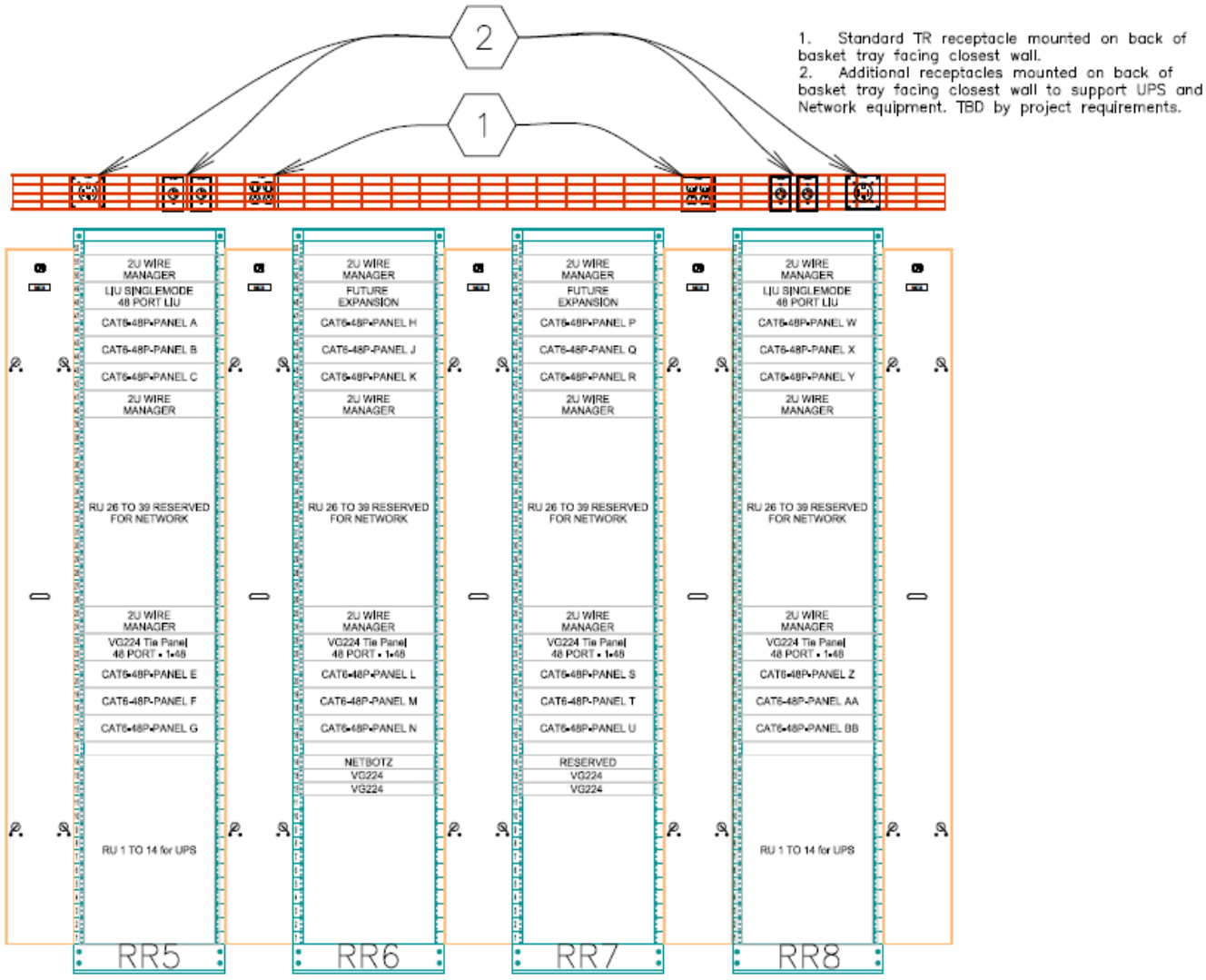
Relay Rack Detail 1 - 4



Note: Wire managers are to be installed in RU 24 & 25, 40 & 41, and 50&51.

MEDICAL CENTER - EXHIBIT Q

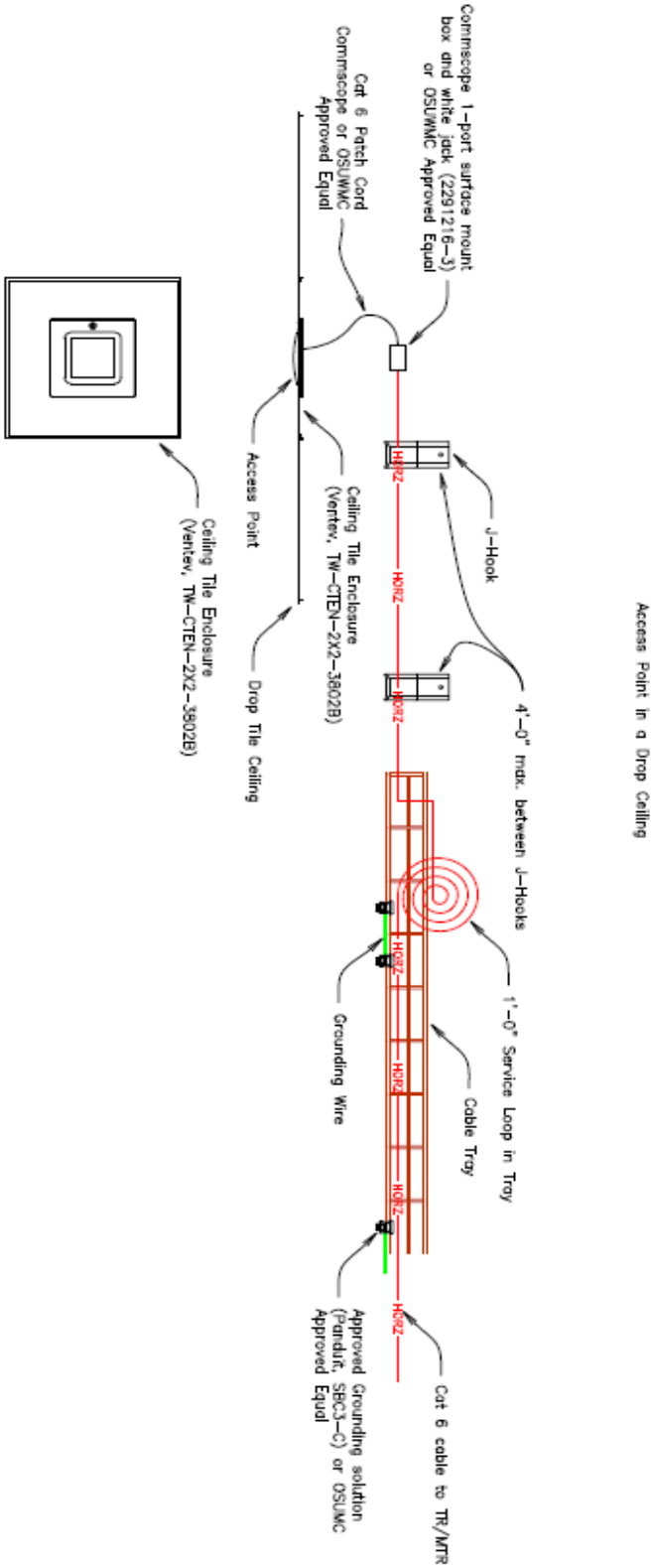
Relay Rack Detail 5 - 8



Note: Wire managers are to be installed in RU 24 & 25, 40 & 41, and 50&51.

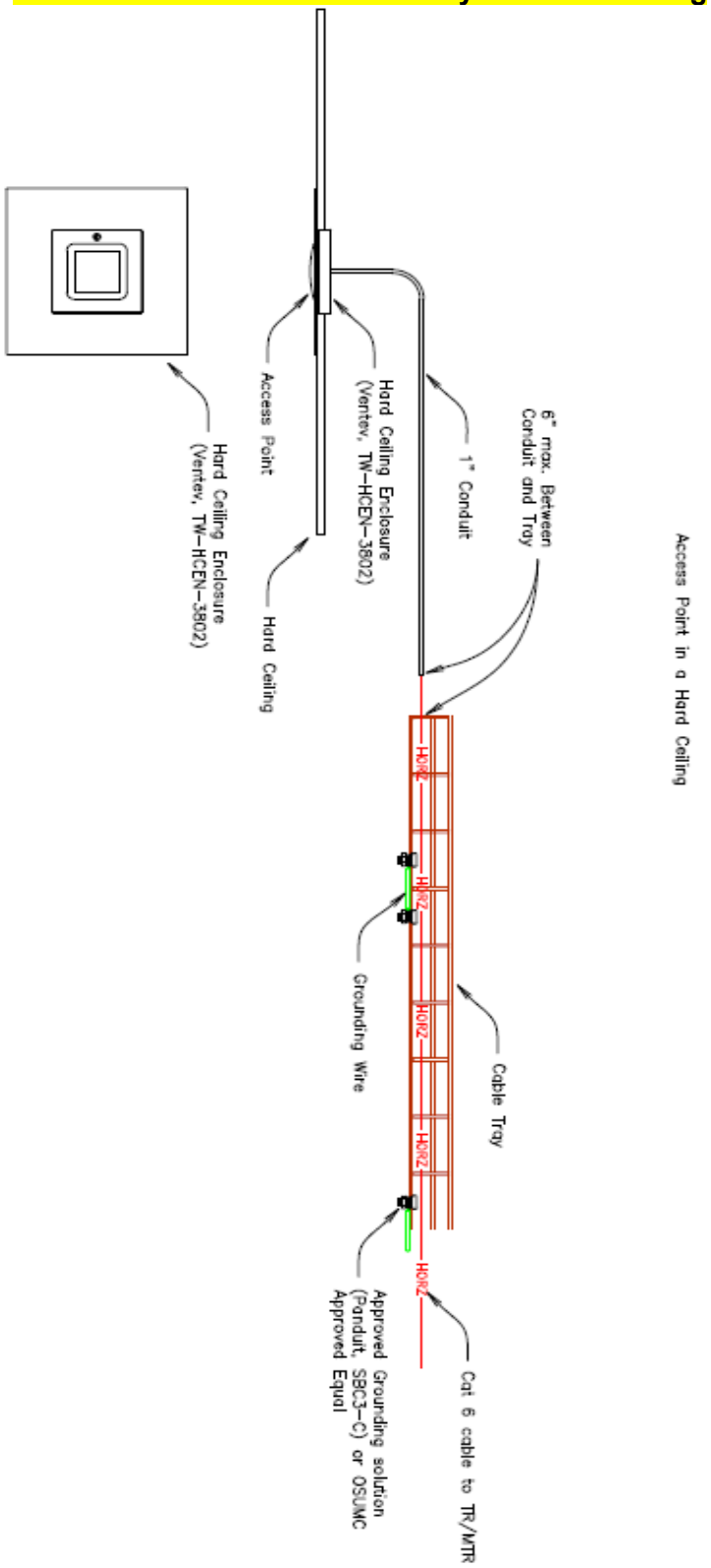
MEDICAL CENTER - EXHIBIT R

Wireless Access Point Detail- Drop Ceiling


Commscope 1-port surface mount box and white jack (2291216-3) or OSUWMC Approved Equal
Cat 6 Patch Cord Commscope or OSUWMC Approved Equal
J-Hook
4'-0" max. between J-Hooks
1'-0" Service Loop in Tray
Cable Tray
Grounding Wire
Approved Grounding solution (Panduit, SBCJ-C) or OSUMC Approved Equal
Cat 6 cable to TR/MTR
Access Point
Ceiling Tile Enclosure (Ventev, TW-CTEN-2X2-3802B)
Drop Tile Ceiling
Ceiling Tile Enclosure (Ventev, TW-CTEN-2X2-3802B)
HORZ
Access Point in a Drop Ceiling

MEDICAL CENTER- EXHIBIT S

Wireless Access Point Detail- Drywall/Hard Ceiling



Summary: Application Application Part 10 of 17 - Exhibit C (Part 8 of 8) electronically filed by Ms. Kari D Hehmeyer on behalf of Alexander, Trevor Mr. and THE OHIO STATE UNIVERSITY