Division 27 - COMMUNICATIONS
UNLV Campus Wiring Design Guide

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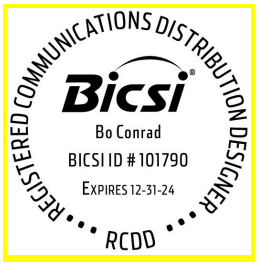

Version	Revision Date	Description
1.0	1/12/2021	Initial Version
1.1	1/25/2021	Miscellaneous Changes
1.2	2/9/2021	Formatting
1.2.5	9/23/2021	Updates for Fiber Optic Testing and Wireless Access Points
1.3	6/01/2023	Complete update

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SECTION 27 00 00

COMMUNICATIONS DESIGN GUIDELINE

Introductory Note :

This UNLV Division 27 *Campus Wiring Design Guide* V.1.3 March, 2023 is written in accordance with the Construction Specifications Institute sectional (CSI) 3-Part Master Format using 6 digits. Each SECTION is then followed by a Subsection (With 8 digits the last two are Subsections .XX) **27 XX XX. XX**

Part 1 - General
Part 2 - Products
Part 3 - Execution Each Part 1,2 and 3 are then itemized in alpha-numeric order.

The intent of this *UNLV Division 27 Campus Wiring Design Guide* is to provide correct, complete, concise, and clear instructions for the design, installation, labeling, testing, and submittal documentation for UNLV's Information and Communications Technology (ICT) low voltage telecommunications structured cabling system (SCS) - The OSI Model Physical Layer One (or 'Zero').

——— End of SECTION 27 00 00 ———

COMMUNICATIONS DESIGN GUIDELINE

SECTION 27 01 00

OPERATION AND MAINTENANCE OF LOW-VOLTAGE COMMUNICATIONS SYSTEMS

PART 1: GENERAL

1.1 Summary

A. The University of Nevada Las Vegas (herein referred to as "UNLV") *Division 27 Campus Wiring Design Guide* is for the use of all campus departments, architects, developers, Contractors and Subcontractors involved in low-voltage telecommunication construction on the UNLV campus(es).

B. UNLV Planning and Commission (herein referred to as "UNLV/P&C"), UNLV Facilities Management (herein referred to as "UNLV/FM''), UNLV Risk Management and Safety (herein referred to as "UNLV/RMS"), and UNLV Fire and Life Safety departments (herein referred to a UNLV/FLS) are identified in select low-voltage telecommunications Sections of this document. Note: The UNLV/P&C has complete design, installation, financial, and managerial oversight of the project. The other departments like the UNLV Network Development and Engineering Department (herein referred to as "UNLV/NDE") functions as an advisory role reporting to the assigned P&C project manager(s) (PM) yet having full audit and project completion responsibilities.

C. The purpose of this document is to provide a uniform, consistent, and industry standards-based guidelines by which UNLV/NDE Information Communications and Technology (herein referred to as "ICT") structured cabling system (SCS) is administered for full acceptance as defined in the contract Scope of Work (SoW).

D. It is the responsibility of the Contractor/Sub to ensure that a fully compliant and efficient structured cabling system (SCS) infrastructure is properly 'provided' inclusive of 'to furnish and install'.

E. The requirements of this document are to be met by the low-voltage telecommunications Contractor/Sub, whether the Contractor/Sub is hired directly by UNLV/P&C as the 'Prime Contractor' or hired by the Contractor as a 'Subcontractor'. This includes 'providing' the cabling infrastructure for both inter-building outside plant (OSP) optical fiber backbone and intra-building premises optical fiber backbone and horizontal copper distribution applications.

F. The 'Owner' referred to as UNLV/NDE and low-voltage telecommunications Contractor/Sub are considered the "Parties to the Contract" or the 'stakeholders' for low-voltage telecommunications projects.

G. Coordination with UNLV/NDE is required prior to actual construction and wiring placement;
   1. The assigned Contractor/Sub to be interviewed by UNLV/NDE referencing the *UNLV/NDE RCDD Check List* which itemizes the major contents of the *UNLV Division 27 Campus Wiring Design Guide.*
   2. For smaller, limited copper cable runs, the assigned Contractor/Sub to be issued the *UNLV/NDE RCDD Jr Check List.*
   3. N*o*te: Both to be completed and signed by both parties before an installation is to begin.

4. UNLV recognizes the (1) Building Industry Consulting Service International (BICSI) professional cabling designation Registered Communication Distribution Design or "RCDD", (2) BICSI Installer 2 Copper (INSTC), (3) BICSI Installer 2 Fiber (INSTF) and, (4) BICSI Technician (TECH 3).

H. Work to be in accordance with industry-best practices as stated with Building Industry Consulting Services International (BICSI) recommended installation standards, ANSI/BICSI, ANSI/TIA, ESPEC (CORE), IBC, IEC, IEEE, ITU, and ISO/IEC specifications. See and Appendix A; *Codes, Standards, and Regulations* and Appendix B; *Abbreviations and Acronyms.*
I. This document takes into consideration but does not take precedence over any federal, State, or municipal code requirements as stated in the NFPA-70 National Electrical Code (NEC) and National Electrical Safety Code (NESC) either partially or wholly being enforced by the local authority having jurisdiction (AHJ).
J. The Contractor/Sub to include in their bid price, communications cabling that is or to become abandoned as part of a renovation project, previous renovation projects, or temporary communications cables used during the construction process to be completely removed.

1.2 Related Documents and References

A. The subsections listed in the *Table of Contents* are all considered to be "Related Documents".
B. Material and work specified to comply with the applicable requirements of the current revisions of the following:
    1. Appendix A; *Codes, Standards, and Regulations*
    2. Appendix B; *Abbreviations and Acronyms*
    3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
    4. Appendix D; *Rack Elevation and Room Sizing Drawings*
C. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification, apply to this Section.
D. See Appendix A; *Codes, Standards, and Regulations.* This includes but not limited to the current published version and/or those enforced by the Authority Having Jurisdiction (AHJ);
    1. ADA Standards for Accessible Design
    2. AIA; American Institute of Architects
    3. ANSI; American National Standards Institute
    4. ASTM; American Society for Testing and Material
    5. BICSI; Building industry Consulting Service International
        a. BICSI *Telecommunications Distribution Methods Manual (*TDMM)

b. BICSI *Information Transport Systems Installation Methods Manual (*ITSIMM)

6. CSI; Construction Specification Institute
7. ESPEC; Telcordia Technologies GR-CORE Specifications
8. ETL; Edison Testing Lab > Intertek
9. FCC; Federal Communications Commission
10. FOA; Fiber Optic Association
11. IBC; International Building Code
12. ICEA; Insulated Cable Engineers Association
13. IEC; International Electrotechnical Commission
14. IECC; International Energy Conservation Code
15. IEEE; Institute of Electrical and Electronics Engineers
16. IFC; International Fire Code
17. ISO; International Organization of Standards
18. ITU; International Telecommunications Union
19. NEC; National Electrical Code
20. NEMA; National Electrical Manufacturers Association Standards
21. NESC; National Electrical Safety Code
22. NFPA 70; National Fire Protection Agency
23. OSHA; Occupational Safety and Health Administration
24. SCTE; Society of Cable Telecommunications Engineers
25. SBCCI; Southern Building Code Congress International
26. SNBO; Southern Nevada Building Officials amendments
27. TIA; Telecommunications Industry Association
28. UBC; Uniform Building Code
29. UL; Underwriter Laboratories Incorporated Standards
30. UMC; Uniform Mechanical Code by IAPMO
31. UNLV Planning and Construction (P&C) specifications

1.3 Quality Assurance and Warranty

A. Installed equipment and material to bear labels attesting to Underwriters Laboratory (UL) or other Nationally Recognized Testing Laboratories (NRTL) including but not limited to ESPEC (GR-CORE) and ETL for cabling certification.
B. The Contractor/Sub to abide by all manufacturer warranty provisions, protocol, and maintain the percentage of approved techs and/or management on site as specified by the manufacturer.
C. A manufacturer system warranty for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub one-year workmanship to be submitted with system pre-bid submittal documentation and as a requirement for the signed Close-out Submittal process.
D. The manufacturer to work in coordination with their approved certified contractor/installer to define the parameters of the 'Master Warranty' for the project including 'supplements' for future moves, adds, and changes (MACs).
E. No mixing of product warranty documentations for the same genuine product. Faulty or replaced materials to be promptly corrected by the same manufacturer at no cost to UNLV/NDE.

F. Warranty begins on the assigned date on the manufacturer warranty documentation to be in conjunction with the final AutoCAD .dwg format As-Builts.
G. A RCDD engineer is on the UNLV/NDE staff and is responsible for the inspection and daily low-voltage oversight of the Contractor/Sub working with the assigned P&C project manager (PM). The Contractor/Sub to be responsible for correcting any work that does not meet the requirements detailed in this document for each project.
H. Products to be furnished with manufacturer's instructions and mounting hardware.
I. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
J. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.

1.4 Contractor/Sub Qualifications

A. The low voltage Contractor/Sub company to be a BICSI member in good standing.
B. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff. Other BICSI ICT certifications including; outside plant (OSP), Registered Telecommunication Project Manager (RTPM) and Data Center Design Consultant (DCDC) are encouraged and preferred.
C. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).
D. The company and their on-site management and technicians to be an approved manufacturer authorized contractor of the product(s) being installed. The manufacturer to dictate the percentage of on-site technicians necessary to have their current certifications in compliance with the provisions of the approved contractor manufacturer warranty provisions.
E. To be an approved UNLV State of Nevada-authorized contractor.
F. Successfully performed at least three projects of low voltage cable installation with similar size and contract Scope of Work (SoW) within two (2) years of the date of the job they are bidding on. Provide proof of performance with brief job description, start and end dates, and reference contact information.
G. All Contractor/Sub personnel to be performing work on this project have been trained properly. This includes being trained on the General Contractor and the Contractor/Sub's company policies with respect to personal safety, telecommunications industry cabling quality and neatness standards, and use of Construction Standard Institute (CSI)-standard specifications and drawings.
H. Note: In highly sensitive areas like the data centers, check with UNLV/NDE who will contact security, if necessary, to schedule having the fire alarm/smoke detectors turned off when any drilling, grinding, or cutting is being conducted.

1.5 Contractor/Sub Responsibilities; Accountability, Obligations, and Services

A. The Contractor/Sub to be fully conversant and capable in the cabling of low-voltage telecommunications applications. They are obligated to exercise the highest standard of care in workmanship to perform its obligations as defined in the project's drawings and specifications in the contract Scope of Work (SoW).
B. The Contractor/Sub to visit the site prior to bid and verify that conditions and infrastructure descriptions are as indicated on the project drawings and specifications. Contractor/Sub to include in the bid costs requirements for any work to meet existing conditions. UNLV/NDE is not held responsible for any incurred costs as a result of failing to verify conditions and requirements.
C. Contractor/Sub agrees to the contract Scope of Work (SoW) to provide a completely wired and operational end-to-end structured cabling system (SCS) as described in the specifications and drawings.
D. The structured cabling system (SCS) provided by the Contractor/Sub to be in full compliance to codes, regulations, and restrictions as dictated by the local authority having jurisdiction (AHJ).
E. The Contractor/Sub to not disrupt any network services during construction. Any required disruption of existing services to be coordinated with the UNLV/NDE in advance.
F. The Contractor/Sub is never to unplug or plug any patch cords from active devices or patch panels for any reason. This is to be performed only by UNLV/NDE technicians.
G. In retrofit projects, UNLV/NDE to remove the patch cords associated with the cable runs that are to be demolished/removed (herein referred to as 'demo'd').
H. The assigned BICSI and manufacturer-certified foreman/supervisor is to be on-site at all times during the installation, testing, and closeout submittal process.
I. The Contractor/Sub to attend weekly project review meetings and provide a status report along with a three-week forecast of the work-in-progress describing any RFIs or any issues encountered as part of the installation.
J. If applicable, any cabled port runs from the patch panel, but not terminated or coiled at the work area (WA), are to be noted on the test results or in email referring to referenced dated/version test results. The patch panel to also be labeled properly and legibly. (Use of painters tape and Sharpie is permissible and secured to the cover of the horizontal wire manager directly below).
K. Each PDF and native tester manufacturer software test results format to follow the same labeling pattern in sequential order by building's:

    "Work Area ID #" - "MDF/IDF ID #" - "Patch Panel (PP) ID #" - "Port ID #"

L. PDF Test Results and As-Builts redline documentation:
    1. To coincide with test results labeling exactly port-to-port.
    2. PDF As-Built redline Work Area (WA) locations not to block room ID. Preferably each location to be boxed with an arrow pointing to the appropriate outlet. All to be the same font size, color, and style.
    3. Test results PDFs can be sent as one current file/folder, but separated by each ER-MDF and/or TR-IDFs. See **27 01 00** Fig 1: *As-Built Data Symbol Schedule*.

4. The designer/engineer for As-Builts to include in the bottom RH corner of each As-Built page; the date, version, and their name with initial.
5. Within 30-days of UNLV/NDE approval of the Test Results and As-Built PDF format, Contractor/Sub to provide final As-Built drawings in AutoCAD .dwg format to comply with Close-out Submittals.

M. Note: Architectural drawings to include floor drawings and elevation drawings for the telecommunications rooms inclusive of equipment rack(s) and communications cabinet(s) locations, grounding busbars, the ladder rack layout, and the position of the modular patch panel(s), optical fiber enclosures, and cable management on the equipment rack(s) and inside the communications cabinet(s). Also to include the location for the telecommunications outlets for voice/data/WiFi/security and the pathways from the telecommunications room(s).

N. If applicable, maintain old-to-new retro port documentation as 'cut sheets' in a spreadsheet and not handwritten format. This record is to be made available within a two (2) day request from UNLV/NDE.

O. Cooperate with the other trades so that the installation of the technology outlets and equipment to be properly coordinated. Conduit, fixtures, and other equipment locations to be checked with the other trade disciplines to avoid interference with the piping, ductwork, steel, beams, or other obstructions and to maintain minimum required distances (for electromagnetic interference or EMI considerations).

P. Restore all fire-rated walls, floors, and ceiling membrane (one-side) and through (both sides) penetrations with UL-approved firestop materials.

Q. Specific to telecom Contractor/Sub to provide weekly progress/status reports with percentage (%) complete before scheduled meetings - including 3-week look-ahead project calendar.

R. Practice good "sweep clean" housekeeping and remove trash on a daily basis.

S. If the cabling system fails to perform its expected operation within the manufacturer warranty period due to inferior or faulty product(s) and/or Contractor/Sub workmanship, the Contractor/Sub to promptly make all required corrections without cost to UNLV/NDE in an expedited time frame.

1.6 UNLV/NDE Responsibility to the Contractor/Sub

UNLV/NDE assumes limited responsibilities in the implementation effort, including:

1. A comprehensive understanding of the RFP project complete with specifications, references, and drawings.
2. Providing the Contractor/Sub with access to buildings, rooms, offices, parking, telecommunications rooms, and outside plant (OSP) pathways, maintenance holes (MHs), pedestals, and vaults (Vs).
3. Providing a project manager and/or RCDD engineer as the main project contact.
4. Facilitating interactions with other trades and/or vendors to promote information exchanges and/or activities required for the installation, implementation, and operation.

AS-BUILT DATA SYMBOL SCHEDULE

COUNT	SYMBOL	LAYER TYPE	DESCRIPTION	LAYER NAME
0		DATA LOCATION	CAT-6A	E-COPPER-DATA-OUTLET
0		DATA LOCATION	CAT-6	E-COPPER-DATA-OUTLET
0		CAMERA LOCATION	SECURITY CAMERAS	E-CAMERA
0		WAP LOCATION	WIRELESS ACCESS POINTS	E-WAP
0		PHONE LOCATION	ANALOG OUTLET	E-COPPER-PHONE
		J-HOOK PATHWAY	CONDUIT	E-JHOOK
0		J-BOX	JUNCTION BOX	E-COND
		CABLE TRAY PATHWAY	CONDUIT	E-CABLETRAY
		CONDUIT PATHWAY	CONDUIT	E-COND
		TUBECELL / TDU	MICRODUCT TUBECELL	E-TUBE
0		TDU LOCATION	TDU TERMINATION	E-TUBE
		FIBER CABLE (VARIOUS)	ONE LAYER PER FIBER LINE AIR BLOWN FIBER LINE	E-FIBER
		FIBER CABLE (VARIOUS)	ONE LAYER PER FIBER LINE TRADITIONAL FIBER LINE	E-FIBER
0		FIBER ENCLOSURE	FIBER ENCLOSURE	E-FIBER
		COPPER DATA (CAT6A)	LINE	E-COPPER-DATA
		COPPER DATA (CAT6)	LINE	E-COPPER-DATA
		COPPER LINE (ANALOG)	LINE	E-COPPER-PHNE
		OUTSIDE SERV PROVIDER	LINE	E-SERV
		EXTERIOR FIBER LINE	LINE	E-EXT-FIBER
		EXTERIOR COPPER LINE	LINE	E-EXT-COPPER

NOTES:

- Project specific. Modify or simplify as necessary

Disclaimer:

Field verification of all pertinent drawing content is recommended before construction begins. This set of drawings is a complilation of multiple projects with multiple vendors. Content accuracy can not always be guaranteed.

27 01 00 Fig 1: *As-Built Data Symbol Schedule*

T. No portion of the telecommunications cabling contract may be subcontracted out to another qualified entity unless prior approval is granted by UNLV/NDE. The awarded Contractor/Sub to incur the charges with no additional cost to UNLV/NDE.
U. Removal of all abandoned or demo'd cabling costs to be included in the Contractor/Sub scope of work (SoW) bid submittal.
V. UNLV/NDE reserves the right to test and re-verify compliance of all fiber and copper cables installed under contract. Any conflict with submitted test results to be resolved by Contractor/Sub at no cost to UNLV/NDE.
W. See Appendix C*; Approved Telecommunications Manufacturers and Part Numbers*

1.7 Scope of Work (SoW)

A. Execution of work includes delivery and storage of materials, preparation, installation, field-testing, and project completion tasks. This includes test results and As-Builts to the satisfaction of UNLV/NDE.
B. This also includes that the structured cabling system (SCS) provided is certified to applicable codes, industry standards and best-practices, regulations, and low voltage telecommunication manufacturer's warranty submittals.

1.8 Architectural Drawings and Specifications

A. Architecture companies low-voltage telecommunications drawings, footnotes, general notes, work notes and project specifications to abide by the guidelines as stated in the entire Sections and Subsections of this *UNLV Division 27 Campus Wiring Design Guide.*
B. Any deviation(s) from this Division 27 Guide are to be noted to the Planning and Commission (P&C) assigned project manager (PM) who, in turn, to communicate the request to UNLV/NDE.
C. Needs to be stated in the project drawings and specifications; "If there is any conflict between architectural specifications and *UNLV* Division 27 *Campus Wiring Design Guide* this document to take precedence unless exceptions are approved by UNLV/NDE".
D. Scale measurements to be included on each architectural "T" drawings. These construction drawings are to be in scale to "E" size drawings unless otherwise noted.
E. Dimensions given or displayed on drawings to take place over scaled drawings.
F. UNLV/NDE acknowledges any existing wires, cabling, utilities, and other construction considerations shown on the drawings are shown for general information and to the best knowledge of the architecture engineer.
G. UNLV/NDE approved project drawings and specifications furnished at the time of the bid solicitation to serve as the basis for product selection, creation of the Bill of Materials (BoM), and determination of labor content.
H. The Contractor/Sub is to verify distances, the outside and inside environments, materials and equipment placements prior to the bid.
I. Any discrepancies or contingencies from a walk-through prior to the bid, are to be brought to the attention of the P&C project manager (PM).

J. Changes, additions, or deletions to require an amendment to the original bid with re-approved project drawings and specifications.

1.9 Pre-bid Submittals

A. This Division 27 document is not a substitute for any governmental code or regulation that takes precedence. The approved Contractor/Sub to be aware of all local and State Codes that may impact the bid submittal or the execution of the project for full compliance.
B. Submittals for UNLV pre-bid approval to have the manufacturer part numbers product data sheets of the materials being used for the project, and installation instructions.
C. Submittals to be complete and at one time. Partial submittals not to be considered.
D. Provide manufacturer system warranty documentation for minimum 25 years warranty covering all components, materials, and equipment plus the Contractor/Sub one-year workmanship to be submitted with system documentation as a requirement of the closeout submittal process.
E. Provide proof of BICSI and manufacturer(s) certifications for all on-site technicians and management before installation work begins.
F. Provide UNLV State of Nevada-authorized contractor documentation and current licensing, permitting, and bonding requirements to the UNLV/P&C department.
G. The Contractor/Sub is responsible to show proof their personnel have the necessary training and certification(s) to satisfy testing and related warranty certification requirements. This may include requiring the testing technician(s) to have the manufacturer's current ' authorized installer's' certification.
H. Firestopping considerations include providing a copy of the same manufacturer firestop assembly specification>application documentation to be used for all types of membrane and through penetrations both the outside and inside of the pathways. The same manufacturer is to be used throughout the installation.
I. Proposed labeling schemes, methods, and samples if requested.
J. Submit a test plan that abides by this Division 27 guidelines to ensure that the installed and tested system meets technical requirements, operational and performance specifications.
K. Submitted drawings to be signed and sealed by a qualified professional engineer.
L. Coordinated with P&C for safety compliance.

1.10 Moves, Adds, and Changes

A. Moves, adds, and changes or MACs initiated by UNLV to require the Contractor/Sub to initiate a Request for Information (RFI)/Change Order (CO) to UNLV/P&C.
B. The RFI/CO to be issued as a written response by P&C that may require revised project drawings and specifications. Changes to be clearly denoted in the As-Builts both PDF and AutoCAD .dwg.
C. Moves, adds, and changes or MACs that affect installations covered in a manufacturer warranty to be performed by the original Contractor/Sub under to which the warranty program was originally issued.

1.11 Maintenance, Retrofitting, and Warranty Repair

A. UNLV/NDE typically does not require a low voltage telecommunications maintenance contract unless specifically requested in a request for proposal (RFP).
B. The Contractor/Sub to furnish a quotation for the time, materials and equipment required to perform low-voltage telecommunication repairs. UNLV has the right of first refusal of selecting a suitable Contractor/Sub. The decision may be based on the original contractor's cable/connector manufacturer's warranty considerations.
C. Additions or retrofitting of either communications optical fiber backbone or horizontal copper distribution cabling to be completed in a professional manner, labeled, tested, and documented with test results and As-Builts.
D. New cabling installations, additions, or retrofitting to an already installed and existing warrantied installation is to be covered and/or extended by the same manufacturer's warranty policies coverage.

PART 2: PRODUCT

2.1 General

A. If the Bill of Materials (BoM) calls for more than one unit of a specific product, all units purchased to be from the same manufacturer.
B. All low-voltage manufacturers are required to have a minimum 25-year warranty.
C. Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*.

2.2 Substitutions

A. No substituted items can be installed without written consent by UNLV/NDE.
B. Approval of a substitution not to relieve Contractor/Sub from responsibility for compliance with all requirements of the contract documents. Where "approved equal" is stated in Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*, materials and equipment to be equivalent in every way or more to that what was specified and still subject to approval by UNLV/NDE
C. Contractor/Sub to bear the expense for any changes in other parts of this work or other work caused by the proposed substitution.
D. Product data sheets documentation required on all submittals as well as Request for Information (RFI)/Change Orders (COs) for approval.

2.3 Materials

A. Equipment and material to be the current model and new, and less than one (1) year from the manufacturer manufactured date), unused, and without blemish or defect.

B. Delivered materials and equipment to the project are to be in the manufacturer's original, unopened, and labeled packaging. Packaging is to provide protection against moisture, tampering, or damage from improper handling or storage. Contractor/Sub to protect and be responsible for any damage to work or materials until final acceptance by the UNLV/NDE.
C. All applicable low-voltage systems components, equipment and material to be NEC fire-rated and bear labels attesting to Underwriters Laboratory (UL) or other Nationally Recognized Testing Laboratories (NRTL) for performance including but not limited to ETL/Intertek for cabling certification.
D. All low-voltage telecommunications connectivity, cable and pathways to be made by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
E. If components from different manufacturers are used, it is up to the Contractor/Sub to ensure that the cable/connectivity manufacturers being offered are from the UNLV/NDE Appendix C; *Approved Telecommunications Manufacturer and Part Number* list and offer the 25-year warranty.
F. The assembled ICT structured cabling system (SCS) is to be certified as an end-to-end solution.
G. All cabling installations to be complete, operable, tested end-to-end in accordance with applicable IEEE 802.3 standards for the specific media involved in the project(s).
H. Contractor/Sub to coordinate delivery, storage and handling of equipment, tools, and materials to the job site. They are to use their own site manager and take responsibility for its security and inventory.

PART 3: EXECUTION

3.1 Intent of Specifications and Drawings

A. The specifications and drawings of low-voltage projects at the UNLV campus are in compliance to industry best-practices inclusive but not limited to the current version of; the *UNLV Campus Wiring Design Guide*, ISO/IEC, ANSI/TIA, and BICSI *Telecommunications Distribution Methods Manual (*TDMM) and BICSI *Information Transport Systems Installation Methods Manual (*ITSIMM) manuals plus adhere to manufacturer warranty requirements.
B. Any descrepancies or contradictions between drawings and specifications is a design error. This needs to be addressed to UNLV/NDE for clarification before proceeding with the design or with the installation.
C. Contractor/Sub to keep a hard or soft copy of the specifications and drawings on-site at all times.
D. The Contractor/Sub needs to be in compliance with the specifications and drawings. Any violations, infringements or infractions of the specifications and/or drawings to require correction by the Contractor/Sub without charge to UNLV/NDE.
E. Length measurement reference is based upon E-size drawings unless otherwise noted.
F. Demolition "T" drawings used strictly for demolition purposes and are not to be used for installation guidelines.

3.2 Examination and Preparation

A. Ensure all stakeholders are referencing the same updated specifications and drawing version and dates.
B. Full examinations of the campus, or building(s), surrounding area, and job-site(s) is the responsibility of the Contractor/Sub.
C. All distances and site surroundings to be field-verified by Contractor/Sub before ordering any material.
D. For intra-building projects; room numbers, equipment room-main distribution frame (ER-MDF), telecommunication rooms-intermediate distribution frames (TRs-IDFs,) - hereto referred to as "telecommunication rooms" - security cameras, wireless access point (WAP) locations are labeled and identified plus type and size pathways are clarified on the drawings.
E. For inter-building projects; outside plant (OSP) pathways, vaults, maintenance holes/manholes, telecommunication distribution units (TDUs) for air-blown jetted fiber (ABF), entrance facility (EF) demarcation point and related fiber cabling type(s) are clarified on the drawings.
F. UNLV/NDE to provide, if any, old-to-new ER-MDF and TRs-IDFs locations on the drawings.
G. UNLV/NDE to provide the patch panel>switch interconnections between the telecommunication rooms network.
H. Contractor/Sub to coordinate work with other trades as necessary and inform UNLV/NDE of any interference or disruption of low-voltage pathways or cable routes from other trades.
I. Cabling installation in telecommunications rooms to be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.

3.3 Installation Practices

A. All workmanship to be in full conformance with applicable building, electrical, and other codes as determined by the authority having jurisdiction (AHJ).
B. Contractor/Sub acknowledges they are obligated to exercise the highest standard of care in performing its responsibilities as defined in the contract Scope of Work (SoW).
C. Products to be installed in accordance with manufacturer installation instructions.
D. Any damage to the building or job-site caused by Contractor/Sub to be repaired and restored at Contractor/Sub's expense to match the condition prior to damage. If determined by UNLV or General Contractor to be too extensive, it may become necessary to provide professional third-party services to clean or repair damage at Contractor/Sub's expense.
E. Contractor/Sub to keep all foods and liquids away from the installation area and use only designated break areas. No smoking of any kind on campus.

3.4 Testing

A. Before testing is to begin, check with UNLV/NDE to verify the copper and/or optical fiber cabling system installations, terminations, and labeling are in compliance to all applicable codes and standards as set forth in this documentation. See Appendix A; *Codes, Regulations and Standards.*
B. Copper tester having optical fiber OLTS adapters to be a minimum Level IIIe per ANSI/TIA 1152-A and IEC 61935-1 (Inclusive of copper 500 MHz rating).

C. It is preferable that the Contractor/Sub show proof of being trained and certified by the UNLV approved tester manufacturer. Verify with the connectivity/cable manufacturer if this is a requirement for warranty purposes. See Appendix C; *Approved Telecommunications Manufacturer List and Part Numbers.*
D. The tester and all related testing components are current in calibration and firmware and of high-quality condition.
E. Copper testing is set to permanent link and optical fiber testing to fiber link through the use of compliant components inclusive of test cordage. No patch cords, no channel testing.
F. PDF and native tester manufacturer software test results are to follow the same pattern in sequential order by building's;

"Work Area ID #" - “MDF/IDF ID #” - “Patch Panel (PP) ID #” - “Port ID #”

G. Separate each PDF and native tester manufacturer software files by the telecommunications rooms with current date/version of test in email file ID #.
H. Both copper and optical fiber test results to have connectivity/cable manufacturer’s name and part numbers.
I. Use ANSI/TIA 568 as a default standard.
J. Minimum network applications for copper is 10GBase-T per IEEE 802an and optical fiber 100GBase-LR4 per IEEE 802.3ba as well as backwards compatibility to lower speed standards.
K. All tester results summaries (in sequential order) to include the graphical documentation for each test.
L. End-to-end cabling to be considered defective if it does not pass PASS tests and are to be replaced or repaired at no cost to UNLV. *PASS is still a FAIL
M. Electronic format copies only required. No hard copies.

3.5 Cleaning

N. Contractor/Sub to practice good “sweep clean” housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas. This includes keeping inventoried material staging areas in the telecommunications rooms organized.
O. Once the telecommunication rooms are complete with terminated modular patch panels yet still be exposed to sanding, dust and debris, the Contractor/Sub is to use painter's blue tape or equivalent to cover the patch panel ports at no additional cost to UNLV/NDE. Only UNLV/NDE to remove the tape when cutover begins.
P. Upon completion of a project, all debris, empty boxes, excess material inventory, installation equipment and tools are to be removed leaving the premises clean, neat, and orderly. Floors are to be cleaned and vacuumed.
Q. This final cleaning includes using a clean HEPA filter vacuum cleaner to remove dust and debris from all installed conduit and electrical outlets, HVAC units, lighting covers, equipment, racks, cabinets, wall mount TDUs and security cabinets, wire managers and the floor itself.

3.6 Examination and Acceptance

Results Expected

1. If applicable, cut sheets for cutover.

2. The ICT structured cabling system (SCS) and related infrastructure to be complete and ready for port activation.
3. Required cable testing completed per specifications with one-hundred percent (100%) PASS rate.
4. Approved test results and As-Builts PDFs to be first approved by UNLV/NDE before port activation can begin.
5. Inside the telecommunications rooms, cables are professionally organized and dressed similar to a "Cigarette Pack" look; same size and equal size and spacing of hook and loop tape (here to referred as Velcro™)
6. Remove any pencil/pen markings or graffiti on plywood walls.
7. Lights, HVAC, and power are all working properly per specifications.
8. Patch panels properly terminated and supported with cables routed into vertical wire managers.
9. Labeling of all patch panels, patch panel ports, cables, and faceplates complete and synchronized.
10. Test results match As-Builts ID ports; AutoCADs in .dwg format and manufacturer warranties to follow within 30 days.
11. Complete cleanup, tool and equipment removal, detailed HEPA vacuuming of the telecommunication rooms.
12. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the P&C PM. In turn, the P&C PM is to notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.
13. After inspection, ceiling tiles are replaced, clean of handprints, aligned and flat - damaged tiles or T-bars to be replaced at no additional cost to UNLV/NDE.

3.7 Close-out Submittals

A. Provide UNLV NDE with accurate and completed test results and corresponding As-Builts exactly port-to-port.
B. Within 30 days of the substantial completion of the project or prior to project closeout -- whichever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub's one-year workmanship documentation.
   Warranty documentation to specify project number and building ID/floor(s) location(s).
C. Coordinate with UNLV/P&C with the authority having jurisdiction (AHJ) for permit and inspection approval documentation.
D. Provide AutoCAD in .dwg format As-Built drawings UNLV/NDE within 30 days upon substantial completion of the project or prior to project closeout - whichever comes first.
E. Close-out Submittals:
   1. Finalized test results in both PDF and native tester manufacturer software format matched port-to-port with As-Builts.

2. Preliminary As-Builts in PDF format.
3. Manufacturer(s) 25-year warranty(s) certifications plus Contractor/Sub one-year workmanship warranty statement.

F. Acceptance

1. Required Close-out Submittals have been submitted, reviewed, and approved.
2. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the P&C PM. In turn, the P&C PM is to notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.
3. Clean up approved.

——— End of SECTION 27 01 00 ———

OPERATION AND MAINTENANCE OF LOW-VOLTAGE COMMUNICATIONS SYSTEMS

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SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

Section 27 05 26

Grounding and Bonding

PART 1: GENERAL

1.1 Summary of the Grounding Electrode System

A. This Section is specific to grounding and bonding. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for either or a combination of low-voltage telecommunications grounding and bonding components in either new or retrofit construction.
B. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of *Grounding and Bonding* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).
C. Electrical calculations and architectural design and drawings to be specified by UNLV/P&C referenced to Division 26 05 26.
D. This document Section does not take precedence over any code requirements either partially or wholly as governed by the local authority having jurisdiction (AHJ).

1.2 Related Documents and References

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".
B. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications*, 27 11 00; *Communications Equipment Room Fittings*, 27 13 00; *Communications Optical Fiber Backbone Cabling,* and 27 15 00; *Communications Copper Horizontal Cabling* includes the following:
    1. Section 27 05 28; *Pathways for Communications Systems*
    2. Section 27 05 33; *Conduits and Back Boxes*
    3. Section 27 05 36; *Cable Trays*
    4. Section 27 05 39; *Surface Mounted Raceway*
    5. Section 27 05 43; *Underground Ducts and Raceways for Communications Systems*
    6. Section 27 11 10; *Telecommunications Rooms and Backboards*
    7. Section 27 11 16; *Communication Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides*
    8. Section 27 11 19; *Communications Copper Modular Patch Panels*
    9. Section 27 11 20; *Communications Optical Fiber Enclosures*
    10. Section 27 13 23 .01; *Intra-building Optical Fiber Backbone Cabling*
    11. Section 27 13 23. 02; *Inter-building Optical Fiber Backbone Cabling*
    12. Section 27 15 01 .13; *Communications Copper Horizontal Cabling Station Applications and POE*

13. Section 27 15 43 .15; *Communications Fiber Connectors and Cassettes*

C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
    1. Appendix A; *Codes, Standards, and Regulations*
    2. Appendix B; *Abbreviations and Acronyms*
    3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
    4. Appendix D; *Rack Elevation and Room Sizing Drawings*

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

E. Grounding and Bonding to comply with the requirements of the current versions and practices in:
    1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)
    2. BICSI *Information Transport Systems Installation Methods Manual* (ITSIMM)
    3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
    4. ANSI/BICSI 002-2019; *Data Center Operations and Maintenance Best Practices*
    5. ANSI/TIA 568.1; *Commercial Building Telecommunications Standard, Part 1: General Requirements*
    6. ANSI/BICSI G1-17*; ICT Outside Plant Construction and Installation: General Practices*
    7. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*
    8. ANSI/BICSI N2-17; *Practices for the Installation of Telecommunications and ICT Cabling to Support Remote Power (PoE) Applications*
    9. ANSI/BICSI N3-20; *Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure*
    10. ANSI/TIA-568.1-E; *Commercial Building Telecommunications Cabling Standard Part 1: General Requirements*
    11. ANSI/TIA-568.2-D; *Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling*
    12. ANSI/TIA-569-E; *Commercial Building Standard for Telecommunications Pathways and Spaces*
    13. ANSI/TIA 607-D; *Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises*
    14. ANSI TIA-758-B; *Customer-owned Outside Plant Telecommunications Cabling Standard*
    15. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facilities,*
    16. IEC 61537; *International Standard for Cable Tray and Cable Ladder Systems*
    17. NEMA VE 1 & 2; Metal Cable Tray Standards
    18. NFPA-70 *National Electric Code*
    19. NEC Article 250; *Grounding and Bonding of Electrical Systems*
    20. NEC Article 392; *Cable Trays*
    21. UL 467; *UL Standard for Grounding and Bonding Equipment*
    22. UL 797; *UL Standard for Safety Electrical Metallic Tubing*

1.3 Scope of Work

A. This section includes the minimum requirements for the *Grounding and Bonding* in the corridors and hallways pathways leading into and within the telecommunications rooms.
B. Included in this section are the minimum composition of the components and installation guidelines for the following:
    1. Grounding electrode system
    2. Grounding busbars
    3. Bonding conductors, lugs, and connectors
    4. Labeling

1.4 Quality Assurance and Warranty

A. Grounding and bonding materials and equipment to be installed in a neat and professional workmanlike manner.
B. All methods of construction not specifically described or indicated in the Contract documents to be subject to the control and approval of the UNLV/NDE.
C. Equipment and materials installed to be of the high-quality as presented with pre-bid submittals.
D. Where “approved equal” or “equal to” is stated for substitution, equipment and materials to be equivalent to that of the equipment specified and subject to UNLV/NDE approval.
E. Strictly adhere to all Building Industry Consulting Service International (BICSI), Telecommunications Industry Association (TIA), and National Fire Protection Agency (NFPA-70) National Electrical Code (NEC) recommended installation practices.
F. Products to be furnished with manufacturer’s instructions and mounting hardware.
G. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.

1.5 Contractor/Sub Responsibilities

A. The licensed electrical Contractor/Sub to provide all labor, materials, tools and equipment required for the complete installation of a low-voltage telecommunications *Grounding and Bonding* system as described in the specification and within the construction drawings.
B. Note: In highly sensitive areas like the data centers, check with UNLV/NDE who will contact security, if necessary, to schedule having the fire alarm/smoke detectors turned off when any drilling, grinding, or cutting is being conducted.

1.6 Pre-bid Submittals

A. Provide manufacturer product data specifications (‘cut sheets’) with installation instructions.

PART 2: PRODUCT

2.1 General

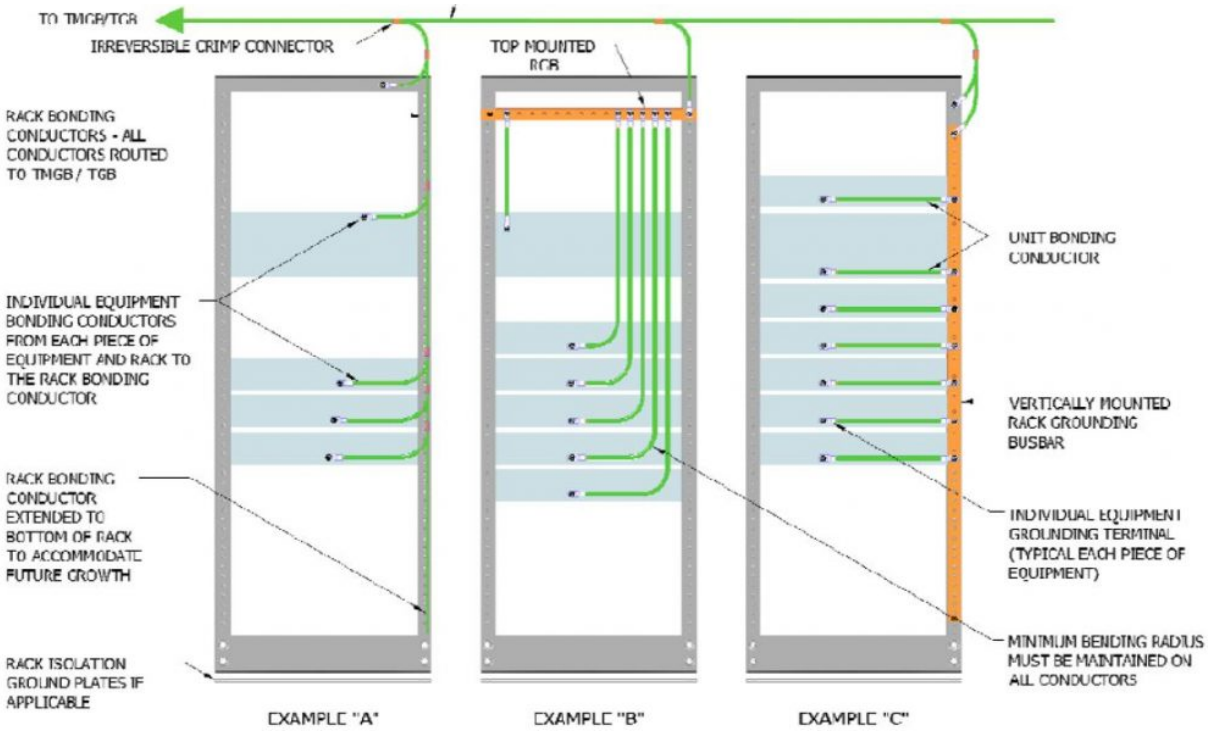
A. The Contractor/Sub is liable to ensure the building's grounding electrode system provides a low resistance to ground and meets local code requirements before connecting the low-voltage telecommunication grounding system.
B. The UNLV project may specify a ground-resistance test and subsequently a bonding resistance test for all bonded connections at the busbars and grounding jumpers.
C. Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*
D. All materials to be new and all from the same manufacturer.

2.2 Wall and Rack-mount Busbars

A. Telecommunications Main Grounding Busbar (TMGB)/Primary Busbar (PBB):
    1. Located in the building's one Equipment Room (ER)-Main Distribution Frame (MDF)
    2. Dimensions to be of .25 inch (6.4 mm) thick), 4 inch (102 mm) height, and be minimum 20 inches (510 mm) in length.
    3. The busbar to be UL listed and per the current version of UL 467 approved, being constructed with a solid, hard-drawn copper or copper-alloy bar having 30 each pre-drilled attachment points (two rows of 15 each) for two-hole compression grounding lugs. Check specifications and drawings for ⅝ and 1.0-inch hole spacing.
    4. The hole pattern for attaching grounding lugs to meet the requirements of the current version of ANSI/TIA 607-D (ANSI-J-STD-607) and to accept 27 each two-hole double-compression lugs with ⅝ inch (15.8 mm) hole centers and three (3) lugs with 1 inch (25.4 mm) hole centers.
    5. The busbar to include wall-mount stand-off brackets with two (2) insulators and assembly screws to allow 4 inch (100 mm) clearance from the plywood wall. Wall location height and orientation (horizontally or vertically) determined in elevation drawings.
B. Telecommunication Grounding Busbar (TGB)/Secondary Busbar (SBB):
    1. Located in the building's Telecommunications Rooms (TRs)-Intermediate Distribution Frames (IDFs).
    2. Dimensions to be of .25 inch (6.4 mm) thick, 2 inch (100 mm) height, and be minimum 12 inches (300 mm) in length.
    3. The busbar to be UL listed and per latest edition of UL 467 approved being constructed with a solid copper or copper-alloy bar having nine (9) each pre-drilled attachment points (one row) for two-hole grounding lugs. Check specifications and drawings for ⅝ and 1.0-inch hole spacing.
    4. The hole pattern for attaching grounding lugs to meet the requirements of the current version of ANSI/TIA 607-D (ANSI-J-STD-607) and to accept six (6) each lugs with ⅝ inch (15.8 mm) hole centers and three (3) lugs with 1 inch (25.4 mm) hole centers.

5. The busbar to include wall-mount stand-off brackets, assembly screws and insulators creating a 4-inch (100 mm) standoff from the wall. Wall location height and orientation (horizontally or vertically) determined in elevation drawings.

C. Rack Bonding Busbar (RBB):
   1. Sometimes referred to as a horizontal equipment rack/communications cabinet Bonding Busbar
   2. 19" (483 mm) wide, 1 inch (25 mm) high busbar to be UL listed, being constructed with a minimum 0.188 inch solid tinned copper bar
   3. Busbar to have minimum 49 each angled pre-drilled #12-24 tapped holes at 0.625 inch spacing to ground>bond up to 24 each 2-hole TBC grounding lugs.
   4. Mounted on top back two post channels of the 4-post equipment rack and communications cabinet.
   5. Another option is a vertical equipment rack/communications cabinet Bonding Busbar 72 or 36 inches (1,827 mm or 914 mm) in length to mount vertically.
   6. Communications racks and communication cabinets are to be bonded to the RBB. In turn, the RBB to be bonded directly to the TMGB-PBB or TGB-SBB (not the ladder racking).
   7. UNLV/NDE only recognizes "Examples B and C".



27 05 26 Fig 1: *Rack Bonding Busbar Layout Options*

2.3 Bonding Components

A. Telecommunications Bonding Conductor (TBC):
   1. Minimum stranded #6 AWG copper wire having solid green or green with yellow stripe insulated thermoplastic jacketing.
   2. Complies with ASTM B.3 and UL 83 as a Type THHN wire rating to support a voltage range of 600V and 90℃ (190F)
   3. Applicable for telecommunications busbar, cable pathways, and armored cable grounding wire and jumper(s) as well as custom-length equipment grounding wire.
   4. Sized per the current version of ANSI/TIA 607-D (ANSI-J-STD-607) to be a Telecommunications Bonding Backbone (TBB) and Telecommunications Bonding Backbone Interconnecting Bonding Conductor (TBBIBC).

B. Irreversible Connectors:
   1. Complies with latest editions of NFPA 70, UL 467, and UL 486A-486B for #6 to 4/0 AWG insulated conductors.
   2. Crimp-and-compression connectors that bond to the conductor when the connector is (double) compressed around the conductor.
   3. Includes exothermic welds.

C. Compression Lugs:
   1. UL-listed manufactured from electroplated tinned copper for the application intended.
   2. Two holes spaced on ⅝ inch or 1 inch centers.
   3. Matched to a specific size conductor (6 AWG).
   4. “I” or “L” shape is permitted.
   5. Requires use of a crimp tool - double crimp process.
   6. Single-hole single compression lugs permissible for bonding to single-stud grounding applications including conduit pipe clamps or collars and pedestal clamps.

D. Cable Tray Grounding Jumper:
   1. Not smaller than No. 6 AWG and not longer than 12 inches (300 mm).
   2. Factory-made or field-terminated use a two-hole grounding lug on both ends each having a long barrel for two (double) compression crimps.
   3. “C”- and “H”-Type Compression Taps UL-listed and manufactured from copper alloy.
   4. Both C-and H-type taps wrap around the two conductors and when doubled crimped creates an irreversible splice.
   5. Matched to a specific size conductor.
   6. Requires hydraulic crimping tools.

E. Pedestal Clamps:
   1. UL-listed and manufactured from electroplated tinned copper or bronze.
   2. Matched to a specific size conductor and up to two (2) each TBC conductors.
   3. Provides support for up to two (2) each TBC conductors.
   4. Use of single-hole single-crimp compression lugs are permissible.
   5. Typically used on raised floor environments.

F. Conduit/Pipe Clamps or “Collars”:
   1. U-listed and manufactured from electroplated tinned bronze. Installation hardware to be stainless steel.
   2. Sized to fit up to two (2) each same-sized conductors ranging from #6 AWG to size 250 MDM (250 fuse voltage protection).

3. Pipe clamp “collars” sized to matching pipe size from trade size 1 to 6 inches (25mm - 152 mm) inside diameter (ID).
4. On sleeves between walls or floors, only one side needs to be grounded back to the telecommunications busbar.
5. Use of single-hole single-crimp compression lug is permissible.
6. On inter-building (between buildings) conduit runs , both ends need to be grounded and connected to the nearest building entrance facility (EF) telecommunications or electrical busbar.

PART 3: EXECUTION

3.1 Summary

A. The UNLV low-voltage telecommunications grounding and bonding system is to be used to ground all telecommunications cable shields, racks, cabinets, pathways, raceways, conduit, and other associated hardware that has the potential to act as a current-carrying conductor.
B. The Contractor/Sub is to provide a low-voltage telecommunications grounding and bonding system to be installed independent of the building’s electrical and building ground. It is designed to be in compliance with the recommendations found in the current version of ANSI/TIA 607-D (ANSI-J-STD-607).
C. The main telecommunications entrance facility (EF) in each building to be equipped with a TMGB-PBB and be connected to the building's electrical entrance grounding facility. Note: The EF may be located in the ER-MDF.
D. Each building’s TRs-IDFs to be provided with a TGB-SBB. The intent is to provide a low-voltage telecommunications grounding system that is equal in potential to the building electrical grounding system. This is to minimize ground loop current potential between telecommunications equipment and the electrical system that supplies power to the equipment.
E. The TMGB-PBB is to be connected to each TR’s/IDF’s TGB-SBB using a TBB. Size the TBB per the tables in the current version of ANSI/TIA 607-D (ANSI-J-STD-607).

3.2 Installation

A. Contractor/Sub to abide by NEC Article 250.96(A) “Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal noncurrent-carrying parts that are to serve as grounding conductors, with or without the use of supplementary equipment grounding conductors, to be bonded where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them.”
B. Check UNLV/NDE or architecture design specifications to determine if the ladder rack, cable tray, or basket wire mesh tray functions as an EGC (Equipment Grounding Conductor). Accordingly, install pathways per manufacturer’s instructions to ensure compliance to Article 250 and other guidelines governed by the authority having jurisdiction (AHJ).
C. Comply with Section 27 00 00 3. EXECUTION; 3.2: Examination and Preparation
D. Outdoor grounding and bonding connections:
    1. Outdoor grounding and bonding (earthing) connections to be accomplished using exothermic welding.

2. Needs inspection by the authority having jurisdiction (AHJ) before burial.

E. OFC or Armored Optical Cable:
   1. OFC or optical fiber conductive (armored) whether standard or blown requires grounding. Use manufacturer supplied hardware and follow manufacturer instructions on the proper methodology of grounding the cable.
   2. If applicable, bond to the cabinet using a strap or to the 4-inch (102 mm) conduit bonding collars on the sleeves or stub-ups.
   3. Whether it be inter-building (OSP) or intra-building premise (ISP) applications , both ends of any armored cable are to be bonded and grounded.

F. Wall-mount Busbars:
   1. Attach busbars to the plywood wall with appropriate stainless steel hardware as provided and instructed by the manufacturer's installation instructions.
   2. Busbar standoff brackets are to provide a 4-inch (102 mm) insulated clearance between the wall and the busbar.
   3. Conductor connections to TMGB-PBB and TGBs-SBBs to be made with two-hole bolt-on double-compression lugs sized to fit the busbar. Single-hole mounts are not permitted on any telecommunications busbars.
   4. Wall-mount telecommunication busbars to be bonded to the building's ground system.
   5. The TMGB-PBB to be bonded to the TGB-SBBs via TBBs or, if applicable, the TBBIBCs.
   6. When there are multiple TBBs, the BBC is employed to interconnect them through the associated busbars, either on the same floor in a multi-story building or in the same general area of a single story building.
   7. The secondary bonding conductor (SBC) is employed to connect the telecommunications equipment, racks and cabinets, to the TMGB-PBB and TGBs-SBBs.
   8. The PBB to be connected with each SBB using the TBB. Size the TBB per the tables in the current version of the ANSI/TIA 607.
   9. When the SBB is not bonded directly to the TBB, the SBC to bond the SBB to the TBB.
   10. All metal equipment racks, cabinets, backboards, cable shields, strength members, splice cases, cable trays, similar continuous cable support mechanisms, and the like entering or residing in ER-MDF to be grounded to the TMGB-PBB and those in or TRs-IDFs to be grounded to the TGB-SBB. The SBC to be a minimum #6 AWG stranded copper bonding conductor and compression connectors.
   11. Reference electrical "E" drawings for clarification to include the location and pathways of the telecommunications busbars connectivity to; (1) the building grounding system and from the (2) Equipment Room-Main Distribution Room (ER-MDF) Telecommunications Main Grounding Busbar-Primary Bonding Busbar (TMGB-PBB) to the Telecommunications Rooms-Intermediate Distribution Frames (TRs-IDFs) Telecommunications Grounding Busbar-Secondary Bonding Busbar (TGBs-SBBs)
   12. Note NEC requires the first (ER-MDF) TMGB and top floor (TR-IDF) TGB to be bonded to each other and each grounded to the building steel grounding infrastructure. Plus every third floor - this equates to a five story building with the first, third, and fifth floor bonded to each other and all grounded. No middle floors need to be but preferred to be bonded for three (3) and four (4) story buildings.

13. Ground wires used for telecommunications grounding purposes to be identified with solid green or green with yellow stripe insulation jacketing.

G. Structural Steel:
   1. Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TMGB-PBB and TGBs-SBBs to the vertical steel of the building frame.
   2. Size the Bonding Conductor for Telecommunications (BCT) to electrical standards.

H. Bonding Conductor for Telecommunications (BCT):
   1. The BCT between the TMGB-PBB and the ac service equipment ground and/or to the building grounding system not be smaller than No. 1/0 AWG.
   2. Check electrical standards for proper sizing.

I. Rack-mounted Bonding Busbars (RBB):
   1. Provide 19 inch (483 mm) equipment rack/communications cabinet-mounted horizontal or vertical Rack Bonding Busbar (RBB) per manufacturer installation instructions.
   2. Alternatively per specifications, provide 72 or 36 inches (1,827 mm or 914 mm) long equipment rack/communications cabinet-mounted vertical rack-mounted bonding busbar (RBB).
   3. Use manufacturer supplied stainless steel or copper-plated hardware for attachment to the equipment rack/communications cabinet. The RBB is equipped to accommodate two-hole double-compression TBC equipment screws with lock washers as well as the RBC to the telecommunications busbar.

J. Pedestal Clamps:
   1. Remove paint and clean the surface between the pedestal and the pedestal clamps.
   2. At a minimum bond every sixth raised floor pedestal with a minimum # 6 AWG to the telecommunications busbar per manufacturer's instructions.

K. Conduit/Pipe Clamps "Collars":
   1. Secure the TBC to the collar clamps using a single-hole single compression lug.
   2. Route the TBC with a minimum #6 AWG to the nearest telecommunications busbar.

L. Corridor Cable Tray and Metal Raceways:
   1. If the metal cable tray supports are attached to concrete or other non conductive materials, bonding jumpers from the cable tray to building steel are required every 50-65 ft. (15.2 m - 19.8 m) or a continuous ground wire attached every 50-65 ft. (15.2 m - 19.8 m) ft. of cable tray run may be a simpler approach.
   2. Upon entering or outside the ER-MDF or TR-IDF, bond to the telecommunications busbar with a TBC.

M. Corridor or ER-MDF and TR-IDF Wire-mesh Basket Tray:
   1. Wire-mesh aluminum trays need no jumper between sections if using the manufactured recommended splice components.
   2. Upon entering or outside the ER-MDF or TR-IDF, bond to the telecommunications busbar with a TBC.

N. TBC, SBC, and TBB Compression Conductors:
   1. Install in the straightest and shortest route between the origination and termination point, and no longer than required.
   2. The bend radius is not smaller than eight times (8X) the diameter of the conductor.

3. No one bend may exceed 90-degrees.
4. Install without splices.
5. Support at not more than 36-inch (900-mm) intervals.
6. Stacking of TBC conductors is not permitted.

O. Electrical Power Panelboards: Check with UNLV/P&C electrical specifications and drawings; only for existing buildings where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each IDF TGB-SBB to the ground bar of the panelboard.

P. Rack- and Cabinet-Mounted Equipment:
1. Bond powered equipment chassis to the equipment rack/communications cabinet RBB grounding busbar.
2. Power connection need to comply with latest edition of NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment to be considered as a supplement to bonding requirements in this Section.

3.3 Cleaning

A. Contractor/Sub to practice good “sweep clean” housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas. This includes keeping inventoried material staging areas in the telecommunications rooms organized.

3.4 Identification

A. Use ½ inch (12-14 mm) size black on white labels to be preprinted or computer-printed type.
1. Label PBB(s) with "fs-PBB," where "fs" is the telecommunications space identifier (ER-MDF room number) for the space containing the PBB.
2. Label SBB(s) with "fs-SBB," where "fs" is the telecommunications space identifier (TR-IDF room number) for the space containing the SBB.
3. Label above the telecommunications busbars on the plywood walls: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTORs. DO NOT REMOVE OR DISCONNECT!"

B. Check project specifications and drawings for labeling instructions.

3.5 Examination and Acceptance

A. UNLV/NDE to reference the specifications and construction drawings of the projects for their walk-through inspection for QA comparison.
B. Comply to Section 27 01 00 3. EXECUTION; 3.3 *Commissioning and Acceptance*
C. Visual examination of the BTC grounding electrode system between the EF TMGB-PBB and AC electrical ground and/or to the building grounding system.
D. Inspect physical and mechanical conditions; Verify bend radius and support of the TBCs, the correct size and proper crimps on connectors and lugs, tightness of accessible bolts, lock washers, the location, mounting and level of the telecommunication busbars, equipment rack/communications cabinet RBBs and their bonding to the busbars, and pathways jumpers and TBC to the busbars.
E. Products have been installed in accordance with manufacturer's instructions.
F. All materials to be installed in a neat and professional manner.

G. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM is to notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.6 Close-out submittals

A. Reference electrical "E" drawings for clarification to include the location and pathways of the telecommunications busbars connectivity to; (1) the building grounding system and from the (2) Equipment Room-Main Distribution Room (ER-MDF) Telecommunications Main Grounding Busbar-Primary Bonding Busbar (TMGB-PBB) to the Telecommunications Rooms-Intermediate Distribution Frames (TRs-IDFs) Telecommunications Grounding Busbar-Secondary Bonding Busbar (TGBs-SBBs).
B. Within 30 days of the substantial completion of the project or prior to project closeout -- which ever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub's one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.
C. Final closeout As-Built submittals in AutoCAD in .dwg format.
D. No test documentation required unless the contract Scope of Work (SoW) requires ground-resistance and/or bond-resistance test results.

SECTION 27 05 00: COMMON WORK RESULTS FOR COMMUNICATIONS

——— End of Section 27 05 26 ———

Grounding and Bonding

SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

Sections 27 05 28, 29, 33, 36, 38, 39, 40

Pathways: Hangers, J-Hooks, Supports, Conduits, Back Boxes, Cable Trays, Fiber Trough Systems, Surface Mounted Raceway, Modular Furniture Pathways and Poke-through Devices

PART 1: GENERAL

1.1 Summary

A. This Section is specific to hangers, J-hooks, supports, conduits, back boxes, cable trays, surface mounted raceway, modular furniture pathways and poke-through devices. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for either or a combination of hangers, J-hooks, supports, conduits, back boxes, cable trays, Surface Mounted Raceway, modular furniture pathways and poke-through device components.

B. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of either or a combination of *Pathways, Hangers, J-Hooks and Supports, Conduits and Back Boxes, Cable Trays, Fiber Trough Systems, Surface Mounted Raceways, Modular Furniture Pathways, and Poke-Through Devices* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).

C. Particularly applicable to this section are the current versions of Division 26 (26 05 26) *Electrical and Lighting*, ANSI/TIA-569 ANSI/TIA-569: *Commercial Building Standard for Telecommunications Pathways and Spaces*, Division 27 11 16: *Communications Cabinets, Racks, Frames, and Enclosures*, accompanying floor drawings and elevation drawings, all to meet or exceed national, State, and local code requirements.

D. All communication cabling to be routed in a designed and approved pathway system per the current version of ANSI/TIA/EIA-569 *Commercial Building Standard for Telecommunications Pathways and Spaces* and meet or exceed all National, State and Local codes and standards.

1.2 Related Documents and References

A. The subsections listed in the *Table of Contents* are considered to be “Related Documents”.

B. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications*, 27 10 00; *Structured Cabling Hardware*, 27 13 00; *Communications Optical Fiber Backbone Cabling,* and 27 15 00; *Communications Copper Horizontal Cabling* includes the following:

1. Section 27 05 28; *Pathways for Communications Systems*
2. Section 27 11 10; *Telecommunications Rooms and Backboards*
3. Section 27 11 19; *Communications Copper Modular Patch Panels*

4. Section 27 11 16; *Communication Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides*
5. Section 27 11 20; *Communications Optical Fiber Enclosures*
6. Section 27 13 23 .01; *Intra-building Optical Fiber Backbone Cabling*
7. Section 27 13 23. 02; *Inter-building Optical Fiber Backbone Cabling*
8. Section 27 15 01 .13; *Communications Copper Horizontal Cabling Station Applications and POE*
9. Section 27 15 01 .19; *Data Communications Copper Horizontal Cabling*
10. Section 27 15 01 .20; *Wireless Data Communication Copper Horizontal Cabling*
11. Section 27 15 43 .10; *Communications Copper Jack Information Outlets and Connectors*
12. Section 27 15 43 .25; *Work Area Faceplates/Wall Plates and Surface Mount Boxes*

C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
   1. Appendix A; *Codes, Standards, and Regulations*
   2. Appendix B; *Abbreviations and Acronyms*
   3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
   4. Appendix D; *Rack Elevation and Room Sizing Drawings*

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

E. Pathways, Hangers, J-Hooks and Supports, Conduits and Back Boxes, Cable Tray, and Raceways for Communication Systems to comply with the requirements of the current versions and practices in:
   1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)
   2. BICSI *Information Transport Systems Installation Methods Manual (ITSIMM)*
   3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
   4. ANSI/BICSI 008-2018; *Wireless Local Area Network (WLAN) System Design and Implementation Best Practices*
   5. ANSI/TIA-568.1-E; *Commercial Building Telecommunications Cabling Standard Part 1: General Requirements*
   6. ANSI/TIA-568.2-D; *Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling*
   7. ANSI/TIA-568.3-E; *Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Component Standard*
   8. ANSI/TIA-569-E; *Commercial Building Standard for Telecommunications Pathways and Spaces*
   9. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facilities*
   10. IEC 61537; *Cable Management-Cable tray Systems and Cable Ladder Systems*
   11. ISO/IEC 11801-1 *Information Technology - Generic Cabling for Customer Premises*
   12. ISO 9000-2015; *Quality Management Systems*
   13. NECA/NEMA 105; *Standard for Installing Metal Cable Tray Systems*
   14. NFPA-70 National Electric Code
   15. NEMA VE 1 & 2; *Metal Cable Tray Standards*

16. NEMA FB 2.10; *Selection and Installation Guidelines For Fittings for Use With Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing*
17. NEC Article 250; *Grounding and Bonding of Electrical Systems*
18. NEC Article 386; *Surface Metal Raceways*
19. NEC Article 770; *Optical Fiber and Raceways*
20. NEC Article 392; *Cable Trays*
21. TIA TSB-190; *Guidelines on Shared Pathways and Shared Sheaths*
22. UL 5; *UL Standard for Surface Metal Raceways and Fittings*
23. UL 6; *UL Standard for Electrical Rigid Metal Conduit*
24. UL 797; *UL Standard for Safety Electrical Metallic Tubing*
25. UL 2024; *UL Standard for Cable Routing Assemblies and Communication Raceways*

1.3 Scope of Work

A. This subsection includes the minimum requirements for the *Pathways; Hangers, J-Hooks and Supports, Conduits and Back Boxes, Cable Tray, and Raceways for Communication Systems* starting from Entrance Facility (EF) demarc, and telecommunication rooms as pathways through the corridors and hallways and into the Work Areas (WAs) to the Telecommunications Outlets (TOs).

B. This includes intra-building premises underfloor and an overhead distribution system inclusive but not limited to:
   1. “J”-hooks
   2. Gordon Grid - N/A
   3. Conduit / Stub outs
   4. Solid, corrugated, and mesh-sleeve innerduct
   5. Pull Boxes
   6. Cable Tray
   7. Mesh Wire Basket Tray
   8. Raceway - plastic and metal
   9. Modular furniture power/telecom poles
   10. Fiber cable troughs / Fiber cable duct
   11. Hand-bendable flex tray
   12. Access raised-floor (grid) systems support guidelines
   13. Flush-mount and pop-up floor assembly boxes, outlets, tombstones, and monuments
   14. Telecommunications outlets (TOs)
   15. Poke-through devices

C. The Contractor/Sub is responsible for the labor, equipment, and supplies necessary to install complete, empty, dry and clean communication pathways and raceways.

D. Refer to the current versions of the project’s specification and drawings for either or combination of internet protocol (IP) data, voice, video, audio, and security cabling for routing and placement parameters.

E. Installation to include; the actual physical installation of the hardware, support structure, sleeves, firestopping, testing (if any) and documentation.
F. Contractor/Sub is responsible for any structural damage or damage to other services and furniture when core drilling or blind drilling through floor-ceilings-walls.
G. Copper or optical fiber cables placed in 4-inch (102 mm) conduit to be allocated in either; solid, corrugated, or mesh-sleeve innerduct with pull tape and sized accordingly.
H. The Work Area (WA) location at which all new telecommunications wiring to terminate is referred to as a Telecommunications Outlet (TO).
I. Plastic wall-mount and non-metal plastic/rubber "speed bump" floor raceways are not acceptable.

1.4 Quality Assurance and Warranty

A. The Contractor/Sub to coordinate with the General Contractor and all other trades prior to final placement of telecommunications pathways. Placement of the pathways to be readily accessible for the placement of low-voltage telecommunications cable both copper UTP and optical fiber.
B. All pathways to be installed in a neat and workmanlike manner to support possible future expansion of the system.
C. Any poke-through devices requiring core-drill to be designed, authorized, located, x-rayed, and managed by the UNLV/P&C department. Ensure the Telecommunications Outlet (TO) is a minimum 4-port to accommodate minimum two (2) each RJ-45 jacks plus possibly other media (e.g. A/V).
D. All methods of construction that are not specifically described or indicated in the contract documents to be subject to the control and approval of UNLV/NDE.
E. Assure that the 'as installed' system(s) per manufacturer specifications are correctly and completely documented in the PDF and As-Builts drawings in AutoCAD .dwg format.
F. Where "approved equal" or "equal to" is stated for substitution, equipment and materials to be equivalent to that of the equipment specified and is subject to UNLV/NDE approval.
G. Strictly adhere to all current version of Building Industry Consulting Service International (BICSI), Telecommunications Industry Association (TIA), and National Fire Protection Agency (NFPA-70), and National Electrical Code (NEC) Article 392 recommended installation practices.
H. SPECIAL NOTE: All completed pathway installations either in whole or in sections are to be inspected and approved by UNLV/NDE RCDD prior to any cables being installed.
I. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
J. Products to be furnished with manufacturer's instructions and mounting hardware.

1.5 Contractor/Sub Responsibilities

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project

installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).

C. The Contractor/Sub is solely responsible to become and remain familiar with all project/site conditions that may have an impact on the lengths, types, delivery, quality and/or quantity of materials for the project.
D. Any additional services by the Contractor/Sub due to a lack of awareness of project/site conditions not to be subject to additional compensation from UNLV.
E. Note: In highly sensitive areas like the data centers, check with UNLV/NDE to contact security, if necessary, to schedule having the fire alarm/smoke detectors turned off when any drilling, grinding, or cutting is being conducted.
F. Under the supervision of UNLV/P&C, Contractor/Sub is required to x-rays floors prior to core-drilling so as not to damage any structural components including rebar and tension bars.

1.6 Pre-bid Submittals

A. Provide manufacturer product technical data sheet that summarizes the information and characteristics of the product along with installation instructions indicating:
    1. Part numbers and UL listing
    2. Design features
    3. Physical dimensions
    4. Ratings to verify anticipated weight capacities
    5. Supporting hardware and installation requirements
    6. Grounding and Bonding requirements and related materials
    7. Quantity of each product by part number
    8. Submit manufacturer's certification indicating ISO 9000/9001 quality certified and be RoHS 2011/65/EU compliant.
B. UNLV/NDE reserves the right to request additional samples and product documentation not explicitly requested with the pre-bid Submittals.

PART 2: PRODUCT

2.1 General

A. All materials for a specific function to be new, unused, free of defects, high-quality, and all from a single source manufacturer and delivered in manufacturer-labeled packaging.
B. Products are to be from UNLV *Appendix C; Approved Telecommunications Manufacturers and Part Numbers.*
C. Provide the accessories required to protect, support, and install a cable tray and raceway system.
D. In no case will field-fabricated cable support products be acceptable.
E. Comply with current version of IEC 61537.
F. All metallic cable trays to be grounded and clearly marked in accordance with the current versions of ANSI/TIA 606-D (ANSI J-STD-607).

G. The Contractor/Sub to be solely responsible and to manage the delivery, storage, inventory, and handling of all materials to prevent any damage. Store materials in the original manufacturer-labeled cartons in a clean dry space and protected from weather, construction traffic and possible theft.
H. No damaged materials to be installed.
I. Any materials that show signs of 'mishandling', or have been stored in a fashion so as to reduce the value of the materials or missing inventory to be replaced at no additional cost to UNLV.
J. All emptied packaging materials to be removed and recycled per UNLV LEEDs directives on a daily basis.
K. Any equipment or tools needed for delivery and removal of excess materials are the responsibility of the Contractor/Sub.
L. Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*
K. Fire Wall membrane and through penetrations to be installed in accordance with the current Division 27 05 41: *Firestopping for Telecommunication Systems* specifications.

2.2 27 05 29: Hangers, J-hooks, and Supports for Communication Systems

A. Cable supports to comprise the manufacturer recommended hardware for a complete system to support standard and blown ABF optical fiber, copper UTP Cat 6 and 6A.
B. Hangers and supports are designed to be either suspended from or attached to the structural ceiling or walls with hardware designed to support the tray's maximum load bearing weight.
C. Standard support systems to consist of wall mounting, trapeze mounting with ceiling mounted threaded rod, and underfloor mounting hardware attachment to raised-floor standoffs.
D. Support for fiber cable troughs / fiber cable duct supports to be:
    1. Overhead: Self-supported by connecting manufacturer-supplied brackets to the above or adjacent metal cable tray(s), threaded rod trapeze, or standoffs atop the cabinets. Alternatively, braces for wall mount options.
    2. Raised Floor: Self-supported by connecting manufacturer-supplied brackets secured to raised floor standoffs. Nothing touches the floor.
E. J-hooks
    1. From the stubbed out work area (TO) conduit, metal-only 'saddle-type' J-hooks having locking clips to be provided as a pathway to the cable tray or conduit.
    2. Minimum J-hook size is two (2) inches with saddle clips but sized according to cable fill.
    3. 9" (Yellow) Drop-wire stand-offs secured with a clip to the T-bars are permitted by UNLV/NDE for special circumstances only.
    4. Bridle rings are not acceptable unless equipped with Cat 6-rated and plenum-rated plastic "saddles".

2.3 27 05 33: Conduits and Back Boxes for Communication System

A. Minimum EMT metal pathway size (e.g. stub-outs): 1-inch trade size and comply with the current version of UL 797.

B. All boxes and conduits to be grounded and installed per the current version of the NFPA 70 (NEC).
C. Electric Metallic Conduit EMT) splice fitting to use set screw or compression steel fittings and comply with the current version of NEMA FB 2.10. If not specified in the specifications or drawings, the conduit and box materials to be designed for the environment in which it is to be installed.
D. Outside and garage applications use outdoor NEMA 250 4X/IEC 60529 IP65 Ingress Protection (IP) minimum-rated flush and surface mount boxes while inside plant rated (ISP) or intra-building (premises) can use inside-rated flush and surface mount boxes.
E. EMT conduits to be rigid and the minimum size is one (1) inch.
F. Only after approval by UNLV/NDE for special circumstances is Flexible Metal Conduit (FMC) and listed Liquid-tight Flexible Metal Conduit (LFMC) conduit permissible for under-the-table laboratory, conference rooms, and cubicles. WAP installation can use 1/2" FMC having just one patch cord.
G. Premises Telecommunications Outlet (TO) boxes are defined as “5-square” 2 3/4 inches (70 mm) deep electrical boxes with built-in wire managers inside. This will also require properly sized mud rings or screw-on covers if used as a pull box.
    1. Furnish and install (minimum 1-inch) conduit stubs-outs inside the walls from the 5-square 2 ¾ inch deep telecommunications outlet (TO), through the top wall plate and attaching a 45 or 90 degree elbow sweep directed to the J-hook or cable tray that leads back to the telecommunications rooms.
    2. Note: The TO to accommodate IP data and/or voice on top left (RJ-45) port.
H. Indoor application for boxes and enclosures to be minimum NEMA 250 Type 1/IEC 60529 IP 10, except use NEMA 250 Type 4/IEC 60529 IP65 stainless steel in institutional, labs, and commercial kitchens having possibly higher temperature, damp or wet environments.

2.4 27 05 36: Cable Trays for Communication Systems

A. General
    1. Cable tray installation to be installed to meet the current version of NEC Article 392 and all federal, State, and local codes as enforced by the authority having jurisdiction (AHJ).
    2. Cable tray to be designed and dedicated to telecommunication low-voltage use only and not to be shared with electrical. Audio/Video (A/V), DAS, and security may reside in or attached to the same pathway but separated from voice and data runs and only with approval through UNLV/NDE.
    3. Contractor/Sub to Provide all components of the tray system (tray, supports, splices, fasteners, and accessories) from a single manufacturer.
    4. To have a UL certified designation.
    5. Finish for Carbon Steel Wire after welding and bending of mesh;
        a. Electrodeposited Zinc Plating
        b. Powder-Coated Trays – UL classified Black powder-coated surface treatment over electrodeposited zinc plating (or plain steel) using black polyester powder coating.

6. Connecting hardware for anodized or galvanized finish cable trays - including splice connectors and support components - is to be considered continuously grounded components for the entire length.

B. Solid Bottom Trough Tray:
   1. Comply with project specifications; overhead load capacity and concealment requirements.
   2. Check project specifications for galvanized or light-weight aluminum construction, and vented and non-ventilated systems.
   3. All accessories, covers, 30/45/90 degree elbows, degree radius and Tee fittings, splice plates, and reducers are from the same manufacturer.
   4. Available in custom paint colors.
   5. Meet required cable load factors.
   6. Corner mold options.

C. Wire Mesh "Basket" Tray:
   1. Basket 'ventilated' tray to be constructed of continuous, rigid-carbon steel wire welded together in a mesh pattern. Project specifications to define painted vs. unpainted having a zinc plating applied only after welding and bending of the mesh.
   2. Standard 'stick' dimensions are four (4) inches (102 mm) height, 18 inches (457 mm) width, and ten (10) ft. (3 meters) lengths. Project specifications or by subsequent approval of UNLV/NDE can height and width be varied based on ceiling clearances, anticipated cable fill, and other trades installed materials.
   3. Cable tray to be sized so as not to exceed the anticipated maximum allowable load bearing rating and/or initial maximum fill volume of fifty percent (50%).

D. Cable Runway:
   1. To be built and tested to the current version of NEMA VE-1 (Metal) and FG-1 (Fiberglass) standards and have a UL classification.

E. Hand-bendable Wire Flex Tray ("Snake Tray™")
   1. Defined as a hand-bendable, welded steel wire cable conveyance system.
   2. Be available in single-spine, single and double-sided pathways.
   3. Open architecture for easy access for installing cables and allowing the cables to enter or exit the entire length of the pathway in any direction.
   4. Not to require special tools or fabrication to construct cable tray bends.
   5. Built-in hanging hardware to provide mounting options for overhead ceiling and underneath raised access floors, and walls without the need for brackets.
   6. Single connections or splice create both mechanical and electrical bonds.
   7. Check manufacturer loading capacity guide for proper sizing and cable types.
   8. Provide all material, labor, and services to complete the installation of a hand-bendable wire flex tray runway management system.

2.5 27 05 38: Fiber Cable Troughs / "Fiber Runners" Cable Ducting

A. All HDPE piping/conduit materials to comply with the latest version of UL 94 V-0 and UL 2024 standards. No wire mesh troughs are permitted.

B. Overhead system to be wall, cable tray, ceiling-mounted threaded rod, or ladder rack mountable.
C. The system's components of channels, transitional fittings, drops and support structures is to provide the flexibility and configurability to fit any installation environment.
D. Designated for the easy access, quick-lock assembly, and snag-proof routing of fiber patch cords (jumpers) and multi-fiber cable runs while providing protection for both overhead and underfloor applications.
E. Single-sourced from the same manufacturer and can be interconnected together.
F. To be modular and can fit into restricted low space applications.
G. If requested, be available with covers.
H. Color of choice is yellow.
I. Support brackets to be self-supporting
J. Be available in (inches); 2X2, 2X6, 4X4, and 4X6 sizes.
K. Provide a transition system from overhead trough into the fiber distribution frames, cabinets, and other terminal devices.
L. Under floor/suspending ceiling system to comply with the current versions of NFPA-70 NEC for plenum air environments.
M. Assembly of piece parts to be purely mechanical. No glue or solvents can be used to assemble the system.

2.6 27 05 39: Surface-Mounted Raceways

A. Per UNLV/P&C, only metal aluminum or steel raceways are authorized. Plastic is not permitted.
B. Alternatively is the installation of 1-inch EMT conduit and 5-square electrical boxes. Substitution with EMT conduit determined by UNLV/P&C.
C. Provide full capacity corner elbows and fittings to meet and/or exceed the specification for optical fiber and copper Cat 6 and 6A UTP cabling bend radius considerations per the recent version of ANSI-TIA-569-E.
D. Accordingly, the surface-mount raceway minimum. size is 1 1/2"H X 2 ¾ inches W (38 mm - 70 mm)to accommodate proper fill ratio and maintain bend radius. This includes having deep surface mount boxes minimum 2 ¾ inches (70 mm) deep to accommodate the RJ-45 jack terminations taking into consideration angled faceplates/wallplates.
E. Surface-mount raceway systems consist of bases, covers, appropriate fittings, mounting brackets, workstation boxes / enclosures and device mounting brackets and fasteners necessary for a complete installation.
F. Fittings to include flat, internal and external elbows, tees, couplings for joining raceway sections, wire clips, blank end fittings, and device mounting brackets and plates as applicable.

2.7 27 05 40: Modular Furniture Raceways

A. Modular furniture raceway systems consist of bases, covers, appropriate fittings, mounting brackets, workstation boxes / enclosures and device mounting brackets and fasteners necessary for a complete installation.

B. Fittings to include flat, internal and external elbows, tees, couplings for joining raceway sections, wire clips, blank end fittings, and device mounting brackets and plates as applicable.
C. Provide full capacity corner elbows and fittings to meet and/or exceed the specification for optical fiber and copper Category 6 and 6A UTP cabling bend radius considerations per the recent version of ANSI-TIA-569-E.
D. Color TBD by UNLV/P&C.
E. Modular raceway boxes to be capable of accepting the specified connectivity and cabling termination hardware inclusive of jacks and faceplates.
F. Poke-through devices usually incorporate electrical power and to include low-voltage telecommunication for horizontal copper distribution cable to the following types of work area (WA) outlets:
    1. Furniture feed
    2. Pedestal
    3. Recessed furniture feed
    4. Surface style

    Note: Be cautious as the faceplate/wall plate ports may be required to be angle-type

PART 3: EXECUTION

3.1 Summary

A. The Contractor/Sub is responsible for providing all appropriate and qualified labor, tools, equipment and materials to complete the installation.
B. Strict compliance to manufacturer's installation instructions and industry best-practices.
C. Receiving the materials on-site to be examined for damage and straightness. Any materials found to be in unsatisfactory condition are to be rejected and cannot be installed. Replacement to be at expense of the Contractor/Sub.
D. Examine all intra-building premises, hallways, corridors, rooms, offices, labs, and telecommunication rooms to ensure the designated pathways are clear and ready for installation. This includes installing backbone pathways, J-hooks, and stub-outs - before the drop ceiling T-bars and gypsum boards are installed.
E. A horizontal conduit "home run" system consists of 1-inch (25 mm) conduit radiating from the telecommunications room to the work area (WA) telecommunications outlet (TO) in a star-like fashion. When using a conduit distribution system, utilize the most direct route following building guidelines and consider where pull boxes would be required and a fill ratio not to exceed 40 percent.
F. Empty conduits to have a pull string secured at both ends.
G. Contractor/Sub to provide horizontal and vertical transitions to suit field conditions in order to meet routing requirements.
H. Pathways and cable tray to be installed level and plumb, and secured per manufacturer instructions.
I. Maximum fill ratios; J-hooks seventy percent (70%) (or 50 cables) for 2-inch J-hooks, conduit forty percent (40%), and basket tray fifty percent (50%).

J. Keep pathways at least twelve (12) inches away from parallel runs of flues and steam or hot-water pipes. If possible, install horizontal pathway runs above water and steam piping.
K. Complete pathway installation before starting conductor installation.
L. Metal horizontal pathways to be installed and grounded to meet applicable federal, State and local code as enforced by the authority having jurisdiction (AHJ).
M. All cable and/or pathway penetrations through fire-rated building structures (walls and floors) to be sealed with an appropriate UL-approved fire stop system. This requirement applies to "through" penetrations (both sides) and "membrane" penetration (one side only). Same manufacturer used for the entire building and to meet or exceed the original fire-rating of the wall or floor.
N. Whenever the cable tray abuts against a wall and cannot be routed through void(s) between support studs and top plate, transition to 4-inch EMT conduit sleeves. Do not cut the wall area to accommodate the cable tray no matter the size of the tray. Ensure sleeves are grounded on one side and proper UL approved firestop is installed.
O. UNLV references "Trade Size" as a common measure of the diameter of the cable or conduit used by the electrical industry.
P. Gordon Grid system or equivalent are non-applicable.

3.2 27 05 29: Hangers, J-hooks and Supports for Communication Systems

A. All communications pathways are to be independently supported. Suspending pathways from piping, HVAC ductwork, and ceiling grids are not acceptable.
B. Mounting Brackets: Surface mounted raceway to be secured to the wall using properly rated anchors and mounting brackets. Brackets to provide un-obscured inspection of fastening bolts at point of wall penetration.
C. Support for cable tray utilizing a ‘trapeze’ with Unistrut requires two minimum size 3/8” ceiling-mounted threaded rods with sections directly supported by and securely clamped to the Unistrut. The exposed rod stud, in turn, is to be flush-cut to the bottom of the lowest locking nut or cut to ½ inch (12 mm) to allow the installation of black plastic cap.
D. Individual J-hooks may support no more than 50 cables or seventy percent (70%) fill capacity.
E. J-hooks attached to support rods may be shared with the same type copper UTP or fiber optics at pathway crossings or where approved by UNLV/NDE beforehand.
F. J-hooks are not to be shared with other non-UNLV/NDE low voltage systems. All other low voltage systems require their own J-hook pathway (e.g. DAS and A/V HDMI, coax, speaker wire, separate copper UTP and optical fiber).
G. J-hooks are not to be shared with any high-voltage systems nor can be mounted to any electrical conduit.
H. J-hooks to be spaced at a minimum four (4) ft. (1.2 meters) or less and a maximum five (5) ft. (1.5 meters) along a pathway. Spacing can be staggered in-between.
I. Low-voltage telecommunications J-hooks to be placed at the bottom of any shared support rod to facilitate frequent moves, adds, and changes (MACs).
J. Low-voltage telecommunications J-hooks wires or ‘stringers’ to be independent of the acoustical tile drop ceiling T-bar support wires or stringers. Be cognizant that the authority having

jurisdiction (AHJ) may require them to be identified before installation with their own spray paint coloring (e.g. orange or green but not red that designated fire alarm) or even with caution tape.

K. Also, clarify with the authority having jurisdiction (AHJ) if the telecommunications stringers need to be left hanging freely or if they are required to be attached to the T-bar supports.

3.3 27 05 33: Conduits and Back Boxes for Communication Systems

A. NECA 101-2013; *Standard for Installing Steel Conduit*; Electro Metallic Tubing (EMT), Rigid Metallic Conduit (RMC) and Intermediate Metallic Conduit (IMC) for conduit pathways.
B. HDPE and PVC Rigid Nonmetallic Conduit (RNC) inclusive of liquid-tight is not allowed in intra-building premises applications. Only in use in outside plant (OSP) inter-building applications.
C. Electro Metallic Tubing (EMT) "conduit" routes are to be installed in the most direct and accessible route possible; parallel and perpendicular to building lines and located in and above accessible hallways and corridors.
D. Conduit is to be reamed at both ends and have a plastic bushing installed on each end to prevent damage to the cable during a cable pull. This includes being routed into a pull box or TO outlet.
E. Downspouts or sweep extended conduit to be installed on all horizontal 4-inch conduit that drops into the tray or ladder rack below.
F. Horizontal wall-mounted riser conduits and/or sleeves entering telecommunication rooms and onto a mesh basket tray or ladder racking below to have a plastic spillway installed onto the end of the conduit to prevent kinking or chaffing of the installed cable bundle.
G. Various bend angle configurations can be combined to accomplish specific requirements but not a single bend to exceed 90-degrees and total not to exceed 180 degrees.
H. Conduit required through areas in which flammable materials may be stored or over and adjacent within three (3) ft. (1 meter) to boilers, incinerators, hot water lines or steam lines.
I. LB conduit box is permissible as in-line pull box for straight 1-inch EMT runs of having less than four (4) cables.
J. Empty metal conduit less than two (2) inches (51 mm) to have a pull cord or pull tape installed and secured at both ends that has a minimum test rating of 200 lb (90 kg). Leave and secure at least 12-inches (305 mm) of slack at each end of the conduit or innerduct.
K. Empty metal conduit greater than two (2) inches to have a pull tape installed and secured at both ends having a minimum test rating of 1200 lb (544 kg). Leave and secure at least 24-inches of slack at each end of the conduit or innerduct.
L. 3- and 4- inch conduit whether empty or partially filled with cable or innerduct, each occupied with empty plastic or mesh innerduct, to have a pull tape installed and secured at both ends having a minimum test rating of 1200 lb (544 kg)
M. 3- and 4-inch conduit wall or ceiling 'through' sleeves require bonding and grounding collars one-side only to the building steel supports.
N. 1-inch through 4-inch conduit floor and ceiling sleeves to protrude a minimum three (3) inches, preferred four (4) inches (102 mm) AFF and have plastic grommets installed on both ends. All new and unused 4-inch conduits to be capped.
O. Support conduit within 12-inches (305 mm) of enclosures to which they are attached.
P. When making a 90-degree penetration through a wall use only (1) 90-degree sweeps, or (2) "Smart" LBs with built in bend radius guide. No exceptions.
Q. 1- inch through 4- inch conduit wall and ceiling protrusions;

1. Entering the telecommunication rooms to have a minimum seven (7) inch (178 mm) clearance above ladder rack or basket tray to maintain high-count cables bend radius (with plastic grommet on both sides).
2. Entering any other rooms or between corridors to have a minimum three (3) inch (76 mm) clearance extending from the wall (with plastic grommet on both sides).

R. Rigid Metallic Conduit (RMC) and Intermediate Metallic Conduit (IMC) to use threaded rigid steel conduit fittings to comply with NEMA FB 2.10. Both are permissible to extend non fire-rated Outside Plant (OSP) cable past the 50 ft. (15 meter) demarcation inside or through a building in compliance with NFPA- 70 (NEC).

S. LB conduit box is not permissible as an in-line pull box. Use a 5-square 2 ¾" deep electrical box only.

T. Do not install metal conduits, boxes, or fittings in contact with concrete or earth.

U. Use only corrugated and mesh innerduct properly sized to the conduit and having the appropriate fire rating including plenum environments. Each to have internal pull tape secured at both ends.

V. All conduits to be bonded and grounded in accordance with the current version of ANSI-J-STD-607 and all federal, State, and local codes per the authority having jurisdiction (AHJ).

W. Telecommunications conduits to maintain large bends and sweeps. Provided are the ratios for minimum conduit bend radius to conduit size diameter.

1. Two (2) inches (50mm) and smaller: 6:1
2. Larger than 2-inches (50 mm): 10:1

X. Conduits fill ratio maximum is forty percent (40%) and to adhere to the maximum allowable conduit fill for cables as shown in : Conduit Sizing Fill Ratio Chart. 27 05 28-40 Fig 1: Conduit Sizing Fill Ratio Table At no time is a 1-inch conduit to exceed six (6) each 0.25 inch (7 mm) Cat 6 or 6A OD cables and no more than 95 cables through a 4-inch floor or ceiling sleeve into a telecommunication room.

Y. Telecommunication Outlets (TOs) to be stubbed out vertically into accessible wall space with a minimum 1-inch EMT having a 45 or 90-degree elbow on top protruding above drop ceiling level and pointing to the pathways (J-hooks and/or tray) leading back toward the assigned telecommunications room.

Z. Appropriate sized pull boxes approved by UNLV/NDE are required when there are more than two 90-degree bends or a combination of bends exceeding 180-degrees in a section or exceeding 100-ft. in length between pulling points. At a minimum use a 5-square 2 ¾ deep electrical box.

AA. A pull box is a pull box, not a turn box. Where pull boxes are utilized, conduits to enter and exit on opposite sides. Turns are to be made outside the pull box with 45 or 90-degree elbow sweeps.

BB. All junction boxes and pull boxes to secure with labeled covers "Telecommunications".

CC. Those in recessed ceilings to be unblocked and readily accessible from other trade's and construction materials. This is especially important in hard cap or drop ceilings where an access door panel may have to be moved or installed and not at the expense of UNLV.

27 05 28-40 Figure 1: *Conduit Sizing Fill Ratio Table* (Not applicable to sleeves)

Conduit Trade Size		Maximum Number of Cables Based Upon 40% Allowable Fill									
		Cable Outside Diameter mm (inches)									
		3.3 -0.13	**4.6* -0.18**	5.6 -0.22	6.1 -0.24	7.4 -0.29	7.9 -0.31	9.4 -0.37	13.5 -0.53	15.8 -0.62	17.8 -0.7
16	½	1	**1**	0	0	0	0	0	0	0	0
21	¾	6	**5**	4	3	2	2	1	0	0	0
27	1	8	**8**	7	6	3	3	2	1	0	0
35	1 ¼	16	**14**	12	10	6	4	3	1	1	1
41	1 ½	20	**18**	16	15	7	6	4	2	1	1
53	2	30	**26**	22	20	14	12	7	4	3	2
63	2 ½	45	**40**	36	30	17	14	12	6	3	3
78	3	70	**60**	50	40	20	20	17	7	6	6
91	3 ½							22	12	7	6
103	4							30	14	12	7

27 05 28-40 Fig 1: *Conduit Sizing Fill Ratio Table*

3.4 27 05 36: Cable Trays for Communication Systems

A. Comply to NECA/NEMA 105; *Standard for Installing Metal Tray Systems* (2015 ANSI)
B. Contractor/Sub to use the installation tools and practices recommended by the manufacturer to field fabricate cable tray intersections and changes in elevation.
C. The Contractor/Sub to coordinate the listed clearances and the routing of the cable tray with all other trades prior to installation, and monitor the installation of the other trades during the progress of the project. UNLV/NDE to hold the General Contractor accountable to make any corrections to condition which interferes with telecommunications low-voltage pathways:
    1. Provide a minimum of 12 inches (300 mm) in-between clearance above cable tray sections measured from the top side of the lower tray side rail to the lowest finished structure of any device, material, or equipment installed by other trades positioned above the cable tray.
    2. Multiple tiers of cable tray to be installed with a minimum clearance of 12 inches (300 mm);
        a. From top of upper tray side to the ceiling above
        b. In-between the trays measured from the top side of the lower tray side rail to the the bottom of the cable tray above.
    3. Contractor/Sub to contact UNLV/NDE immediately if any other trades install any device, material, or equipment across and below the six (6) inches and/or having support brackets pierce through the pathway after the pathway was already installed and approved after inspection. On exceptional circumstances, UNLV/NDE may authorize reduced clearances based upon ceiling conditions and structural arrangements.

4. Provide a preferred six+ (6+) inches (152 mm) but a minimum three (3) inches (76 mm) clearance above acoustical drop-ceiling T-bar supports.
5. When installed under a raised floor, cable tray to be installed with a minimum six (6) inches (154 mm) clearance measured between the bottom of the cable tray and the top of the floor tiles or floor system stringers, whichever are lower in elevation.
6. Maintain a three (3) inch (76 mm) clearance between trays wherever trays cross over at 90-degrees measured from the top of the sides of lower tray to bottom of tray above.
7. Given ceiling congestion, attempt to allow a minimum 30 inches (762 mm) of clear working space adjacent to the cable tray on at least one side of the cable tray for cable access.

D. Use the same manufacturer mounting hardware and fasteners per manufacturer instructions.
E. Follow the manufacturers' recommended assembly, splice and intersection-forming practices.
F. Cable trays to be continuous without gaps, misalignments, having no openings or breaches.
G. At no times can the tray sides and bottoms be cut away for cable entry and exit. Alternatively, use clip-on plastic radius down spouts sized to the cable bundle(s) but able to fit between the spokes.
H. Metal cable tray to be bonded to the Telecommunications Main Grounding Busbar - Primary Busbar TMGB-PBB) in the Equipment Room - Main Distribution Frame (ER-MDF) or the Telecommunications Grounding Busbar - Secondary Busbar (TGB-SBB) in the Telecommunications Room - Main Distribution Frame (ER-MDF) using an approved ground lug on the tray and a minimum #6 AWG (green) stranded grounding wire.
I. Follow UL Classified splicing methods recommended by the manufacturer or ground the tray per NEC requirements and verify bonds at splices and intersections between individual cable tray sections. Cable pathways to be electrically continuous through bonding and attached to the telecommunications grounding busbar (TGB).
J. Separate and isolate different media types within the tray. Treat each type of media separately when determining cable fill limits.
K. The quantity of cables within the tray not to exceed a whole number value equal to fifty percent (50%) of the interior area of the tray divided by the cross-sectional area of the cable. Any cable fill or segmented cable types and bundles not to exceed the depth of the cable tray's side rails.
L. Solid Bottom Trough Tray:
    1. Install per manufacturer instructions.
    2. Install proprietary prefabricated cable support system and maintain distance between each select support based upon size, load factor, and location pathway of the system.
    3. Tray and cover cuts and alignment are critical to a professional-looking installation.
M. Wire Mesh 'Basket' Tray:
    1. Cable tray to be secured to the structural ceiling, building truss system, wall or floor using manufacturer's recommended supports and appropriate hardware as defined by local code or the authority having jurisdiction (AHJ).
    2. Any cutting of mesh style trays wire mesh "Basket tray" 'spokes' to be made with side-action bolt cutters or hand-held hydraulic "Gator Byte". Both to be equipped with an offset head to ensure more consistency in cutting alignment, the integrity of the protective galvanic layer, and to reduce burrs.

3. Horizontal wire mesh basket tray to be supported per manufacturer instructions but not to exceed every five (5) ft. (1.5 meter) per the current versions of ANSI/TIA-569 and NEMA VE-2 by either ceiling-mounted threaded rod trapeze using; (1) Unistrut, (2) the manufacturer pre-galvanized slotted trapeze, or (3) manufacturer specific supports rods.
4. Vertical wire mesh basket tray to attach to wall-mounted Unistrut at a minimum every four (4) ft. (1.2 meter).
5. Support cable tray within 2 ft. (0.6 m) of each splice and intersection. Support cable tray on both sides of the change in elevation/direction and intersections. The weight of the load on the cable tray not to exceed the stated limits per span in the manufacturer's published load table. Use additional supports as specified by the manufacturer.
6. At no times can the tray sides and bottoms be cut away for cable entry and exit. Alternatively, use clip-on plastic radius spouts sized to the cable bundle(s).
7. If transitioning from wire mesh basket tray to other supports like J-hooks or conduit ensure that the cables are not touching any metal basket tray spokes tops edges;
    a. Use a plastic radius guide or equivalent affixed to the top side(s) of the tray so that the cables are not being pulled or installed directly atop of the metal spokes.
    b. Use manufacturer's rounded outside/inside corner spoke assembly or plastic radius guide inserts when cable is transitioning around "T" or 90-degree basket tray intersections.
    c. Route cables away from vertically-supported threaded or use appropriate plastic radius guides.
8. All surfaces are to be left completely smooth and finished. No cut edges are to be exposed. Remove burrs and sharp edges from cable trays. Exposed edges to be covered with appropriate fittings like plastic caps or studs and to ensure cables being installed not to be damaged or chafed being routed through the tray.
9. Install no more than the equivalent of three (3) each horizontal 90-degree bends in any pathway run. Provide support within 12 inches (305 mm) of changes in direction.
10. Basket tray not to share with other disciplines (e.g. electrical) except A/V copper UTP.
11. Optical fiber to be enclosed in a properly fire-rated innerduct and secured to either outside corner of the tray.
12. Any DAS and non-UTP copper UTP A/V cabling including HDMI, coax, speaker wire can be secured to the outer sides of the tray with metal-only fasteners.
13. Check project specifications if an optional polypropylene cable tray liner is to be installed (usually in office corridor open ceilings). Check with the authority having jurisdiction (AHJ); local code may prohibit liners as they may interfere with fire sprinkler systems.
14. If requested in the contract Scope of Work (SoW), test cable tray system per the current version of NFPA 70 (NEC), Chapter 18 to verify grounding less than 1.0 ohm.

N. Hand-bendable wire metal flex tray:
1. Field verification is required before installation.
2. Install per manufacturer instructions and industry-best practices.
3. Re-confirm with the manufacturer cable loading guide for proper sizing and mounting options.

4. All open pathways to be installed a preferred 12 inches (305 mm) and minimum six (6) inches (152 mm) away from any light fixture or other sources of Electromagnetic Interference (EMI).
5. Do not support pathways using ductwork, conduit, piping, or other equipment hangers.
6. Install cable tray level, straight, and plumb unless noted on the project construction drawings.
7. All pathways to be grounded per the latest enforced version of ANSI/TIA 607-D and NFPA-70 (NEC).
8. Provide external grounding strap at expansion joints, sleeves and crossovers, and at other locations where pathway continuity is interrupted.

3.5 27 05 38: Fiber Cable Troughs / "Fiber Runners" Cable Ducting

A. Install per manufacturer instructions and industry best-practices.
B. Utilize compound miter saws or miter boxes to make even cuts.
C. Depending on the installed cabling support and cabinet placement structure, be prepared to provide a variety of mounting options for full interconnectivity.
D. Ensure all drop outs are placed on the correct side(s) of cabinets.
E. Maximum distance between the linear module sections support brackets is five (5) ft. (1.5 meters).
F. Installation to be aligned, plumb, straight, and level, having no gaps nor loose fitting components.

3.6 27 05 39: Surface-Mounted Raceways and Pathways

A. Only metal aluminum or steel raceways are permitted.
B. Pathway sizing for 90-degree elbow or T-fitting bends to allow for a minimum two (2) inch radius control at bend points for up to four (4) each Cat 6/Class E and Cat 6A/Class EA cables.
C. Support surface pathway according to manufacturer's written instructions and secure to surfaces via anchors of the appropriate type for the wall being attached to.
D. Anchor type devices at intervals not to exceed 48 inches (1.2 meters) and with no less than two supports per straight pathway section.
E. Maximum pathway fill ratio is forty percent (40%).

3.7 27 05 40: Modular Furniture Raceways and Pathways

A. If electrical power and telecommunications services are both run in the same raceway or 'power pole', they are to be separated by compartments or channels and to comply with applicable electrical codes.
B. All furniture pathways to adhere to the current version of ANSI/TIA/EIA-569-E standards.
C. Maximum pathway fill ratio is forty percent (40%).

3.8 Poke-through Devices

A. Any poke-through devices requiring core-drill to be designed, authorized, located, x-rayed, and managed by the UNLV/P&C department.
B. Ensure the Telecommunications Outlet (TO) is a minimum 4-port to accommodate minimum two (2) each RJ-45 jacks plus possibly other media (e.g. A/V).
C. Professionally dress cables in the ceiling below in the same best-practices manner as any horizontal cable run if using one or a combination of tray and J-hooks.
D. Be extra cautious working around electrical fixtures, conduit, water and sprinkler piping.

3.9 Cleaning

A. Contractor/Sub to practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas. This includes keeping inventoried material staging areas in the telecommunications rooms organized.
B. Clean any debris left from installing and terminating cable in the ceiling below for poke-through applications above including floor-boxes, monuments, and tombstones.
C. Fiber troughs "Runners" to be thoroughly de-burred and cleaned out of any debris that may require vacuuming with HEPA filter vacuum cleaner.

3.10 Identification Schedule

A. Check project specifications and drawings for labeling instructions if any.
B. 4- inch outside plant (OSP) stubup conduits to be labeled on the floor and/or around the conduit sleeve as to its to-and-from origins.

3.11 Examination and Acceptance

A. Pathways and raceways to be secured per manufacturer instructions, aligned, level and plumb, no gaps, without fingerprints or backing tape exposed, clean and dry, and covers where applicable.
B. Grounding and bonding completed and to comply with Section 27 05 06; *Grounding and Bonding.*
C. All through penetrations to have proper firestopping installed in both the inside and outside of the designated pathway.
D. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM to notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.12 Close-out Submittals

A. Final approval for items detailed on all punch lists.
B. PDF and final As-Built drawings in AutoCAD .dwg format floor drawings to show the pathway infrastructures in designated layers as described in the project drawings.
C. Within 30 days of the substantial completion of the project or prior to project closeout -- which ever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub's one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.
D. If requested in the contract Scope of Work (SoW) provide ground and/or bonding points resistance test results.

SECTION 27 05 00: COMMON WORK RESULTS FOR COMMUNICATIONS

——— End of Sections 27 05 28, 29, 33, 36, 38, 39, 40 ———

Pathways: Hangers, J-Hooks, Supports, Conduits, Back Boxes, Cable Trays, Fiber Trough Systems, Surface Mounted Raceway, Modular Furniture Raceways and Pathways

SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

Section 27 05 43

Underground Ducts and Raceways for Communications Systems

PART 1: GENERAL

1.1 Summary

A. This Section is specific to underground ducts and raceways for communications systems. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for either or a combination of underground ducts and raceways communications systems components in either new or retrofit construction.
B. UNLV/P&C to design, approve, and manage the installation process. UNLV/NDE is providing the guidelines and auditing services for the design and build of *Underground Ducts and Raceways for Communication Systems.*
C. On the UNLV campuses, only underground conduit pathways are permitted, not aerial cabling.
D. The only underground pathway conduit permitted is designated high-density polyethylene (HDPE). Polyvinyl-Chloride (PVC) commonly referred to as Schedule 40/80/120 is not acceptable.
E. Standard size inter-building outside plant diameter HDPE piping/conduit is trade size 4-inch (102 mm).
F. Approved outside plant (OSP) rated conduits for special projects are HDPE trade sizes one 1- or 2-inch (25 mm or 51 mm) used with direct burial or directional boring.
G. UNLV's underground conduit pathway infrastructure is designated only for UNLV optical fiber (standard or blown) and not shared with any other low voltage cabling, other utilities, or electrical. Arrangements need to be made with UNLV/NDE to discuss Internet Service Providers (ISP) and distributed antennas system (DAS) pathway access requirements.
H. Components covered in this section:
    a. Conduit types
    b. Duct accessories, including rigid innerduct and fabric innerduct.
    c. Precast concrete handholes.
    d. Polymer concrete handholes and boxes with polymer concrete cover.
    e. Fiberglass handholes and pull boxes with polymer concrete cover.
    f. Fiberglass handholes and pull boxes.
    g. High density plastic boxes.
    h. Precast maintenance holes.
    i. Cast-in-place maintenance holes.
    j. Utility structure accessories.
    k. Vaults
    l. Maintenance Holes / Manholes (MH)
    m. Pull boxes PB)/Junction boxes (JB)
    n. Innerduct

o. Airblown/Jetting Microduct system
p. Tracing methods

1.2 Confined Spaces and Hazardous Assessment Protocol - Special Note: Strictly enforced

A. In the bid process project overview, UNLV/NDE along with UNLV/P&C and UNLV/FMS project managers (PM) to conduct a visual walkthrough inspection of the identified pathways of the project inclusive of the maintenance holes (MHs) and vaults (Vs).
B. Open inspection without entry to a OSHA defined 'confined space' is permissible for top-view inspection only. A 'pre-entry checklist' to be distributed to each bidder to complete during the walk-through and to keep for their records.
C. Should any poisonous spiders, snakes, frogs, rodents or the like be prevalent, UNLV/FMS to contact the exterminator before entry can be conducted.
D. UNLV/P&C to include in the request for quotation (RFQ)
    1. The prerequisite that the Contractor/Sub provide in their submittals their in-house confined space protocol (as required).
    2. They are also to include the assigned on-site technicians confined space certifications.
    3. Contractor/Sub to submit an addendum to the RFQ bid with extra costs associated with this confined space entry protocol. Be aware that if multiple maintenance holes (MHs) and vaults (Vs) are open, they have to be manned and equipped with rail guards, personnel, blowers, tripod crank retrieval, and more.
    4. This documentation to be reviewed and must be approved by UNLV/FMS before the Contractor/Sub can conduct business in any maintenance hole (MH) or vault (V).
E. The low-volt contractor to provide a projected schedule of maintenance hole (MH) /vault (V) work to be completed. This schedule to be forwarded by UNLV/P&C to UNLV/FMS project manager and UNLV/NDE.
F. The contractor/Sub will review the UNLV Confined Spaces Map and other resources, to familiarize themselves with the conditions in the vaults to be entered.
G. Once the project is awarded the Contractor/Sub needs to go to the website;
UNLV Permit Required Confined Space Entry Program
(https://www.unlv.edu/sites/default/files/page_files/27/RMS-ConfinedSpaceEntryProgram.pdf)
    1. Fill out the "Confined Space Entry Notification Permit Request" form based upon their provided schedule:
    Confined Space Entry Notification
    (https://rms.unlv.edu/forms/permitRequest/index.php?p=8).
    2. Allow a minimum 24-hour advanced notice.
    3. Have your schedule and checklists on-site and readily available for inspection by UNLV/FMS.
H. All OSHA established confined space entry requirements will be met and that air monitoring will occur prior to entry and during the duration of the entry.
I. Advise that all emergency rescue services will need to be arranged by the contractor, through either in-house, or outside agency resources. There are no rescue services by UNLV staff.

1.3 Contractor/Sub Responsibilities

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).
C. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of *Underground Ducts and Raceways for Communications Systems* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).
D. This includes the outside plant (OSP) low-voltage telecommunications inter-building pathways of conduits connecting between buildings through either or a combination of maintenance holes/manholes (MH), vaults (V), hand holds (HH)/ pull boxes (PB)/ and pedestals (PEDs).
E. Directional Boring
    1. High-density polyethylene (HDPE) piping/conduits is to be used for directional boring.
    2. A swivel to be used at all times to prevent rotation of the product pipe.

1.4 Related Documents and References

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".
B. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications*, 27 11 00; *Communications Equipment Room Fittings*, 27 13 00; *Communications Optical Fiber Backbone Cabling* includes the following:
    1. Section 27 02 00; *General Requirements for Structural Cabling Systems, Pathways and Spaces Systems for all Voice and Data Systems - Under Construction*
    2. Section 27 05 26; *Grounding and Bonding*
    3. Section 27 05 33; *Conduits and Back Boxes*
    4. Section 27 05 41; *Firestopping System for Communications*
    5. Section 27 05 44; *Sleeves and Sleeve Seals for Communication Pathways and Cabling*
    6. Section 27 05 53; *Identification for Communication Systems*
    7. Section 27 11 10; *Telecommunications Rooms and Backboards*
    8. Section 27 13 23. 02; *Inter-building Optical Fiber Backbone Cabling*
C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
    1. Appendix A; *Codes, Standards, and Regulations*
    2. Appendix B; *Abbreviations and Acronyms*
    3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
    4. Appendix D; *Rack Elevation and Room Sizing Drawings*
D. This Section has a direct correlation to Division 26 (Electrical) and Division 33 (Utilities).
E. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification, apply to this Section.
F. Underground ducts and pathways to comply with the requirements of the current versions and practices in;
    1. BICSI *Telecommunications Distribution Methods Manual*

2. BICSI *Information Transport Systems Installation Methods Manual*
3. AASHTO-M-306; *Standard Specification for Drainage-Sewer-Utility-and Related Castings* (Vault lids)
4. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
5. ANSI/BICSI 008-2018; *Wireless Local Area Network (WLAN) System Design and Implementation Best Practices*
6. ANSI/BICSI G1-17; ICT Outside Plant Construction and Installation
7. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*
8. ANSI/TIA-568.1-E; *Commercial Building Telecommunications Cabling Standard Part 1: General Requirements*
9. ANSI/TIA-568.3-E; Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling
10. ANSI/TIA-569-E; Commercial Building Standard for Telecommunications Pathways and Spaces
11. ANSI TIA-758-B; Customer-owned Outside Plant Telecommunications Cabling Standard
12. ASTM A 48; *Standard Specification for Gray Iron Casting*
13. ASTM C 270; *Standard Specification for Mortar for Unit Masonry*
14. ASTM C 387; *Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete (Aug, 2017)*
15. ASTM C 858; *Standard Specification for Underground Precast Utility Structures (Feb, 2010)*
16. ASTM C 891; *Standard Practice for Installation of Underground Precast Concrete Utility Structures (Dec, 2020)*
17. ASTM C 990; *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants*
18. ASTM C 1037; *Standard Practice for Inspection of Underground Precast Concrete Utility Structures*
19. ASTM C 1107/C 1107M; *Grade B: Standard Specification for Packaged Dry, (Non Shrink) Hydraulic-Cement Grout*
20. ASTM F 2160; *Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)*
21. NEMA RN 1; *Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit*
22. NEMA TC 7-2021: *Solid-Wall Coilable and Straight Electrical Polyethylene Conduit*
23. NEMA 250; *Enclosure Ingress Protection Rating* (IEC 60529)
24. SCTE 77; *Specifications for Underground Enclosure Integrity*
25. UL 467; *UL Standard for Grounding and Bonding Equipment*

1.5 Definitions

Conduit

A. Direct Burial: Cabling, conduit or a duct bank that is buried directly in the ground, without any additional casing materials including concrete, stone or sand.
B. Duct: A single cable-protective conduit.
C. Duct Bank:
    1. Two or more ducts installed in parallel, with or without additional casing materials.
    2. Multiple duct banks.
D. Fabric Innerduct: Continuous, polyester, single or multi-pocket fabric innerduct, with internal pull tape and tracer wire.
E. Blown/Jetted air blown fiber system uses compressed air to push or propel micro optical fiber cables through pre-installed tubular microducts. Also known as jetting fiber by 'air lubrication' along with lubricants as required.
F. High-density polyethylene (HDPE) piping/conduit for direct burial or encasement in concrete:
G. Rigid Metal Conduit (RMC) includes:
    1. GRC: Galvanized rigid conduit and PVC encased GRC
    2. IMC: Intermediate metal conduit
    3. Note: Electrical Metallic Conduit (EMT) nor Black gas pipe are not recognized for underground applications even in underground HDPE transition
H. RMC applications:
    1. Outside plant (OSP) building riser or above ground horizontal applications transitioning from the underground HDPE piping/conduit
    2. Outside plant (OSP) underground for sections to transition from HDPE piping/conduit to RMC if necessary for use in under sidewalks, driveways, or ramp areas subject to heavy traffic.
    3. Extend through a building or past the 50 ft.(15.25 meters) demarc requirement per NEC code to transition from outdoor rated cable to indoor fire-rated (riser or plenum) cable.
I. Other types of conduit not permissible for outside plant (OSP) applications:
    1. Electrical Non-metallic Conduit (ENC)
    2. Rigid Non-metallic Conduit (RNC)
    3. Multiple Plastic Duct (MPD)
J. Flexible Metal Conduit (FMC), Flexible Non-metallic Conduit (FNC), and Liquid Tight Flexible Metal Conduit (LFMC) in small less than or equal to 1-inch sizes are approved only for containing patch cords for special equipment applications above ground levels including CCTV security cameras and access points (APs).

Maintenance Holes/Manholes (MH), Vaults (V) and Pull Boxes (PB)/Junction Boxes (JB)

A. A maintenance hole (MH) system is the structure that makes up a "manhole" and any related parts to give access to campus' underground 4-conduit system infrastructure. The term also applies to vaults (V).
B. Handhold (HH) functions as the access point for pulling and feeding cable through the pathway HDPE piping/conduit system. Also referred to and functions as a pull box (PB).

1.6 Field Conditions, Design and Installation Parameters for Conduit

A. Contractor/Sub to ensure they have the most current version of the project's campus layout drawing issued by UNLV or by the assigned architect firm.
B. Do not interrupt existing communications services to facilities occupied by UNLV or others unless permitted under the following conditions, and then only after arranging to provide temporary communications service according to requirements indicated:
    1. Notify UNLV/NDE no fewer than two days in advance of the proposed interruption of communications service.
    2. Do not proceed with interruption of communications service without the UNLV/NDE's written permission by hard copy or electronic communication.
C. Determine where the conduit entrance facility (EF) point is for each building. For precautions, determine location, pathway availability, and size of the closest existing underground conduit system as well as all underground utilities.
D. Conduit routes not to cross open land areas where future building may occur.
E. Any branch conduits entering/exiting a maintenance hole (MH)/vault (V)/handhold (HH) to be designed as subsidiary conduits only (exit from the end wall of the maintenance hole (MH)/vault (V)/pull box (PB) not from the side wall). Lateral conduits entering/exiting a maintenance hole (MH)/vault (V)/handhold (HH) are not allowed.
F. The lowest conduit knock-outs or cut-outs to be used first then move upwards when adding new conduit to a maintenance hole (MH)/vault (V)/handhold (HH) . Plan upper conduits for future use.

1.7 Field Conditions, Design and Installation Parameters for Conduit for Maintenance Holes/Manholes (MH), Vaults (V) and Handhold (HH)/Pull Boxes (PB)

A. Maintenance Holes/Manholes (MH), Vaults (V) and Handhold (HH)/Pull Boxes (PB) are required:
    1. Where the length of any outside plant (OSP) 4-inch HDPE piping/conduits are not to exceed 600 ft. (183 meters).
    2. At the intersection of main and branch conduit runs.
    3. And pulling cable tension maximum is 600 lb (272 kg).
    4. Adjacent and in-line to pedestals or WiFi bollards.
    5. More than two (2) each 90 degree bends in 4-inch HDPE piping/conduit between MHs/PBs.
B. Maintenance hole (MH) and vault (V) covers along with the type of locking mechanism and spring doors to comply with ANSI/TIA-758-B; *Customer Owned Outside Plant Telecommunications Infrastructure Standard* and *BICSI Outside Plant Design Manual.*
C. Pulling eyes to be a minimum of 7/8-inches in diameter and permanently affixed at opposite ends of each conduit entrance/exit points.
D. Maintenance holes (MH) locations where the distance between the ceiling and the street level exceeds 24-inches to require:
    1. The installation of permanent cement steps around the neck of the maintenance holes (MH) per manufacturer instructions.
    2. These steps are to be installed at the same time as the maintenance hole's (MH) neck ring is being installed. Steps not to be cut nor cemented in place after the installation.
E. Provide minimum eight (8) each L-Cable Racks per maintenance holes (MH) and vault (V) and four (4) each L-Cable Racks per pull box (PB).

F. Where placement location is a roadway, driveway, bike path, fire line, loading dock or trash pickup area, provide only a maintenance hole (MH) or vault (V).
G. Handhold (HH)/Pull boxes (PB) to be equipped with slip resistant covers with height adjustment brackets, torsion assist openings, guard bars and hex head type bolts.
H. Handhold (HH)/Pull boxes (PB) locations:
    1. Handhold (HH)/Pull boxes (PB) are only to be placed at strategic locations in the 4-inch HDPE piping/conduit pathway to allow installers to pull cable through the conduit with minimum difficulty and to protect the cable from excessive tension.
    2. Step rungs are to be installed within Handhold (HH)/Pull boxes (PB) that, in turn, are installed deeper than the standard two (2) ft. (610 mm) depth. Extension rings are required to match grade level.
I. If the total number of conduits being placed is significantly less than the capacity of the designated termination area in the Entrance Facility (EF), or the maintenance Hole (MH), vault (V), or handhole (HH)/pull box (PB), the conduit is to enter at the lowest level first and progress upwards. The upper space to be reserved for future additions.

1.8 Quality Assurance (QA) and Warranty

A. Qualified according to the current version of ASTM E 329 for outside plant construction inspection.
B. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
C. Manufacturer 25-year warranty documentation.

1.9 Contractor/Sub Responsibilities

F. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
G. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).
H. Directional Boring
    3. Only high-density polyethylene (HDPE) conduit can be used for directional boring.
    4. A swivel to be used at all times to prevent rotation of the product pipe.

1.10 Pre-bid Submittals

A. Product data for each type of product:
    1. Duct and conduits and their accessories, including elbows, end bells, bends, fittings, duct spacers, and solvent cement.
    2. Accessories for maintenance holes (MH), vaults (V), and pull boxes (PB)
    3. Underground-line warning tape.
B. Shop drawings to provide: Precast or factory-fabricated underground utility structures:

1. Drawings, elevation drawings, sections, details, attachment to other work, and accessories
2. Duct entry provisions, including location and duct size.
3. Reinforcement details.
4. Frame and cover design and maintenance hole chimneys.
5. Ladder entry and step details.
6. Grounding and bonding details.
7. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
8. Joint details.

C. Shop drawings to provide: Factory-fabricated handholes and boxes other than precast concrete:
   1. Dimensioned drawings, sections, and elevation drawings, fabrication and installation details.
   2. Duct entry provisions, including location and duct size.
   3. Cover design.
   4. Grounding and bonding details.
   5. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
D. Duct and duct bank coordination drawings:
   1. Show duct profiles and coordination with other utilities and underground structures.
   2. Include drawings and sections to show bends and locations of expansion fittings.
E. Product certificates: For concrete and steel used in precast concrete maintenance holes and handholes specified by ASTM C 858.
F. Qualification data having the professional engineer(s) and testing agency responsible for testing non concrete handholes and boxes.
G. Source and field quality-control documentation.
H. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
I. Furnish cable-support stanchions, arms, and associated fasteners in quantities to complete the installation.

PART 2: PRODUCT

2.1 Rigid Metallic Conduit

A. Includes: Galvanized Rigid Conduit, PVC encased Galvanized Rigid Conduit, and PVC encased Intermediate Metallic Conduit (IMC) to comply with current version of NEMA RN and NEMA TC 3.
B. General Requirements for metal conduits and fittings:
   1. Listed and labeled as defined in the current version of NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
   2. Comply with the current versions of TIA-569 and TIA-758.

2.2 HDPE Piping/Conduit

A. Comply with the current versions of ASTM F2160 with matching fittings
B. General Requirements for Nonmetallic Ducts and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with ANSI/TIA-569-E and TIA-758-B.

C. Solvents and Adhesives: As recommended by duct manufacturers.
D. 22-degree and 45-degree 4-inch HDPE piping/conduit angles are preferred. Regardless of depth, there is not to be more than the equivalent of combined 180-degrees between pull points, including offsets and kicks. Back-to-back 90-degree bends to be avoided.
E. All manufactured 3- and 4-inch HDPE piping/conduit sweeping bends or elbows to have a radius not less than ten (10) times the internal diameter of conduit while 1-inch and 2-inch to have a radius not less than six (6) times the internal diameter of the conduit.
F. 4-inch HDPE piping/conduits to be provided with mule tape with a minimum of 1200 pound (544 kg) pulling tension and secured at both ends with or without innerduct installed.
G. 4-inch “Smart LBs” for entering/exiting a building above surface grade.
H. Where possible, entrance and distribution 4-inch conduit floor penetrations to enter and exit on the same outside wall(s). Design and use ladder racking inside the telecommunications room to provide distribution wall-to-wall.
I. Jackmoon or Shaw Plugs to plug 4-inch stub-ups inside the entrance facility (EF).

2.3 Innerduct

A. Optical fiber cable is to be installed with corrugated or mesh fabric innerduct for protection of optical fibers in a shared pathway. Both to have pre-threaded mule tape installed in each cell.
B. Only corrugated HDPE innerduct, orange in color, is approved for outside plant (OSP) applications designed for installation within a 4-inch HDPE piping/conduit pathway. Ensure sizing to accommodate blown fiber microduct housing:
    1. A 4-inch conduit can typically house four (4) each 1-inch innerduct (25 mm) or three (3) each 1-¼-inch innerduct (38 mm).
    2. Or, a combination with mesh fabric innerduct.
C. Check specifications for using mesh fabric innerduct: Maximum one (1) each 4-inch x 3-cell in 4-inch HDPE piping/conduit and to be sized to accommodate blown fiber Microduct housing. Can be installed after the ABF optical fiber is already installed.

2.4 Duct Spacers

A. Factory-fabricated rigid PVC or HDPE interlocking spacers, sized for type and size of duct selected. This is to provide minimum PVC or HDPE piping/conduit duct spacing indicated on submittals during concreting or backfilling.

2.5 Underground-Line Warning Tape

A. Underground-line warning tape specified in Sections 27 05 00 Part 1 GENERAL: 1.5 J and 27 05 53; *Identification for Communications Systems*
B. Approved types are:
    1. Electronic marker system (EMS) ball markers
    2. Warning tape containing metallic tracings

2.6 Precast Concrete Handhold (HH)/ Pull box (PB)

A. Maintenance hole(MH)/vault (V)/handhold (HH)/pull box (PB) covers to:
    1. Comply with the current version of the AASHTO-H20-44 standard to withstand the tractor full load rating factor, heavy and constant vehicular traffic, regardless of placement.
B. Hardware in maintenance holes (MH)/vault (V)/pull box (PB)s to be galvanized or stainless steel.
C. Handhold (HH)/Pull boxes (PB) minimum dimensions: 18 inches (457 mm) wide by 36 inches (914 mm) in length by 24 inches (610 mm) in depth (height):
    1. Any larger units to have inserts for cable racks and pulling-in irons installed before concrete is poured.
D. Comply with ASTM C 858 for design and manufacturing processes:
    1. Monolithically poured, factory-fabricated, reinforced-concrete walls, and bottom unless open-bottom enclosures are indicated.
    2. Frame and cover to form the top of the enclosure and have a load rating consistent with that of handhole or box.
E. Frame and Cover options:
    1. Weatherproof cast-iron or steel covers.
    2. Recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
    3. Steel or aluminum frame with hinged steel or aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
    4. Recessed cover handle.
    5. Concealed cover hinges with hold-open ratchet assembly.
F. Cover features:
    1. Non-Skid finish.
       To be marked for easy identification (“Communications”) and have a permanently attached metal label indicating the assigned number from UNLV/NDE.
G. Units to be designed for flush burial and have open, closed, or integral closed bottom unless otherwise indicated.
H. Extensions and Slabs:
    1. Designed to mate with the bottom of the enclosure and made of the same material as the enclosure.
    2. Extension to provide increased depth of 12 inches (305 mm) minimum.
    3. Slab to have the same dimensions as bottom of enclosure and arranged to provide closure.
J. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
K. Knockout Panels to have precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional 6 inches (152 mm) to 12 inches (304 mm) vertically and horizontally to accommodate alignment variations:
    1. To be located no less than 6 inches (152 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.

2. Opening to have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
3. Openings to be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
4. To be 1-1/2 to 2 inches (38 to 50 mm) thick.

L. Duct Entrances in Handhole Walls:
1. Cast end-bell or duct-terminating fitting in wall for each entering duct.
2. Type and size to match fittings to duct or conduit to be terminated.
3. Fittings to align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

2.7 Polymer Concrete, Fiberglass, High-Density Plastic Handhole (HH)/PullBoxes (PB) with Polymer Concrete Frame and Cover

A. Vault (V) minimum dimensions: Two (2) ft. (610 mm) wide by six (6) ft. (1.8 meter) in length by three (3) ft. (914 mm) in depth.
B. Polymer Concrete: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
C. Fiberglass: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
D. HIgh-density Plastic: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover to be made of polymer concrete, hot-dip galvanized-steel diamond plate, plastic.
E. All three to comply with SCTE 77
F. Color: Gray or green
G. Units to be designed for flush burial and have open, closed, or integral closed bottom unless otherwise indicated.
H. Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
I. Cover:
1. Non-skid finish
2. To be marked for easy identification (“Communications”) and have a permanently attached metal label indicating the assigned number from UNLV/NDE.
J. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure walls.
K. Duct-terminating fittings to mate with entering duct for secure, fixed installation in the enclosure wall.
L. Handholes are 12 inches (305 mm) wide by 24 inches long (610 mm) and larger to have factory-installed inserts for cable racks and pulling-in irons.

2.8 Precast Maintenance Holes/Manholes (MH)

A. Maintenance Hole (MH) minimum dimensions: Four (4) ft. (1.2 meter) wide by six (6) ft. (1.8 meter) in length by four (4) ft. (1.2 meter) in depth (height).
B. Comply with ASTM C 858 for design and manufacturing processes.

C. Defined as a 'one-piece' precast unit with interlocking mating sections, complete with structural collar.
D. Knockout panels considered:
    1. Precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional six (6) inches (150 mm) or 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
    2. Splay or center window location and be located no less than six (6) inches (150 mm) from interior surfaces of walls, floors, or roofs of maintenance holes, but close enough to corners to facilitate racking of cables on walls.
    3. Have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
    4. To be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
    5. Minimum Sizes to be 1-1/2 to two (2) inches (38 to 50 mm) thick.
E. Duct Entrances in maintenance hole (MH) walls to be end-bell or duct-terminating fitting in wall for each entering duct:
    1. Type and size to match fittings to duct or conduit to be terminated.
    2. Fittings to align with elevations of approaching duct and be located near interior corners of maintenance holes to facilitate racking of cable.
F. Ground Rod Sleeve to provide a 3-inch (75-mm) PVC sleeve in maintenance hole floors two (2) inches (50 mm) from the wall adjacent to, but not underneath, the duct routed from the facility.
G. Ground joint sealant to be asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.9 Ground Cast-in-Place Maintenance Holes/Manholes (MH)

A. Defined as an underground utility structure, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.
B. Comply with ASTM C 858 for design and manufacturing processes.

2.10 Utility Structure Accessories

A. Utility equipment and accessory items used for utility structure access and utility support are to be listed and labeled for intended use and application.
B. Maintenance hole frames, covers, and chimney components to comply with structural design loading specified for maintenance hole.
C. Frame and cover to be weatherproof, gray cast iron complying with ASTM A 48, Class 30B or cast aluminum, with milled cover-to-frame bearing surfaces; 26 inch (660-mm) or 29 inch (725-mm) diameter.
D. Covers' finish to have a non-skid finish with a minimum coefficient friction of 0.50:
    1. If requested in project specifications, special covers to be recessed and designed to accept finish material in paved areas.

E. Maintenance hole chimney components to be precast concrete rings, with dimensions matched to those of roof opening:
    1. Mortar for chimney ring and frame and cover joints to comply with ASTM C 270, Type M, except for quantities of less than 2.0 cu. ft. (60 L), where packaged mix complying with ASTM C 387, Type M, may be used.
    2. Seal joints are watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.
    3. Maintenance hole sump frame and grate to comply with ASTM A 48/A 48M, Class 30B, gray cast iron.
F. Pulling eyes:
    1. In concrete walls, the eyebolt with reinforcing-bar fastening insert is to have a minimum two (2) inch (50 mm) diameter eye and be 1-by-4-inch (25-by-100-mm) in length. Working load embedded in six (6)Inch (150 mm) 4000-psi (27.6-MPa) concrete to have 13,000-lbs (58-kN) minimum tension.
    2. In non-concrete walls, the eyebolt with reinforced fastening is to have a minimum 1-¼ inch (31 mm) diameter eye, rated to 2500-lbs (11 kN) minimum tension.
G. Pulling-In and lifting irons in concrete floors to be a minimum ⅞ inch (22 mm) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening yield strength to be minimum 40,000 lbs (180 kN) shear and 60,000 lbs (270kN) tension.
H. Bolting Inserts for concrete utility structure cable racks and other attachments to be flared, threaded inserts of noncorrosive, chemical-resistant, non conductive thermoplastic material sized to a minimum ½ inch (13 mm) ID by 2 3/4 inches (70 mm) deep, flared to a minimum of 1 1/4 inches (31 mm) at the base. Ultimate pullout strength to be a minimum 12,000 lbs (53 kN).
I. Ground rod PVC sleeves to be 3-inch (76 mm) located in maintenance hole floors two (2) inches (50 mm) from the wall adjacent to, but not underneath, the duct entering the structure.
J. Expansion anchors for installation after concrete Is cast to be zinc-plated, carbon-steel-wedge type with stainless-steel expander clip, a ½ inch (13 mm) bolt, 5300 lbs (24 kN) rated pullout strength, and minimum 6800-lbs (30-kN) rated shear strength.
K. Cable rack assembly to be nonmetallic having components fabricated from nonconductive, fiberglass-reinforced polymers:
    1. Stanchions to be nominal 36 inches (900 mm) high by four (4) inches (102 mm) wide, with a minimum of nine holes for arm attachment.
    2. Arms to be arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms to be available in lengths ranging from three (3) inches (76 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250 lb (114 kg) minimum capacity. Top of the arm to be nominally four (4) inches (102 mm) wide, and the arm to have slots along the full length for cable ties.
L. Duct-sealing compound to be non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 degrees F (2 degrees C). Capable of withstanding temperature of 300 degrees F (150 degrees C) without slump and adhering to clean surfaces of plastic duct, metallic duct, duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
M. Maintenance hole ladders:

1. Fixed hole ladders capable of attachment to roof or wall and floor of maintenance hole. Ladder, mounting brackets, and braces to be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin or hot-dip galvanized steel.
2. Portable maintenance hole ladders to be UL-listed OSHA certified, heavy-duty fiberglass specifically designed for portable access to electrical maintenance holes. Minimum length equal to distance from deepest maintenance hole floor to grade plus 36 inches (900 mm). One required.

N. Cover hooks per project specifications:
1. Heavy duty is designed for lifts greater than 60 lbs (270 N).
2. Light duty is designed for lifts less than 60 lbs (270 N).

2.11 Vault Lids/Covers

A. The two most frequent UNLV hinged vault lids/covers requirements per ANSI/TIA 758-D and ASSHTO-M-306 are:
a. Single lid/cover having a pedestal load rating for both off-street locations including walkways and campus open-spaces.
b. Double-lid/cover for vehicle traffic areas having a H-20 rating (2-axles truck) or HS-20 rating (trucks with more than two (2) axles).

B. The minimum design criteria for both H-20 and HS-20 consists of truck axle loading of 32,000 lbs (14,515 kg) or 16,000 lbs (7,257 kg) per wheel load plus a 33% impact load factor.

C. Either mill-finish aluminum diamond head or galvanized diamond head steel lids/covers and thickness are acceptable based upon vault size and load factor requirements. Frame material to match lid/cover.

D. Incorporate an oversize recessed staple for a padlock with bolt-down lid, flush lifting handle(s), and automatic hold-open arm(s) with locking pin(s).

E. All manufacturer-supplied mounting hardware, tamper-resistant bolts/locknuts, hinges, slam latch, hold-open 90-degree arm, and compression springs are to be made of stainless steel.

F. All this hardware can be removed and replaced in the field if necessary.

G. The vault/lid assembly to be manufactured in the United States and guaranteed for materials and workmanship for a minimum period of ten (10) years.

2.12 Air- Blown/Jetted (ABF) Fiber Microduct System

A. 'Blown' or 'Jetted' ABF optical fiber systems are composed of a series of microducts or tubes bundled in an outer 'sheath' to house and protect the microduct system. Both indoor and outdoor rated systems to be composed of HDPE dielectric materials.

B. Comply to Telcordia GR-3155-CORE.

C. Terminate properly into a NEMA 250 Type 4/IEC 60529 IP65 rated optical fiber 'termination distribution unit' or TDU.

D. Each outer sheath is to be secured onto the TDU with Kellum Grips™ mounted on the outside. This is to prevent any shrinkage of the sheath from pulling out of the TDU and exposing the microducts. Refer to the ABF fiber manufacturer for specific guidelines and third-party for sizing and part numbers.

E. Specifications include:
1. Microduct type (quantity): 1, 2, 3, 4, 7, 12, 19 and 24 way; from 5 mm to 27 m OD
Note: 19-way most frequently used on UNLV campus.

2. Configurations limited to 8.5/6 mm.
3. Capable of handling a minimum 432 fibers.
4. Coextruded sheath with smooth or ribbed inner lining to reduce friction on cable installs.
5. Outer sheath to be smooth and orange in color - rated for the proper environment.
6. Available ratings: UL rated Riser, Plenum, or LSHF (Low-Smoke Zero Halogen) .
7. Handling temperature: 0 degrees C to +40 degrees C.
8. Maximum pulling tension: Per manufacturer's recommendations.
9. Bending radius: 20x OD during installation, 10x OD after installation.
10. Footage/meter markings.

F. Indoor applications suitable for installation in any type of cable tray and metallic conduit housing conventional or split corrugated and mesh fabric innerduct. Not to be supported by J-hooks.

G. Outdoor applications:
   1. Needs to be rodent resistant defined in project specification; either by the outer sheath jacketing/armor, installing a pull over metal rodent-resistant mesh sox, or being installed in a flexible mesh innerduct.
   2. Check project specifications for armor if required.
   3. Suitable for underground HDPE piping/conduit housing and mesh fabric innerduct.
   4. Not needed for aerial applications.
   5. If requested and authorized by UNLV/DNE; direct burial/directional boring applications for speciality projects (e.g. WiFi, security, and emergency telephone).

H. Offer a complete line of accessories including couplers, plow chutes, end caps, and pull tape.

I. Speciality tools, lubricants, and air-blowing equipment to complete an installation.

PART 3: EXECUTION

3.1 General

A. Practice only OSHA-approved safety procedures when working in hand holds, vaults, and maintenance environments; inclusive of tripods, sniffers, blowers, and cattle guards where applicable;

B. Effective 03/15/23 requires the Contractor/Sub to fill out a "Confined Space" entry notification form when any technician enters into a handhold, vault or maintenance hole that is three (3) ft. or deeper. The form can be acquired from the UNLV/RMS department. This link is: https://rms.unlv.edu/forms/permitRequest/index.php?p=8

C. Contractor/Sub to submit an Underground Service Alert (USA) ticket to locate and mark all subsurface utilities, for power, communications, gas, water, outdoor lighting, and other related utilities 48 hours or in accordance with statutes regulating utilities prior to any excavation on campus. An USA call number receipt (ticket) needs to be present and on-site when all utilities are located and marked before any construction work involving excavation begins.

D. Coordinate layout and installation of conduit/duct, duct bank, maintenance holes/manhole (MH), vaults (V), handholes (HH)/pull boxes (PB) with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify UNLV/P&C, the Architect and UNLV/NDE if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

E. Coordinate elevations of conduit/duct and duct-bank entrances into maintenance holes/manhole (MH), vaults (V), handholes (HH)/pull boxes (PB). This may be determined with

the final locations and profiles of duct and duct banks, by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations necessary to suit field conditions and to ensure that duct runs drain to maintenance holes and handholes, and as approved by UNLV/P&C, the Architect and UNLV/NDE.

F. Grub vegetation to be removed and protected vegetation to remain according to UNLV Planning & Construction Technical Design Guidelines Section 31. Subsequently, remove and stockpile topsoil for reapplication accordingly.
G. Core-drilling of holes through structural fire-rated floors, walls, or ceilings to have approval by a structural engineer or Professional Engineer (PE) and be X-rayed for structural steel facilities.

3.2 Earthwork

A. Excavation and Backfill: Comply with UNLV Planning & Construction Technical Design Guidelines Section 31 05 16, *Aggregate For Earthwork* but do not use heavy-duty, hydraulic-operated, compaction equipment.
B. Restoration: Replace area [immediately after backfilling is completed] [or] [after construction in immediate area is complete].
C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated.
D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with UNLV Planning & Construction Technical Design Guidelines Section 32 92 00*; Turf and Grasses* and Section 32 93 00; *Plants.*
E. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures in accordance with UNLV Planning & Construction Technical Design Guidelines Section 3.

3.3 Installation Guidelines for Rigid Metallic Conduit (RMC)

A. This includes the installation of Galvanized Rigid Conduit, PVC encased Galvanized Rigid Conduit, and PVC encased Intermediate Metallic Conduit (IMC) both to comply with current version NEMA RN 1 standard.
B. To be installed only as a transition from:
    1. Outside plant (OSP) building riser or above ground horizontal applications transitioning from the underground HDPE piping/conduit
    2. Outside plant (OSP) underground for sections to transition from HDPE piping/conduit to RMC if necessary when installing under sidewalks, driveways, or ramp areas subject to heavy traffic
    3. Extending through a building or past the 50 ft. (15.2 meters) demarc is a requirement per NEC code to transition from outdoor rated cable to indoor fire-rated (riser or plenum) cable.
C. Make the transition from underground HDPE conduit/duct to galvanized rigid conduit (GRC) or PVC encased GRC at least 10 ft. (3 meter) outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Install GRC penetrations of building walls as specified in Section 27 05 44; *Sleeves and Sleeve Seals for Communications Pathways and Cabling.*

D. Use fittings manufactured for HDPE duct-to-GRC conduit transition. This may include HDPE or PVC threaded couplings and/or non-hub couplings with torque-nut housings.
E. The GRC - without the PVC casing - can also be used to extend the outside plant non-fire rated optical fiber cabling/microduct system beyond the 50 ft. (15.2 meters) demarcation point or even through the building per the NFPA 70 NEC requirement to transition to a fire-rated traditional cable/microduct.
F. All conduit, couplers, and fittings to be threaded. If applicable, both ends to have a plastic threaded protective collar installed on both ends to prevent chaffing of the cable during the installation process.
G. Emergency splices need to be sealed.
H. RMC conduit is to be secured to the building infrastructure using properly sized clamps designed for RMC or the use of unistrut and mounting brackets. Either to be secured using properly sized and designed inserts for the buildings outside wall materials.

3.4 Installation Guidelines for HDPE Conduit/Duct Bank

A. Install HDPE conduit/duct and duct bank according to the current versions of NEMA TC7-2021
B. Underground conduit/duct applications types:
    1. HDPE piping/conduit in concrete-encased duct bank unless otherwise indicated.
    2. HDPE piping/conduit in direct-buried duct bank unless otherwise indicated.
    3. Underground Duct Crossing Paved Paths, Walks, Driveways, Roadways and Railroads: HDPE piping/condit in encased in reinforced concrete.
    4. Stub-Ups for Communications: Concrete-encased RNC, GRC, or PVC-coated GRC.
C. The minimum recommended separation between telecommunications conduit systems and outside surfaces of foreign structures as specified by the National Electrical Safety Code (NESC) for personnel safety and the protection of telecommunications equipment to be maintained at all times.
D. Any size HDPE underground piping/conduit to be kept at a minimum 10-ft. (3 meter) distance from steam/condensate and main water lines unless approved by UNLV/NDE. Where conduit/duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank not to be subject to environmental temperatures above 40 degrees C (104 degrees F):
    1. Where environmental temperatures are calculated to rise above 40 degrees C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
    2. When crossing is necessary within the ten (10) ft. (3 meter) distance limitation, transition to galvanized rigid conduit (GRC) for at least ten (10) ft. (3 meter) on either side of the intersection.
E. UNLV/NDE to observe and inspect utilities trenching, excavation, backfilling and compaction to ensure compliance to contract Scope of Work (SoW), industry best-practices, and code compliance. Contractor/Sub schedule all inspections prior to commencing trenching and backfilling operations. All installations are subject to satisfactory inspection by UNLV/NDE.
F. Install conduit/duct, spacers, and accessories into the duct bank configuration as indicated on the project drawings. Designed for 4-inch HDPE piping/conduit and to be used in the trenches for support and separation of the conduits.

G. Ground Water:
    1. Assume ground-water level or 'freeze line' is 36 inches (914 mm) below ground surface unless a higher water table is noted on Drawings.
    2. The minimum depth of a trench to be 36 inches (544 mm) continuously from the top of the conduit system to final grade.

H. 4-inch (102 mm) HDPE piping/conduit continuous pathways, bends and sweeps to be encased in concrete when the following conditions exist. This is to prevent movement and thus the possibility of "burn-through" by the pull rope during cable installations. Conduits to be secured with rebar when covering conduits with concrete:
    1. Minimum conduit depth cannot be attained
    2. Conduits pass under sidewalks, roadways, driveways, and railroad tracks
    3. At bend points

I. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of four (4) ft. (1.2 meters) both horizontally and vertically, at other locations unless otherwise indicated.

J. Not to exceed two (2) 90-degree bends (180-degrees total) between pull points, including offsets and kicks. Back-to-back 90-degree bends to be avoided. Bends to be manufactured having a radius not less than six (6) times the internal diameter of conduits 2-inches or smaller or ten (10) times the internal diameter of conduits larger than two (2) inches (51 mm).

K. Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

L. Make the transition from underground HDPE piping/conduit to galvanized rigid conduit (GRC) or PVC encased GC at least 10 ft. (3 meter) outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Use PVC or HDPE fittings manufactured for HDPE duct-to-GRC conduit transition. Install GRC penetrations of building walls as specified in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

M. Conduit stubs entering the building above grade to extend four (4) inches (102mm) beyond the foundation as needed to prevent shearing of the conduit while allowing for access.

N. Conduit entering vertically from a below grade point to:
    1. Use 4-inch "Smart LBs" entering/exiting a building above surface grade.
    2. Extend a minimum four (4) inches (102 mm) above the finished floor inside the Entrance Facility (EF) or the Equipment Room-Main Distribution Frame (ER-MDF).

O. Conduit entering downward into the (EF) or the Equipment Room-Main Distribution Frame (ER-MDF) at ceiling height to terminate a minimum four (4) inches (102 mm) below the finished ceiling and seven (7) inches (178 mm) above ladder racking.

P. Provide temporary closure at terminations of conduit/duct entering the entrance facility (EF).
    1. Unused entrance conduits to be capped/plugged with expandable type duct plugs, Jackmoon or Shaw Plugs or equal inside the building. This is to prevent rodents, water or gasses from entering the building.
    2. Entrance conduits having cable and or innerduct inside to have the void filled with proper UL approved pliable firestop putty. Ensure pull tape is secured.

Q. 4-inch HDPE conduits to be installed so that a slope exists to allow drainage and to prevent the accumulation of water per ANSI/TIA 758:

1. Pitch conduit/duct and duct bank a minimum slope of 1:100 down toward maintenance holes/manholes (MH) and handholes (HH)/pull boxes (PB) and away from buildings and equipment.
2. When conduits connect between maintenance holes/manhole (MH) and vaults (V) a slope of .125 (3.2 mm) in per foot (305 mm) to exit from the middle or high-point of the span in both directions to each maintenance hole.

R. Installed conduit - and prior to installing cable - to be free of debris, clean, dry, unobstructed, labeled with destination (both ends) and if applicable, firestopped. For 4-inch (102 mm) HDPE piping/conduit, this will require a flexible mandrel and a stiff brush or equivalent. Mandrels to be minimum nine (9) inches (229 mm) in length and sized to within 1⁄4-inch of the inside diameter of the conduit.

S. Conduits empty, or having innerduct or cable installed to be provided with mule tape having a minimum of 1200 pound (544 kg) pulling tension.

T. There are two (2) options for the purpose of locating and tracing tracing underground pathways to minimize any chance of an accidental dig-up:
   1. Warning tape containing metallic tracings to be placed a minimum of 18-inches directly above the underground conduit structure cable. Both ends of the metallic warning tape to be accessible after installation.
   2. Use of electronic marker system (EMS) programmable ball markers is also permitted. Balls are to be placed according to manufacturer instructions and at locations identified by UNLV/NDE staff. Typically, plan to place the EMS ball over the conduit facility parallel or offset by three (3) to four (4) inches (76 to 102 mm) from the conduit centerline and spaced at a maximum six (6) ft. (1.8 meters) for clear identification. Ensure they are buried within the threshold of the generated signal. Check with UNLV/NDE project specifications to also verify color choice and facility information to be programmed.

U. Use of minimum 1- to 2-inch diameter HDPE piping/conduit permissible for special projects authorized by UNLV/NDE (e.g. WiF APs between bollards):
   1. Still subject to a minimum 36 inches (544 mm) 'Freeze Line' burial depth
   2. Outdoor rated copper UTP subject to the same indoor limitations having a maximum 100 ft. (33 meters) between pull points and no more than two (2) each 90 degree bends or a combination of bends not to exceed 180 degrees.
   3. Applications for one 1- to 2-inch HDPE conduit do not need to be encased in concrete unless the following conditions exist:
      a. Minimum conduit depth cannot be attained
      b. Conduits pass under sidewalks, roadways, driveways, railroad tracks and at bend points

3.5 Installation Guidelines for Concrete-encased Conduit/Duct and Duct Bank

A. Excavate trench bottom to provide firm and uniform support for duct or duct bank. Prepare trench bottoms as specified in Section 26 05 43; *Underground Ducts and Utility Systems f*or pipes less than six (6) inches (152 mm) in nominal diameter.
B. Width: Excavate trench 12 inches (305 mm) wider than duct or duct bank on each side.
C. Width: Excavate trench three (3) inches (76 mm) wider than duct or duct bank on each side.
D. Depth: Install top of duct and duct bank at least 24 inches (610 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (762 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
E. Support conduit/duct and duct bank on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
F. Support conduit/duct and duct bank on duct spacers coordinated with proper duct size, duct spacing, and outdoor temperature.
G. Minimum space between conduit/duct: Three (3) inches (72 mm) between the edge of duct and exterior envelope wall, two (2) inches (51 mm) between ducts for services, and four (4) inches (102 mm) between power and communications ducts.
H. Spacer installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers each per 20 ft. (6 meters) of duct. Place spacers within 24 inches (610 mm) of duct ends. Stagger spacers approximately six (6) inches (152 mm) between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie the entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around the duct or duct bank.
I. Use manufactured duct elbows for stub-ups; building entrances and at changes of direction in the conduit/duct run unless otherwise indicated. Extend concrete encasement throughout the length of the elbow:
    1. Couple GRC to duct with adapters designed for this purpose and encase coupling within three (3) inches (76 mm) of concrete
    2. Stub-Ups to outdoor equipment: Extend concrete-encased GRC horizontally a minimum of five (5) ft. (1.5 meter) from edge of base. Install insulated grounding bushings on terminations at equipment
    3. Stub-Ups to indoor equipment: Extend concrete-encased GRC horizontally a minimum of five (5) ft. (1.5 meter) from the edge of the wall. Install insulated grounding bushings on terminations at equipment
    4. Stub-ups to be minimum three (3) inches (76 mm) above finished floor (AFF) and minimum three (3) inches (76 mm) from conduit side to edge of slab

3.6 Installation Guidelines for Innerduct

A. Corrugated HDPE
    1. The internal corrugations provide increased crush resistance and reduce surface contact between the inside wall of the conduit and the cable jacket. This lowers the friction protecting the cable from high tensile stress during installation.
    2. Comply to UL 2024.
    3. Install immediately after mandreling the duct/cleaning process.
    4. Use jacks and mandrels for positioning the spool(s) for the installation. Ensure HDPE piping/conduit is properly reamed, clean and dry. Lube if necessary.
    5. Properly prepare the pulling end per industry best-practices; ensure at least two (2) ft. of the innerduct pull tape is extending past the end. Cut the innerduct into a long angle

"V" to create a bullet-nose headend to reduce getting snagged during pulling. Wrap the end with electrical tape to close the hole. Create a loop with the conduit-installed mule tape; secure both the innerduct tape as well as a secondary mule tape to the loop and wrap with electrical tape.

6. For multiple innerduct pulls; fashion and replicate this bullet nose procedure with each innerduct, stagger their placement, and use pull string or mule tape around the first prepared innerduct to create a larger bullet nose configuration. Tie all the innerducts tape to the same loop as the first innerduct, wrap with (wide) electrical tape and cover the open ends. Suggest using a swivel and pulling eye to reduce twisting the innerduct during the pull.

B. Mesh fabric innerduct
   1. Ensure it is sized to the appropriate conduit; For 4-inch HDPE piping/conduit use 4-inch (102 mm) three (3)-cell. Two (2) each maximum.
   2. Install per manufacturer instructions which includes a bullet swivel/pulling eye.
   3. Use silicon-based or hydra-based lube if necessary. Do not use electrical Yellow 77.

3.7 Underground Enclosure Installation Guidelines.

A. TIA-758B - Customer Owned Outside Plant Telecommunications Infrastructure Standard
B. BICSI OSP Design Guide
C. Handholes (HH) and Pull Boxes (PB) for Communications
   1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, [H-10] [H-20] structural load rating.
   2. Units in driveway, parking lot, and off-roadway locations, subject to occasional, non deliberate loading by heavy vehicles: [Precast concrete, AASHTO HB 17, H-20] [Polymer concrete, SCTE 77, Tier 15] [Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15] [Fiberglass-reinforced polyester resin, SCTE 77, Tier 15] [High-density plastic, SCTE 77, Tier 15] structural load rating.
   3. Units in sidewalk and similar applications with a safety factor for non deliberate loading by vehicles: [Precast concrete, AASHTO HB 17, H-5] [Precast concrete, AASHTO HB 17, H-10] [Polymer concrete units, SCTE 77, Tier 8] [Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8] [High-density plastic, SCTE 77, Tier 8] structural load rating.
   4. Units in roadways and other deliberate traffic paths: precast concrete. AASHTO HB 17, [H-10] [H-20] structural load rating.
   5. Units in driveway, parking lot, and off-roadway locations, subject to occasional, non deliberate loading by heavy vehicles: [Precast concrete, AASHTO HB 17, H-20] [Polymer concrete, SCTE 77, Tier 15] [Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15] [Fiberglass-reinforced polyester resin, SCTE 77, Tier 15] [High-density plastic, SCTE 77, Tier 15] structural load rating.
   6. Units in sidewalk and similar applications with a safety factor for non deliberate loading by vehicles: [Precast concrete, AASHTO HB 17, H-5] [Precast concrete, AASHTO HB 17, H-10] [Polymer concrete units, SCTE 77, Tier 8] [Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8] [High-density plastic, SCTE 77, Tier 8] structural load rating.

7. Units subject to light-duty pedestrian traffic only: [Fiberglass-reinforced polyester resin] [High-density plastic], structurally tested according to SCTE 77 with 3000-lbs (13,345 N) vertical loading.
8. Cover design load not to exceed the design load of the handhole or box.

D. Maintenance holes/manhole (MH): [Precast] or [cast-in-place] concrete:
   1. Units located in roadways and other deliberate traffic paths by heavy or medium vehicles: H-20 structural load rating according to AASHTO HB 17.
   2. Units not located in deliberate traffic paths by heavy or medium vehicles: H-10 load rating according to AASHTO HB 17.
   3. End-Bell entrances to maintenance holes/manhole (MH) and concrete and polymer concrete handholes (HH)/Pull boxes (PB): Use end bells, spaced approximately six (6) inches (152 mm) o.c. for 4-inch (102 mm) duct, and vary proportionately for other duct sizes.
      a. Begin change from regular spacing to end-bell spacing 10 ft. (3 meter) from the end bell without reducing duct slope and without forming a trap in the line.
      b. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to the maintenance hole or handhole. Install an expansion fitting near the center of all straight-line direct-buried duct and duct banks, with calculated expansion of more than 3/4 inch (19 mm).
      c. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Terminator entrances (TE) to maintenance holes/manholes (MH) and concrete and polymer concrete handholes (HH)/pull boxes (PB): Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately six (6) inches (152 mm) on center. for 4-inch (102 mm) duct and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to terminator spacing ten (10) ft. (3 meters) from the terminator without reducing duct slope and without forming a trap in the line.
   2. Expansion and deflection fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to the maintenance hole or handhole. Install an expansion fitting near the center of all straight-line duct or duct bank, with calculated expansion of more than 3/4 inch (19 mm).

F. Reinforce concrete-encased conduit/duct and duct bank where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
   1. Forms: Use trench walls to form side walls of duct and duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
   2. Install a minimum of three (3) inches (76 mm) of concrete cover between edge of duct to exterior envelope wall, two (2) inches (51 mm) between ducts, and four (4) inches (102 mm) between power and communications duct. The bed to be sand a minimum of 3 - inches depth compacted to 90%.
   3. Pour each run of envelope between maintenance holes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of conduit/duct as its temperature changes during and after the pour. Use

expansion fittings installed according to manufacturer's recommendations or use other specific measures to prevent expansion-contraction damage.

b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing-rod dowels extending a minimum of 18 inches (457 mm) into concrete on both sides of the joint near the corners of the envelope.

4. Comply with requirements in in Section 03 30 00; *Cast-in-Place Concrete* "Concrete Placement" Article: Place concrete carefully during pours to prevent voids under and between ducts and at the exterior surface of the envelope. Do not allow a heavy mass of concrete to fall directly onto the duct. Allow concrete to flow to the center of the bank and rise up in the middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

G. Underground-Line Warning Tape: Bury conducting underground-line warning tape specified in Section 27 05 53; *Identification for Communication Systems n*o less than 18 inches (300 mm) above all concrete-encased duct and duct bank and approximately 12 inches (300 mm) below grade. Align tape parallel/offset to and within 3-4 inches (76-102 mm) of the centerline of the duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

H. Use of electronic marker system (EMS) programmable ball markers is also permitted. Balls are to be placed according to manufacturer instructions and at locations identified by UNLV/NDE staff. Typically, plan to place the EMS ball over the conduit facility parallel or offset by three (3) to four (4) inches (76 to 102 mm) from the conduit centerline and spaced at a maximum six (6) ft. (1.8 meters) for clear identification. Ensure they are buried within the threshold of the generated signal. Check with UNLV/NDE project specifications to also verify color choice and facility information to be programmed.

3.8 Installation Guidelines for Concrete Maintenance Holes (MH), Vaults (V), Handholes (HH)/Pull boxes (PB), and Cast-in-Place Maintenance Hole Installation:

A. General:
   1. Finish interior surfaces with a smooth-troweled finish.
   2. Knockouts for future duct connections: Form and pour concrete knockout panels 1-1/2 to two (2) inches (38 to 51 mm) thick, arranged as indicated on project drawings.
   3. Comply with requirements in Section 03 30 00; *Cast-in-Place Concrete* for concrete, formwork, and reinforcement.

B. Precast concrete handhole (HH)/pull box (PB) and maintenance hole/ manhole (MH) installation:
   1. Comply with ASTM C 891 unless otherwise indicated.
   2. Install units' level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to a No. 4 (4.75-mm) and compacted to the same density as adjacent undisturbed earth.

C. Elevations:
   1. Maintenance hole (MH) roof: Install a rooftop at least 15 inches (381 mm) below finished grade.

2. Maintenance hole (MH): In paved areas and traffic ways, set frames flush with finished grade. Set other maintenance hole frames one (1) inch (25 mm) above finished grade.
3. Install handholes with bottom below three (3) ft. (0.9 meter) frost line.
4. Handhole Covers: In paved areas and traffic ways, set surface flush with finished grade.
5. Set covers of other handholes one (1) inch (25 mm) above finished grade.
6. Where indicated, cast handhole (HH)/pull box (PB) cover frame integrally with the handhole (HH)/pull box (PB)structure.Drainage: Install drains in bottom of maintenance holes where indicated. Coordinate with drainage provisions indicated.

D. Maintenance hole (MH) access:
   1. Circular opening in maintenance hole (MH) roof; sized to match cover size.
   2. Maintenance hole (MH) with fixed ladders: Offset access opening from maintenance hole centerlines to align with ladder.
   3. Install chimneys constructed of precast concrete collars and rings to support the cast-iron frame to, in turn, connect cover with maintenance hole (MH) roof opening.
   4. Provide moisture-tight masonry joints and waterproof grouting for the frame to the chimney.
E. Waterproofing:
   1. Apply waterproofing to exterior surfaces of maintenance holes, handholes, and vaults after concrete has cured for at least three days.
   2. Waterproofing materials and installation are specified in the waterproofing section.
   3. After conduit/duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars.
F. Circular opening in the maintenance hole (MH) roof is to be sized to match cover size.
G. Maintenance hole (MH) with fixed ladders: Offset access opening from maintenance hole (MH) centerlines to align with ladder.
H. Install chimneys constructed of precast concrete collars and rings to support the cast-iron frame to, in turn, connect cover with maintenance hole (MH) roof opening.
I. Provide moisture-tight masonry joints and waterproof grouting for the frame to the chimney.
J. Dampproofing:
   1. Apply damp-proofing to exterior surfaces of maintenance holes/manholes (MH) and handholes (HH)/pull boxes (PB) after concrete has cured at least three days.
   2. Dampproofing materials and installation are specified in Section 07 11 13 "Bituminous Dampproofing."
   3. After the conduit/duct has been connected and grouted, and before backfilling, damp proof joints and connections, and touch up abrasions and scars.
   4. Damp Proof exterior of maintenance hole chimneys after mortar has cured at least three days.
   5. Install removable hardware, including pulling eyes, cable stanchions, and cable arms, required for the installation and support of cables and conductors.
K. Field-Installed bolting anchors in maintenance holes/manhole (MH) and concrete handholes (HH)/pull boxes (PB): Do not drill deeper than 3-7/8 inches (97 mm) into the walls for maintenance holes/manholes (MH). Use a minimum of two anchors for each cable stanchion.
L. Vault (V) access:
   1. Vault opening to be two piece spring loaded doors with recessed locking attachment.
   2. Provide moisture-tight masonry joints and waterproof grouting from the frame to all sides.

3.9 Installation Guidelines for Handholds (HH)/Pull boxes (PB) Other Than Precast Concrete

A. Install handholes (HH)/pull boxes (PB):
    1. Level and plumb and with orientation and depth coordinated with the connecting duct.
    2. Minimize bends and deflections required for proper entrances.
    3. Use pull box (PB) extension if required to match depths of conduit/duct and duct bank
    4. Seal joints between box and extension as recommended by the manufacturer.
B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12 mm) sieve to No. 4 (4.75 mm) sieve and compacted to the same density as adjacent undisturbed earth
C. In paved areas and traffic ways, set cover flush with finished grade. Set covers of other handholes one (1) inch (25 mm) above finished grade.
D. Install handholes (HH)/pull boxes (PB) with bottom below three (3) ft. (0.9 meter) frost line.
E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, necessary for the installation and support of standard and blown optical fibers (Microduct) and conductors. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
F. Field cut openings for conduit/duct according to the enclosure manufacturer's written instructions.
G. Cut the wall of the enclosure with a tool designed for the material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
H. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring, encircling, and in contact with, enclosure:
    1. Ensure the top surface is screened to the top of the box cover frame. Bottom of the ring to rest on compacted earth.
    2. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 03 30 00 "Cast-in-Place Concrete," with a troweled finish.
    3. Dimensions: 10 inches wide by 12 inches deep (254 mm wide by 305 mm deep).

3.10 Installation of Vault Lids/Covers

A. Follow manufacturer installation instructions.
B. It is essential that all bolts and hardware are secured in place whenever the cover(s) is exposed to pedestrian or vehicle traffic.
C. Abide by Division 33; *Utilities - Master Specifications/Design Guidelines*
D. Each lid(s) will have two (2) ⅛ inch (3 mm) stainless steel labels permanently riveted or bolted to the lid/cover as follows:
    1. 2 X 6 inch (52 X 152 mm) label marked “COMMUNICATIONS” in CAPs.
    2. 2 X 6 inch (52 X 152 mm) label marked with the vault number assigned by UNLV/PC in CAPS; “V-###-X” (e.g. V-158-D).

3.11 Installation Guidelines for Air-Blown Fiber/Jetted (ABF) Fiber Microduct System

A. Beginning the installation means the Contractor/Sub accepts existing conditions. This includes access to and inspection of the maintenance holes/manholes (MH), vaults (V) and handholes (HH)/pull boxes (PB).

B. Contractor/Sub to furnish all required tools to facilitate Blown/Jetted Fiber "Microduct" installation without damage to the existing or newly installed Microduct.
C. The ABF equipment is to include, but not limited to, sheaves, winches, cable reels, cable reel jackets, duct entrance funnels, compressed air, pulling tension gauges, and similar devices.
D. All equipment to be of high-quality construction to allow a steady progress once pulling has begun.
E. Prior to blowing/jetting the Microduct, the awarded Contractor/Sub is the one responsible for ensuring the conduits/ducts are clean, free of dirt and debris, foreign materials and animals of any kind. This is to require the use of a properly sized mandrel and possibly a vacuum cleaner or like to ensure the conduit/duct is dry and clean. Verify cable trays are free of sharp edges and protruding uncapped bolts. This is a requirement before any Microduct fiber is blown/jetted.
F. Each outer sheath is to be secured onto the TDU with Kellum Grips™ mounted on the outside. This is to prevent any shrinkage of the sheath from pulling out of the TDU and exposing the microducts.
G. For existing and newly installed Microduct, the assigned Contractor/Sub is to verify that the tubes are sealed prior to pulling Microduct fibers by performing a pressure check first.
H. Makeshift devices posing a hazard to the Microduct or personnel not to be used.
I. Pulling a Microduct with a motorized vehicle is not acceptable.
J. Microduct blowing/jetting or removal to be done in accordance with the manufacturer's installation guidelines. Manufacturer's instructions and data sheets to be part of the Contractor/Sub's submittals.
K. Recommended pulling tensions and minimum bending radii not to be exceeded. Any Microduct bent or kinked to a radius less than recommended not to be installed or replaced at no extra cost to UNLV.
L. During the blowing/jetting operation, an adequate number of workers to be made available to provide observation points of each pathway conduit/duct entry and exit. If daisy chaining a pull between pull points, make Figure "8" of the excess Microduct tubes and fiber before feeding back into the next succession of Microduct tubes.
M. Cable pulling lubricants to be used when needed so as not to exceed recommended pulling tensions as set by the manufacturer. Lubricant to be of silicon-based or hydra-based type that is non-injurious to the Microduct. Lubricant Yellow 77 not to be used as it hardens with age.
N. Avoid abrasion, chafing, kinking and other damage to Microduct during installation.
O. Install Microduct with "Kellum" grips and break away swivels using the manufacturer's recommended pulling tension for the break point.
P. Allow a minimum of 24 hours between the installation of the Microduct and the installation of fiber units per manufacturer's guidelines.
Q. During installation, Microduct tube ends are to be completely sealed with end caps - not plugs - to prevent ingress of contaminants, including water.
    1. Upon completion of Microduct installation, all internal Microduct need to pass the standard pressure test and proof test per the manufacturer's recommended procedures. Indoor Microduct specifications are as follows:
    2. 15 bars (217 PSI) at 35 CFM is the ideal and maximum pressure that can be used, while 10 bars (145 PSI) at 180 CFM of pressure is the minimum.
R. The following test sequences to be followed per manufacturer's specifications after installation of ABF Microduct:
    1. Air Flow Testing
    2. Pressure Testing

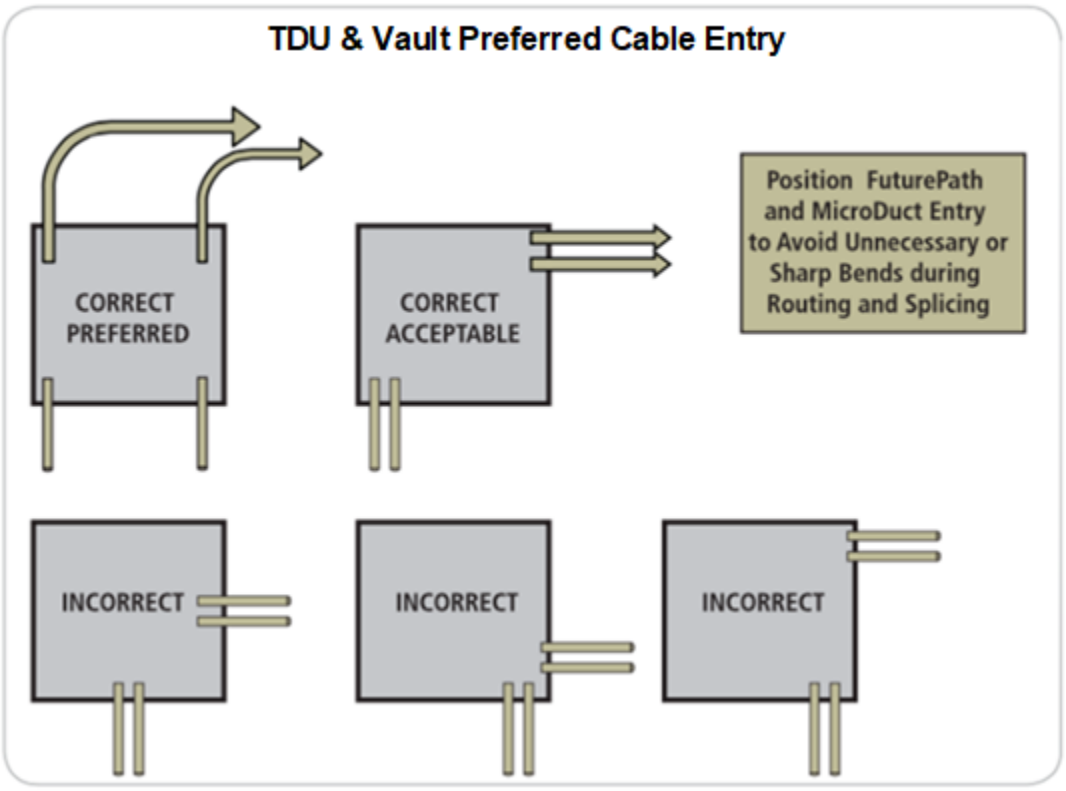
3. Continuity Testing
4. (Subsequently, the installed fiber to undergo either or both Level I (OLTS) and possibly Level II (OTDR) with Level I test results.

S. Contractor/Sub to ensure there is the proper amount of slack of the Microduct tubes inside the telecommunications distribution units or TDUs to provide proper bend radius and cable access.

T. When the ABF cabling is routed into a TDU, ideally the design to have the turns outside the box. However, if necessary by circumstances, the turn can take place on the far opposite side/corners as depicted in 27 05 43 Fig 1: *TDU & Vault Preferred Cable Entry*. At no time are the turns to take place in the middle or near side corners.

U. The Microduct tubes are to be professionally dressed and that each tube is properly coupled.

V. Any open tubes in a TDU are to be secured with micro end caps - not plugs - whether the Contractor/Sub installed the Microduct tubes or not.



27 05 43 Fig 1: *TDU & Vault Preferred Cable Entry*

3.12 Grounding and Bonding

A. Ground any Rigid Metallic Conduit (RMC) metal conduit/duct, duct bank, and utility structures according to Section 27 05 26 "Grounding and Bonding for Communications Systems."

3.13 Examination and Acceptance

A. Inspection to demonstrate the capability and compliance with the requirements on the contract Scope of Work (SoW) for a completed underground conduit/duct, duct bank, and utility system.
B. The underground pathways to be free of debris, clean and dry, capped, labeled, and pull tapes are secured to the eyebolts.
C. If applicable, ensure the sump pump is working properly.
D. Covers and lids are flush with the frame, lockable, lids are aligned and open and close freely.
E. The grounds and landscape removed for the underground pathways installations are repaired, top soil replaced and groomed to the original condition to match the immediate surroundings.
F. UNLV/NDE, UNLV/FM, and UNLV/P&C will jointly perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM will notify the UNLV/NDE PM and UNLV/FM PM. This is a requirement to complete the UNLV/NDE closeout documentation.

3.14 Cleaning

A. Installed maintenance hole (MH)/ vault (V), handhole(HH)/pull box (PB) to be clean of all debris, leftover material, garbage, dirt and gravel, tools and equipment, and the like.
B. If changing just the vault lid, the Contractor/Sub is still responsible for the 'sweep clean' clean up of the existing vault and to remove and empty trash on a daily basis around the associated work areas.

3.14 Close-out Submittals

A. Testing and inspection of precast concrete utility structures to be under the jurisdiction of UNLV Facilities Maintenance (FM) based upon but not limited to ISO 9000/9001, ASTM C 1037 and SCTE 77 standards.
B. Within 30 days of the substantial completion of the project or prior to project closeout -- which ever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub's one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.
C. If requested by UNLV Facilities Maintenance (FM) department in the SoW provide ground resistance testing results from the maintenance holes/manholes (MHs), vaults (V), and handholes (HHs)/pull boxes PB) grounding and bonding connections per Section 27 05 26 "Grounding and Bonding for Communications Systems."
D. Photographs and documentation for the repair of the grounds and facilities damaged during the underground pathway installation.

SECTION 27 05 00: COMMON WORK RESULTS FOR COMMUNICATIONS

——— End of Section 27 05 43 ———

Underground Ducts and Raceways for Communications Systems

SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

Sections 27 05 41 and 44

Firestopping Systems for Communications, Sleeves and Sleeve Seals for Communication Pathways and Cabling

PART 1: GENERAL

1.1 Summary

A. This Section is specific to firestopping systems for communications including sleeves and sleeve seals for communication pathways and cabling. It describes the minimum requirements for the PART I General requirements, PART II Product selections and PART III Execution installation guidelines for either or a combination of firestopping systems including sleeves and sleeve seals for communication pathways and cabling components in either new or retrofit construction.

B. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of *Firestopping Systems for Communications, Sleeves and Sleeve Seals for Communication Pathways and Cabling* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).

C. Compliance and management of firestopping is under the UNLV/FLS and UNLV/RMS departments.

D. UNLV/NDE role is to provide the guidelines and joint inspections for low-voltage telecommunications firestopping practices. UNLV/NDE and UNLV/P&C will join UNLV/FMS during rough-in and final acceptance inspections.

E. The work of these two Sections includes, but is not limited to, firestop systems including sleeves and seals and their 'firestopping' installation process as it relates to communications cabling.

F. Firestopping is intended to prohibit the spread of fire, smoke, and toxic fumes from one location within a building to another. This means restoring the integrity of fire-rated walls, floors, and ceilings when these barriers are penetrated.

G. Firestopping is the process of installing firestop UL-listed fire-rated materials into penetrations of fire-rated barriers to reestablish the barriers fire rating.

H. Penetration is an opening made in a barrier of an architectural structure or assembly. There are two types of penetrations;
   1. A 'membrane' penetration pierces or interrupts the outside surface of only one side of a hollow barrier (e.g. work area telecommunications outlet on a fire-rated wall) and,
   2. A 'through' penetration pierces or interrupts both sides of a barrier. (e.g. fire-rated floor ceiling or wall penetrated by cable tray, ladder racking, cables, sleeves, and conduits.)

I. A fire resistance rating uses the time (in hours) that a firestop 'assembly' or an architectural feature shows an acceptable resistance to fire. The rating of the firestop assembly to meet or exceed the rating of the architectural barrier that is penetrated.

J. All firestop systems to be a UL listed system/assembly.

K. The authority having jurisdiction (AHJ) to be enforcing local building codes with firestop restrictions intended to ensure the safety of the buildings' occupants.
L. This section includes both 'mechanical' and 'non-mechanical' firestop systems inclusive of; sleeves and sealants, rap strips, putty, caulks, blankets, pads, foam, pillows, collars, and foam.
M. Use the same original-source manufacturer and no mixing of firestop materials for each building (s) defined in the contract Scope of Work (SoW).
N. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
O. Transmission performance parameters to be independently verified by UL or ETL/Intertek Nationally Recognized Testing Laboratory (NRTL) testing organizations.

1.2 Related Documents and Reference

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".
B. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications* includes the following:
    1. Section 27 05 29; *Hangers, J-Hooks, and Supports*
    2. Section 27 05 33; *Conduits and Back Boxes*
    3. Section 27 05 36; *Cable Trays*
    4. Section 27 05 39; *Surface Mounted Raceway*
    5. Section 27 05 41; *Firestopping System for Communications*
    6. Section 27 05 44; *Sleeves and Sleeve Seals for Communication Pathways and Cabling*
C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
    1. Appendix A; *Codes, Standards, and Regulations*
    2. Appendix B; *Abbreviations and Acronyms*
    3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
    4. Appendix D; *Rack Elevation and Room Sizing Drawings*
D. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
E. This combined Section 27 05 41; *Firestopping Systems for Communications* and Section 27 05 44; *Sleeves and Sleeve Seals for Communication Pathways and Cabling* represents and includes the similar but not replacement documentation as would be found in a CSI Section 07 84 13 *Penetration Firestopping*.
F. Firestopping Systems to comply with the requirements of the current versions and practices in:
    1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)
    2. BICSI *Information Transport Systems Installation Methods Manual* (ITSIMM)
    3. ANSI/TIA 569; *Telecommunications Pathways and Spaces*
    4. ANSI/NFPA 70; *National Electrical Code (NEC)*
    5. ANDI/NFPA 101; *Life Safety Code*
    6. ASTM C719; *Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement*
    7. ASTM E 814; Standard Test Method for Fire Tests of Through-Penetration Firestops Systems
    8. ASTM C920; *Standard Specification of Elastomeric Joint Sealants*

9. ASTM C 1107/C 1107M Grade B; *Standard Specification for Packaged Dry, (Non Shrink) Hydraulic-Cement Grout (Feb, 2020)*
10. ASTM D1785; *Standard Specification for Pollyvinylcloride (PVC) Plastic Pipe Schedule 40, 80 and 120*
11. ASTM E84; *Standard Test Methods for Surface Burning Characteristics of Building Materials*
12. ASTM E 119; *Methods of Fire Tests of Building Construction Materials*
13. ASTM E 814; *Standard Method of Fire Tests of Through-Penetration Firestops*
14. NECA 1; *Standard For Good Workmanship In Electrical Construction (ANSI)*
15. NFPA 101; *Life Safety Code*
16. SSBCCI; *Southern Building Code Congress International*
17. UBC; *Uniform Building Code*
18. UL 263; *Fire Tests of Building Construction Materials*
19. UL 723; *Surface Burning Characteristics of Building Materials*
20. UL 1479; *Fire Tests of Through Penetration Firestops*
21. UL 2079; *Standard for Fire Tests of Joint Systems*

G. This section only pertains to the penetrations of 'fire-rated' walls and floors and the UL-approved firestop options to restore to their original fire-rating. 'Non-fire rated walls and floors' are non-applicable (N/A) to this Section.
H. Cable fill calculations to be included to show the maximum cable fill ratio for each firestopping system and cable type.

1.3 Pre-bid Submittals

A. Provide manufacturer's standard catalog technical information data sheet(s) for each of the UL specified products demonstrating compliance with referenced standards. Also to list quantities anticipated in which and where each product is to be used.
B. Include any engineering recommendations/documentations depicting the fire-rating for each penetrating barrier type.
C. Provide manufacturer instructions displaying typical installation details for the methods of installation.
D. Contractor/Sub to show proof of being manufacturer qualified and trained by providing proof of the firestop manufacturer's certifications for both the company and the employees.
E. Submit schedule of firestopping opening locations, penetrating items, and required manufacturer UL listed part numbers to seal openings so as to maintain the fire resistance ratings.
F. Provide manufacturer warranty documentation.

1.4 Quality Assurance and Warranty

A. Firestop products to bear the classification marking of the qualified testing and inspection agency (e.g. UNLV/NDE recognizes Underwriters Laboratory or "UL").
B. Firestopping systems (materials and design) to conform to both UL Flame (F) ratings, Temperature (T) and possible Leakage (L) ratings to be in compliance with local building codes. These have been tested by nationally recognized testing laboratories (NRTL) per ASTM E 814 or UL 1479 fire tests in a configuration that is representative of field conditions.

C. Deliver material in the manufacturer's original, unopened containers or packages with the manufacturer's name, product identification, lot number, UL label, and mixing/installation instructions as applicable.
D. Store materials in the original, unopened containers or packages, and under conditions recommended by the manufacturer.
E. Protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by the manufacturer. Do not install products in damaged packaging and replace products at no additional cost to UNLV.
F. Avoid breakage, denting and scoring finishes. Damaged products not to be installed.
G. Install only firestop products bearing the UL classification marking of qualified testing and inspection agency to be used.
H. Firestop materials to be installed prior to expiration of shelf life.
I. Products to be furnished with manufacturer's instructions and mounting hardware.
J. Products to be UL Listed and be manufactured by an ISO 9000/9001 approved manufacturer and be RoHS 2011/65/EU compliant.
K. Ensure adequate supply of adhesive firestop identification wall labels/placards to be filled out and attached to at least one side for through penetrations.

1.5 Contractor Qualifications

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).

1.6 Field Condition

A. The installer is to determine the specific type of firestop material or assembly to be used;
    1. Starting with the type of structure (ceiling, wall, floor, wall, and/or combination)
    2. The penetrated material (cable tray, steel conduit, pipe, innerduct, or any other pathways)
    3. The type of material being penetrated (acoustic, brick, concrete, framed wall or wood)
    4. The environment (wet, dry, cold, hot, hazardous, and dusty)
    5. The barrier fire-rating (typically 2-hours)
    6. Subsequently, to provide the appropriate manufacturer part number and assembly instructions /drawings with their pre-submittals.
B. Do not install products when ambient or substrate temperatures are outside limitations recommended by the manufacturer.
C. Do not install products when substrates are wet due to rain, frost, condensation, dust and debris, or other causes.
D. Install and cure penetration firestop materials per manufacturer's written instructions using natural means of ventilations.
E. Do not use materials that contain flammable solvents.

F. When installing sealants, ensure there is adequate ventilation.
G. Coordinate with the General Contractor and other trades of the timeframes when firestopping openings and penetrations are to be scheduled. The purpose is not to disrupt the construction schedule or other trades possibly needing access or working in the vicinity of an assigned opening.
H. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate the proper through-penetration firestop systems.
I. Note: Check with UNLV/P&C to contact security, if necessary to schedule having the fire alarm/smoke detectors turned off when any drilling, grinding, or cutting is being conducted.

PART 2: PRODUCT

2.1 General

A. Fire-rated cable pathways devices to be used in fire-rated construction for low voltage video, data and voice cabling, optical fiber raceways where frequent cable moves, adds, and changes (MACs) may occur.
B. To meet or exceed the ratings of the wall or floor being penetrated.
C. Materials and products required for work of this Section not to contain asbestos or polychlorinated biphenyls (PCB).
D. Most common sealants are non-halogenated that limit heat by forming a char effect.
E. The manufacturer's firestop system needs to be approved by the UNLV/NDE and Fire Life and Safety department before purchase or installation.
F. Products can be selected from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*
G. Materials to meet and be acceptable for use by the applicable SBCCI building and NFPA-70 codes as enforced by the authority having jurisdiction (AHJ).
H. Do not use any firestop products which re-emulsify, leach active intumescent ingredients, nor dissolve when exposed to water after curing.
I. Be ‘maintenance free’ once installed except for cabling MACs conditions
J. On insulated pipe, fire-rating classification does not require removal of insulation.
K. Materials to be suitable for the firestopping of penetrations made by rigid metallic conduit (RMC), galvanized metallic conduit (GRC), electrical metallic tubing (EMT) and sleeves, solid bottom cable and basket tray.
L. Low voltage (telecommunication) cable(s) penetration through any fire-rated wall or floor alone is not permitted and needs to be placed in an approved firestop pathway.
M. Ensure technicians have access to Material Safety Data Sheets (MSDS) - superseded by Safety Data Sheets (SDS).
N. Sealants to be composed of single-component, silicone-based, neutral-curing elastomeric properties that upon curing do not re-emulsify during exposure to moisture.

2.2 Accessories

A. Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required.
B. Use only those components specified by penetration firestop manufacturer. This may include permanent and temporary forming/daming/backing materials:
    1. Mineral wool fiber or rock-wool-fiber insulation/batting
    2. Sealants used with other materials to prevent leakage of fill materials
    3. Fire-rated form board
    4. Substrate primers
    5. Collars and sleeves

2.3 Mechanical Firestop Systems - UNLV/NDE approved

A. Elastomeric (flexible rubber) firestop materials house in a compression applied frame:
    1. Reliable pressure and environmental sealing
    2. Resistance to shock and seismic vibrations
    3. Waterproofing
    4. Reconfigurable with different size elastomeric components

2.4 Non-mechanical Firestop Systems - UNLV/NDE approved

A. Intumescent Composite Sheets:
    1. Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel-sheet.
    2. For use in large openings.
    3. Check with the authority having jurisdiction (AHJ) for approval before installation begins.
B. Pads:
    1. Firestop putty in the form of a pre-sized pad.
    2. Used to seal membrane penetrations by work area telecommunications outlets or other electrical fixtures. See Putty.
C. Intumescent Wrap Strips:
    1. Single-component intumescent elastomeric sheet with aluminum foil on one side.
    2. Used for firestopping plastic pipe/conduit, innerduct or any material that may burn away and leave a significant void.
D. Endothermic Wraps:
    1. Incorporates a protective foil scrim designed for the fire protection of critical circuits and cabling conduit (electrical metallic tubing or EMT) infrastructures.
    2. At a certain high temperature, some may be classified as being halogenated; releasing chemically bound water to have a cooling effect that provides up to two (2) hours of protection under fire conditions.
    3. May incorporate a circuit integrity (CI) rating to be able to operate when exposed to heat and flame.
E. Firestop putty:
    1. Depending on the application to be either endothermic (absorbs) or intumescent (expands) sealant.
    2. Non-hardening dielectric, water resistant containing no solvents, nor inorganic fibers.

3. Similar in texture to glazing putty.
4. Remains soft and pliable unless exposed to heat.
5. Commonly used to seal the inside of conduit and pipe. Ideal for easy cable reentry.
6. Available in bulk, bars, or sticks.
7. Consistent smoke seal.
8. May be used in conjunction with backing material like mineral wool.

F. Caulk:
1. Depending on the application to be either endothermic (absorbs) or intumescent (expands), and ablative (resist erosion by fire and flame)sealant.
2. Dispensed from tubes or pails.
3. Solid (wall or ceiling) or self-leveling (top of floor).
4. More for permanent installation not intended for cable reentry.
5. Some solvent-based caulk may give off toxic fumes till cured. Ensure proper ventilation and warning placards to be placed in the general area.
6. Commonly used to seal the outside of conduit and pipe.
7. May be used in conjunction with a backing like mineral wool.
8. Exothermic flexibility for use in expandable floors and driveways.

G. Pillows/bags:
1. Reusable heat-expanding pillows/bags.
2. Composed of specialty treated compressible, non-curing, intumescent fiber-matrix core contained in a flame retardant poly bag.
3. At certain high temperatures, they swell to provide further sealing and become rigid to withstand the force from a firehose hose stream.
4. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillow/bags from being removed or falling out.
5. Re-enterable for large cable tray openings when frequent cable moves, adds, and changes (MACs) may take place.

H. Flexible block:
1. Intumescent blocks commonly called ‘bricks’ are similar in size.
2. Same effect as pillows.
3. Used for medium to large openings from the cable tray.
4. Ideal for cable reentry.
5. Like brick masonry, it can be cut and sized to fit the opening.
6. Check with the manufacturer and authority having jurisdiction (AHJ) and manufacturer if outside edges are to be fire caulked.

I. Collars:
1. Factory-assembled collars from galvanized steel and lined with intumescent putty
2. Commonly referred to as a ‘pipe choke’ collar.
3. Sized to fit specific conduit diameter.

J. Foams:
1. Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam or sealant.
2. Depending on the application to be either endothermic (absorbs) or intumescent (expands), and ablative (resist erosion by fire and flame).
3. Dispensed from a two-part mixing tube and quickly forms a tight seal.
4. Flexible, moisture and smoke resistant.
5. Can be used on concrete floors, framed walls, and masonry walls.

6. May be used in conjunction with mineral wool or the like.

K. Grommets:
   1. Molded, two-piece metal round and sometimes pivotable hinged assembly housing integral fire and smoke sealing foam membrane inside.
   2. Designed for sealing individual conduit penetrations through framed wall assemblies.
   3. Grommet snaps together around the conduit and locks tightly into the wall.

L. Sleeve systems:
   1. Includes the sleeve, wall flanges, couplings, rated bushings, adhesive documentation labels, and firestop material to seal the system.
   2. Use only manufacturer supplied rigid metallic conduit (RMC) solid conduit for through penetrations in new construction.
   3. Use RMC split-sleeve conduit along with slotted flanges and couplings for possible retrofit low-voltage telecommunications applications.

M. Cable Pathway Firestop Assembly:
   1. Self-contained 'through penetration' firestop system having a square or round metal pathway with self-adjusting intumescent foam pads inside.
   2. Adjusts load capacity for cable removal and reentry; 0 to 100 percent cable fill capacity
   3. Designed for field assembly.
   4. Ideal for frequent cable moves, adds, and changes (MACs) without having to remove or replace firestop materials.
   5. Independently supported; refer to manufacturer instructions for proper separation to maintain the integrity of the wall.

N. Sprays:
   1. An insulating firestop material or sealant.
   2. Applied by spray pumps.
   3. Commonly used on building gray or red iron.
   4. Can be applied to RMC/EMT conduit, but never to be in contact with the cabling inside.

O. Cast-in-Place Firestop Devices:
   1. Factory-assembled devices for use in concrete floors.
   2. Consists of an outer metallic sleeve lined with an intumescent strip.
   3. Extended flange attaches to one end to the sleeve (placed on top of the floor penetration)with a neoprene gasket.
   4. Fastens to concrete formwork secured by the flange.

P. Cementitious materials:
   1. Endothermic cement-like form having endothermic (absorbs) and ablative (insulate) characteristics.
   2. Available in premix or dry powder.
   3. More suited for large openings not suitable for caulk or putty.
   4. Commonly used to reseal or grout concrete floor and wall barrier applications.
   5. Applied with a trowel or pump.
   6. Can easily be bored/drilled through.

PART 3: EXECUTION

3.1 Examination and Preparation

A. Before beginning installation, examine both sides of a through penetration where firestop materials are to be installed. Verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.
B. Abide by the manufacturer's installation instructions only. Not by industry-best practices.
C. Both sides of the wall are to be firestopped.
D. More is not always better.
E. In retrofit and new projects, the drawings may not always indicate fire-rated barriers. Check with UNLV/P&C for clarification.
F. If there are discrepancies with the hardware penetrations, notify UNLV Fire and Life Safety (FLS) and UNLV/NDE immediately.
G. Proceed with installation only after unsatisfactory conditions have been corrected in a manner acceptable to notify UNLV Fire and Life Safety (FLS).
H. If necessary for good aesthetics and protecting surfaces from permanent stain or damage, provide masking tape and/or temporary covering to protect adjacent surfaces.
I. Prime substrates only where recommended by the manufacturer. Use their recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.2 Installation Guidelines for Firestopping

A. Installation of firestops can only be performed by an applicator/installer qualified and trained by the manufacturer.
B. Install penetration firestop to comply with manufacturer's installation instructions and published drawings for products and applications indicated. Firestopping installations are to bring any fire rated wall, floor, or ceiling penetrations to the same or higher fire rating.
C. No mixing or substitutions of different firestop manufacturers.
D. Follow safety procedures recommended in the Material Safety Data Sheets (MSDS).
E. Install forming materials and other accessories of types required to support fill materials during their application process:
    1. Ensure they are in the secured position needed to produce cross-sectional shapes and depths required to achieve the correct fire ratings as specified.
    2. After installing fill materials and allowing them to fully cure, remove combustible forming materials, masking tape, and other accessories not indicated as permanent components of firestopping.
F. Install fill materials per manufacturer installation instructions to fill voids and cavities formed by openings, forming materials, accessories, and the penetrating items to achieve the proper fire-resistance rating:

1. All materials applied to be in good contact and adhere to substrates openings and penetrating items. Nothing to be peeling away, loosely adhered, or inadequate amounts.
2. Outside of penetrating conduit can be caulked, puttied, or the use of collars or grommets.
3. Use self-leveling caulk with backing and only on floors and not walls.
4. Inside of penetrating conduit use only putty.
5. Finish surfaces of firestopping which is to remain exposed in the completed work to a uniform and level condition.

G. Where deficiencies are found, repair firestopping products so they comply with requirements.
H. If one observes improper firestopping of other trades installations, notify the General Contractor (GC) and the UNLV Fire and Life Safety (FLS) department.
I. Keep areas of work accessible until inspection and approval by the UNLV/NDE, Fire Life Safety departments, as well as the authority having jurisdiction (AHJ).

3.3 Identification Schedule

A. Adhesive firestop identification wall labels/placards to be filled out and attached to at least one side of a fire-rated wall for through penetrations.
    1. When applicable, place inside the equipment room (ER) - main distribution frame (MDF) and/or the telecommunications room (ER) - intermediate distribution frame (IDF) wall or floor.
    2. Continue this process for any succeeding fire rated wall(s) and affix label on the side closest to the originating telecommunication rooms.
B. The following information is required:
    1. The words or a combination thereof; "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage".
    2. Contractor/Sub's name, address, and phone number or (URL).
    3. Date of installation
    4. Firestop assembly number
    5. Room number of where label being placed and room number where the penetration is feeding into: (e.g. IDF #108 to Rm # 109)
    6. Manufacturer's name and PN reference number
    7. Installers name

3.4 Cleaning

A. Clean off any excess fill materials as per manufacturer instructions and not to damage the adjoining surfaces where the firestopping occurred.
B. If a surface, floor, or office equipment is stained or damaged during the firestopping installation, the Contractor/Sub to be responsible for repair to its original condition without any extra cost to UNLV.
C. After inspection, remove all equipment and ladders.

D. Contractor/Sub to practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas. This includes keeping inventoried material staging areas in the telecommunications rooms organized.

3.5 Examination and Acceptance

A. Final walk-through visual inspection will be performed jointly between UNLV/FLS, UNLV/NDE, and UNLV/P&C with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM to notify UNLV/NDE and UNLV/FLS PMs. Note: UNLV/FMS has final acceptance as this is a requirement to complete the UNLV/NDE closeout documentation.

3.6 Close-out Submittals

A. Review of the manufacturer's documentation for each application to ensure compliance with the instructions/drawings. A 3rd party contractor will inspect and certify that fire stopping and fire caulking has been installed in an approved method.
B. Fire stopping locations are not usually indicated on drawings. The drawings will have indicated the fire rating of the wall, floor or ceiling, which would include any penetrations. Usually on the drawings, fire and smoke dampers are indicated.
C. Unless otherwise requested by UNLV/FLS the only photos required for submittals will be the location for each fire and smoke damper.
D. Manufacturer's minimum warranty is three (3) months - one (1) year depending on the manufacturer. For extended warranty requests the Contractor/Sub is to contact the manufacturer's regional firestopping specialist/manager for written documentation.
E. Contractor/Sub to supply one year warranty on parts and labor to include:
    1. Repairs and replacement of penetration seals which fail in joint adhesion, cohesion, abrasion, resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability.
    2. Any firestopped area that appears to deteriorate in any other manner not clearly specified in submitted manufacturer's data as an inherent quality of the material for exposure indicated.

SECTION 27 05 00: COMMON WORK RESULTS FOR COMMUNICATIONS

——— End of Sections 27 05 41 and 44 ———

Firestopping System for Communications, Sleeves and Sleeve Seals for Communication Pathways and Cabling

SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

Section 27 05 53

Identification for Communications Systems

PART 1: GENERAL

1.1 Summary

A. This Section is specific to identification for communications systems. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for the identification or labeling of communications systems in either new or retrofit construction.

B. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of *Identification for Communications Systems* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).

C. Product data sheets, general design considerations, and installation guidelines are also provided in this document. None to take precedence over the labeling manufacturer instructions.

D. Administration of the telecommunications infrastructure includes documentation of cables, termination hardware, patching and cross-connection facilities, horizontal home-run conduits, inter-building stub-ups, cross-connections between equipment room-main distribution frames (ER-MDF), telecommunications rooms-intermediate distribution frames (TR-IDF), and other telecommunications spaces.

E. Installer will maintain accurate, up-to-date installation/construction drawings. At a minimum, the drawings will show all pathway locations and routing, configuration of telecommunications spaces including backboard and equipment rack configurations, and wiring details including identifier assignments.

F. Installer will provide a complete and accurate set of 'As-Built' drawings. The As-Built drawings will record the identifiers for major infrastructure components including; the intra- and inter-building pathways, spaces, work area (WA) telecommunications outlets (TO) and disseminate the applications; IP data and voice. Wifi, cameras, and alarms. These notations will not interfere with the drawings' special notes nor room numbers.

G. UNLV/NDE maintains a campus wide, repeatable labeling scheme for work area (WA) telecommunications outlets (TOs) and patch panels and the cabling at both ends:

"Work Area ID #" - "MDF/IDF ID #" - "Patch Panel (PP) ID #" - "Port ID #"

H. Labels to be installed in a neat and workmanlike manner. All methods of labeling that are not specifically described or indicated in the contract documents will be subject to the control and approval of UNLV/NDE.

I. UNLV/P&C to provide and be responsible for mounting telecommunication rooms or other telecommunication space's number plaques to the outside door entrances.

1.2 Scope of Work (SoW)

A. This Section includes the minimum requirements for the identification and labeling of the communications systems for the project as outlined in the bid documentation.

1.3 Related Documents and References

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".

B. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications*, 27 10 00; *Structured Cabling Hardware*, 27 13 00; *Communications Optical Fiber Backbone Cabling,* and 27 15 00; *Communications Copper Horizontal Cabling* includes the following:

1. Section 27 01 00; *Operation and Maintenance of Low-Voltage Communications Systems*
2. Section 27 05 26; *Grounding and Bonding*
3. Section 27 05 28; *Pathways for Communications Systems*
4. Section 27 05 40; *Modular Furniture Pathways and Poke-through Devices*
5. Section 27 05 43; *Underground Ducts and Raceways for Communications Systems*
6. Sections 27 10 20 .10 and .30; *Copper System Testing and Documentation*
7. Sections 27 10 20 .20 and .30; *Optical Fiber Cable Testing and Documentation*
8. Section 27 13 23 .01; *Intra-building Optical Fiber Backbone Cabling*
9. Section 27 13 23. 02; *Inter-building Optical Fiber Backbone Cabling*
10. Section 27 15 01 .13; *Communications Copper Horizontal Cabling Station Applications and POE*
11. Section 27 15 01 .19; *Data Communications Copper Horizontal Cabling*
12. Section 27 15 01 .20; *Wireless Data Communication Copper Horizontal Cabling*
13. Section 27 15 43; *Communications Work Area Faceplate/Telecommunications Outlets, Surface Mount Boxes, and Connectors*

C. Material and work specified to comply with the applicable requirements of the current revisions of the following:

1. Appendix A; *Codes, Standards, and Regulations*
2. Appendix B; *Abbreviations and Acronyms*
3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
4. Appendix D; *Rack Elevation and Room Sizing Drawings*

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

E. Identification and labeling will meet the requirements in this Section and adhere to the current versions and practices in:

1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)
2. BICSI *Information Technology Systems Installation Manual* (ITSIMM)
3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
4. ANSI/BICSI G1-17; ICT *Outside Plant Construction and Installation: General Practices*
5. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*

6. ANSI/TIA-568.3-E; *Commercial Building Telecommunications Cabling Standard Part 1: General Requirements*
7. ANSI/TIA-569-E; *Commercial Building Standard for Telecommunications Pathways and Spaces*
8. ANSI/TIA/TIA-606-D; *Administration Standard for Commercial Telecommunications Infrastructure*
9. ANSI TIA-758-B; *Customer-owned Outside Plant Telecommunications Cabling Standard*
10. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facilities, Including Addendum 1: Updated References Accommodation of New Media Types*
11. ISO/IEC 11801-1 4th Edition; *EN 50173-2: 2007 + A1: 2012 (CENELEC TC215); Information Technology - Generic*
12. UL 969A; *UL Standard for Safety and for Marking and Labeling Systems*

1.4 Contractor/Sub Qualifications and Responsibilities

A. The low voltage Contractor/Sub assigned project manager (PM) to have at a minimum a BICSI Registered Communications Distribution Designer (RCDD) certification and the on-site foreman/supervisor to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification.
B. UNLV/NDE preference is for the Contractor/Sub to assign the same one (1) or two (2) technicians to perform all the labeling throughout the project.
C. Contractor/Sub is to refer and have full understanding of the project drawings to confirm:
    1. Telecommunications Outlets (TO): Scaled drawings indicating location and proposed designation
    2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation
    3. Racks: Scaled drawings indicating location and proposed designation
    4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations
D. When appropriate and, if required in the contract Scope of Work (SoW), coordinate the installation of labels with other trades and the general contractor (GC).

1.5 Pre Bid Submittals

A. Product data documentation sheet for the labeling manufacturer(s) being used.
B. The style, size, and finishes of the labels to be used for each application inclusive of outside plant (OSP) and inside plant (ISP) premises.
C. If requested, samples for each application (preferably on a display board).

PART 2: PRODUCT

2.1 Performance Requirements

A. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, will comply with the current version of UL 969A.
B. Labels to be resistant to the environmental conditions at the point of installation for moisture, heat, wind, dust, and ultraviolet light.
C. Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*
D. Have a design life equal to or greater than five (5) to seven (7) years for both outside plant (OSP) and inside plant (ISP) premises applications.

2.2 Color and Legend Requirements

A. All labels will be machine-created labels, clearly legible, black letters on white background.
B. Identification labels or "identifiers" are required on, but not limited to, maintenance holes/vaults, TDUs, blown fiber (ABF) sheaths and microducts, pathways conduits, racks, (copper) modular patch panels, fiber optic enclosures and their related ports and cassettes, telecommunications outlets' (TO) windows, cable wrap-arounds, and busbars.

2.3 Labels

A. Self-Adhesive and Vinyl Wraparound Labels:
    1. Vinyl flexible labels with acrylic pressure-sensitive adhesive.
    2. To be UV, weather, and chemical-resistant sized so that the clear shield tail end overlaps the entire printed legend for protection.
    3. Nominal Sizes: ⅜ inch (10 mm) and ½ inch (12-14 mm).
B. Self-Adhesive Labels:
    1. Vinyl flexible labels with acrylic pressure-sensitive adhesive.
    2. To be UV, weather, and chemical-resistant sized and configured for intended use and location. Ensure that the clear shield tail end overlaps the entire printed legend for protection.
    3. Nominal Sizes: ⅜ ich (10 mm), ½ inch (12-14 mm), and ¾ inch (19 mm).

2.4 Snap-around Bands

A. Slit, pretensioned, flexible, acrylic sleeves, minimum two (2) inches (51 mm) long, with diameters sized to suit the diameters of raceway or cable they identify along with origin ID locations for both ends. Secured in place by gripping action and/or small cable ties.

2.5 Tags

A. Can be metal or high-density polyethylene (HDPE) orange-color plastic suitable for the environment and application.
B. Secured with tie-wraps onto the optical cable, blown fiber sheath, or innerduct.
C. The identification area to have a clear protective film or weather proof window to protect the print area.

2.6 Underground-Line warning Tape

A. Direct-burial, detectable-metallic warning tape to identify and locate underground communications utility lines conduits.
B. Printing on the metallic tape will be permanent and not be subject to damage by burial operations.
C. Tape material and ink to be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
D. Inscriptions to read "Caution Buried Communication Line Below" or the like to distinguish telecommunications pathways.
E. All tapes are printed on APWA approved colors (Orange for 'Communications') to meet or exceed industry standards.
F. Minimum 5-mil tape has aluminum backing to make it easy to find underground pathways using a non-ferrous locator.

2.7 Pull-boxes and Junction Boxes

A. To have the covers labeled in ½ inch (13 mm) or ¾ inch (19 mm) black on white self-adhesive tape "Telecommunications".

2.8 Vault(V) and Maintenance/Manhole(MH) Covers

A. Will be marked for easy identification ("Communications") and have a permanently attached metal label indicating the assigned number from UNLV/NDE.

PART 3: EXECUTION

3.1 Preparation

A. Before applying communications identification product labels, clean substrates of substances that would impair the bond, using materials and methods recommended by the manufacturer of identification products.

3.2 Visibility and Durability

A. The size, color, and contrast of all labels selected is to ensure that the identifiers are easily read. Labels to be visible during the installation of and normal maintenance of the infrastructure.
B. Labels are generally of either the adhesive or insert type. Labels to be legible, resistant to defacement, and maintain adhesion to the application surface for at least five (5) to seven (7) years.
C. Outside plant labels to be totally waterproof, even when submerged.
D. Other types of labels, including tie-on labels, may be used (e.g. corrugated innerduct).. However, the label is to be appropriate for the environment in which it is used and to be used in the manner intended by the manufacturer.
E. Handwritten labels or the use of masking tape for permanent applications are NOT acceptable.

3.3 Label Installation Guidelines

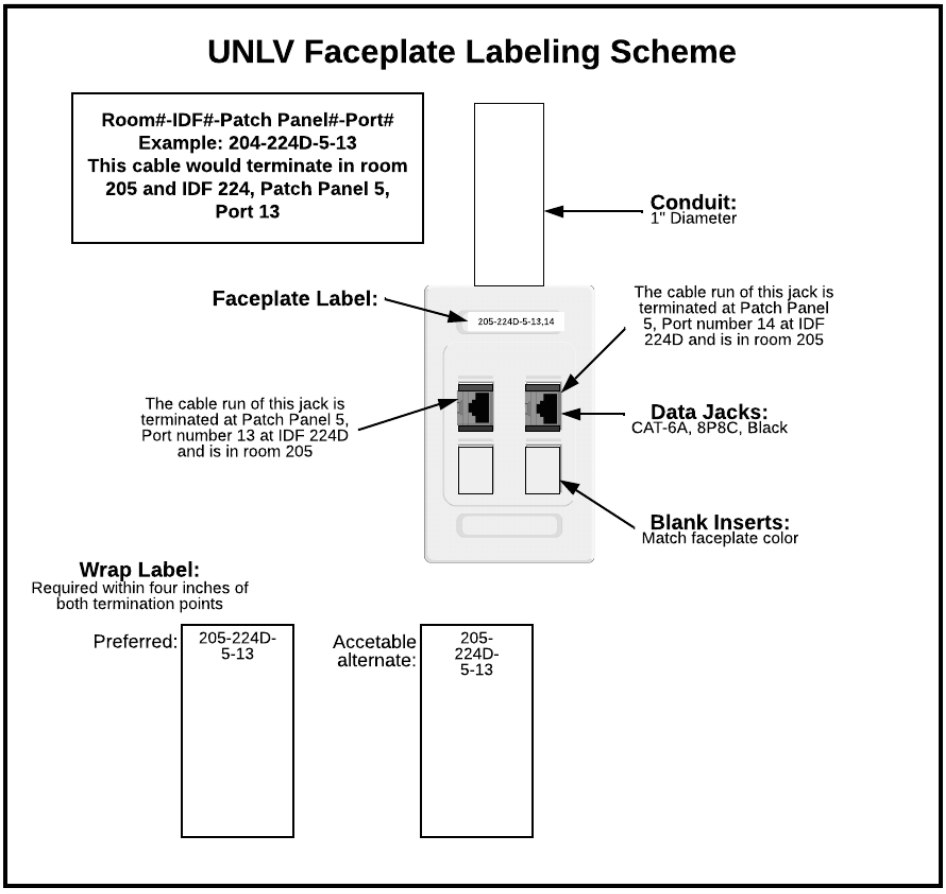
A. Install identifying labels before installing acoustical ceilings and similar concealment.
B. Verify the identity of each item before installing identification products by correlating with the project drawings.
C. Self-Adhesive and Vinyl Wraparound Labels:
    1. Secure tight to the surface at a location having high visibility and accessibility.
    2. Provide labels within four (4) inches (102 mm) from the cable end.
D. Self-Adhesive and Insertion Labels:
    1. Each item of the structured cabling system (SCS) will have its own unique designation label that is consistent with the wiring diagrams.
    2. ⅜ inch (10 mm) wide insertion-style labels width to be able to fit behind the telecommunications outlets (TO) plastic windows and for some window-equipped modular patch panels labeling - do not cover the patch panel port IDs.
    3. Typically, ⅜ inch (10 mm) wide self-adhesive labels used for patch panel port identification.
    4. Any patch panel port, telecommunications outlet (TO) port as well as the cabling run between both terminations to have:
       "Work Area ID #" - “MDF/IDF ID #” - “Patch Panel (PP) ID #” - “Port ID #”
    5. ½ inch (12-14 mm) wide labels for designation ID on patch panels, enclosures, busbars and TDUs.
    6. ¾ inch (19 mm) wide labels for racks, cabinets, pathways, and busbars.
E. Snap-Around Bands:
    1. Secure tight to surface at a location with high visibility and accessibility.
    2. Provide labels within six (6) inches (152 mm) from the cable end outside the TDU..
F. Tags:
    1. Tie-wrap labels or tags permissible on innerduct and separation of cable bundles.
    2. Plenum rating applies in plenum-rated environments.
G. Underground-Line Warning Tape:
    1. During backfilling of trenches, install continuous underground-line warning tape placed 18 inches (457 mm) directly above cable inside 4-inch HDPE piping/conduit. At a three (3) ft. (914 mm) freezeline, this equates to being 18 inches (457 mm) below finished grade.
    2. Use multiple tapes where the width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches width (400 mm) overall.
    3. For other smaller size buried raceways having copper inside (e.g. WiFi bollards), “Warning Tape” is not required.

3.4 Identification Schedule

A. Install identification materials and labels at locations for convenient viewing without interference with operation and maintenance of equipment.
B. Each permanent link is assigned a unique ‘identification number’ or ‘ identifier’;
       "Work Area ID #" - “MDF/IDF ID #” - “Patch Panel (PP) ID #” - “Port ID #”
C. By definition, copper UTP cabling identifiers are only applied to the intra-building premises “permanent link”; this consists of labeling within four (4) inches (102 mm) on both horizontal

Category 6 or 6A, 4-pair cables terminated onto the RJ-45/110 jacks of both the modular patch panel and the work area (WA) telecommunications outlet (TO) ports.

D. Thus, the modular patch panel identifier labeling system will clearly identify all components of the horizontal structured cabling system (SCS):
    1. The labeling system will designate the cable's origin and destination.
    2. Station identifiers will match the corresponding patch panel port number for each drop.
    3. The drops will be in consecutive order whenever possible.
    4. The labeling scheme is to be used for test documentation and coincide port-to-port with the As-Built drawings.
E. Identify covers of junction and pull boxes with 1/2 inch (17 mm) or ¾ inch (19 mm) self-adhesive labels containing wiring system legend; “Telecommunications”.
F. 4-port wall plate/faceplate; or commonly referred to as Telecommunication Outlet (TO) ‘station labels’:
    1. Incorporate upper and lower clear plastic windows and be provided by the same manufacturer. Tinted or smoke color windows are not acceptable.
    2. The label will follow the format listed in Section 27 05 53 Fig 1: *UNLV Faceplate Labeling Scheme*. The top label includes both top ports e.g. "205-244D-5-13,14".
    3. The first patch panel port number will always be the top left faceplate port and the second patch panel port number will always be the top right faceplate port.
    4. Strive to have a labeling sequence with the odd number in the upper left corner (e.g. “13”) and the even number in the upper right corner (“14”).
    5. The bottom label will follow the same guidelines when used. When unused, the label will be left blank. The font size will be the largest size that fits the required information but no smaller than 10-point font.

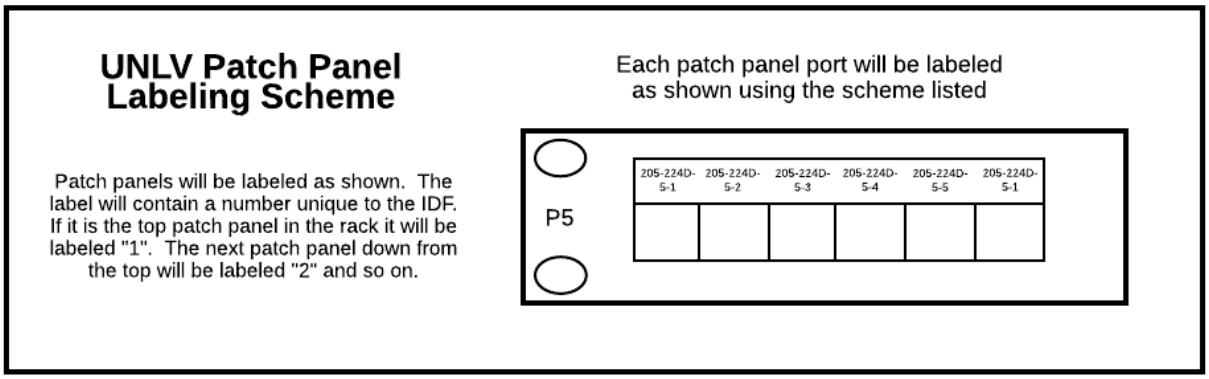


27 05 53 Fig 1: *UNLV Faceplate Labeling Scheme*

G. Equipment Room-Main Distribution Frame (ER-MDF) and Telecommunications Room-Intermediate Distribution Frame (TR-IDF) copper modular patch panels' identifiers will be labeled by the installer on the left side of the patch panel centered between the RU mounting holes/slots. Alternatively, optical fiber (standard and ABF) blown fiber enclosures to be labeled and centered on the outside left side corner of the door:
   1. Counting from the top of the rack down, the first installed patch panel/enclosure will be identified with the number "P1", the second with the number "P2", "P3", "P4" and so forth.
   2. Note: Between any two or more copper modular patch panels install a 1 RU horizontal wire manager.
   3. If continuing to a second rack (facing right), maintain the sequence to "P5", "P6" and so forth.
   4. Counting from the top of the rack down, the first installed optical fiber enclosure will be identified with the number "F1", the second with the number "F2", "F3", "F4" and so forth. Optical fiber enclosures are to be labeled front and rear.
   5. Use ½ inch (12 mm - 14mm) wide labels for both modular patch panels and optical fiber enclosures..

H. The modular patch panel port identifier labels to be in the format listed in Section 27 05 53 Fig 2: *UNLV Patch Panel Labeling Scheme* "205-224D-5-1":

1. Space limitations may require the ⅜ inch (10 mm) label to be in two rows.
    a. The top row designates the room ID # and ER-MDF/TR- IDF#
    b. The second row the patch panel #P and port #
2. The font size will be the largest size that fits the required information, but no smaller than 8-point font.
3. These labels to be center-justified and located directly above the port they are labeling or in other manufacturer-provided locations for port labels. Do not cover the patch panel printed port numbers.



27 05 53 Fig 2: *UNLV Patch Panel Labeling Scheme*

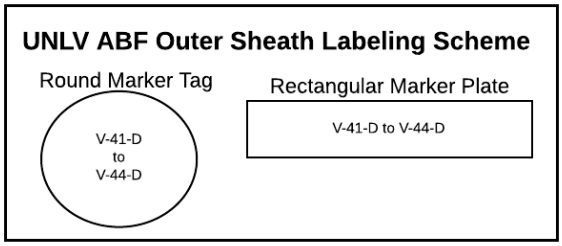
I. Cable wrap identifier labels are to be secured on the rear of the modular patch panels and faceplates and are required within four (4) inches (102 mm) of the cable's termination point at both ends:
    1. Cable wrap labels will follow the format listed in **27 05 53** Fig 1: *UNLV Faceplate Labeling Scheme*; e.g.. "205-224D-5-13"
    2. Splitting this into two lines is acceptable in which case "205-224D" would go on the first line and "5-13" would go on the second line.
    3. Use ⅜ inch (10 mm) wide labels. Flag labels are not acceptable.
    4. The font size will be optimized to fit the required information, but no smaller than 8-point font.

J. The only conduit systems that need identifiers are:
    1. Inter-building 4-inch (102 mm) HDPE piping/conduit stub-ups in the entrance facility (EF) or equipment room-main distribution frame (ER_MDF) designating their “to and from origin including any maintenance holes (MH)/manholes, vaults (V), and pedestals or the ‘hops’ in between”.
    2. ‘Home run’ dedicated conduit runs of any size between other telecommunication rooms-intermediate distribution frames (TRs-IDFs) and horizontal work area (WA) outlets. "Designate their to and from origin”.

K. Unless noted in the project specifications and/or drawings, all other intra-building pathways are exempt from having identifiers.

L. outside plant (OSP) ABF blown fiber cabling identifiers to be clearly marked using machine-printed labels able to withstand the environmental elements.

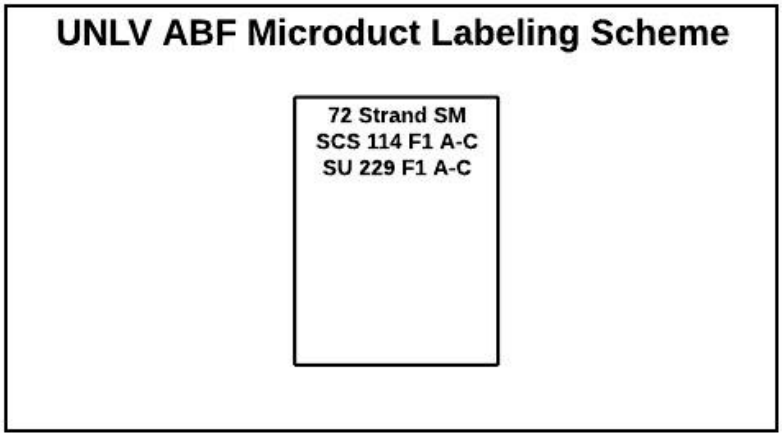
M. The marker plate identifier for outside plant (OSP) HDPE air-blown fiber outer sheath (ABF) outside the TDU in a vault or maintenance hole (see 27 05 53 Fig 3: *UNLV ABF Outer Sheath Labeling Scheme*):
   1. Minimum 1"x 3" (25 mm x 77 mm) in size and be made of a material able to withstand environmental conditions (e.g., extreme heat, underwater, wind, dirt, and dust).
   2. Can be made of stamped metal or a plastic type tag with a self- laminating water-proof cover for use with pre-printed labels and attached with a plastic tie wrap.
   3. The marker plate is to be placed approximately 12 inches (305 mm) outside from the outer sheath entry side into the TDU.
   4. The marker plate label will be in the format of V-41-D to V-44-D; where V stands for vault, MH for maintenance hole, and 41 is the previous vault number whereas 44 is the next vault number.
   5. The marker plate is to be placed approximately 12 inches (305 mm) outside from the outer sheath exit side from the TDU and secured with tie-wraps.
   6. The marker plate label will be in the format of V-44-D to MH-45-D; where V stands for (the existing) vault #44 and MH stands for next maintenance hole, #45 location number.
   7. Note: This latter exit label may also indicate the run being routed into the building's ER-MDF/TR-IDF) room number where the ABF blown fiber will be terminated.
   8. The letter D shows which section of campus the vault is located in.



27 05 53 Fig 3: *UNLV ABF Outer Sheath Labeling Scheme*

N. The marker plate identifier for inside plant (ISP) premises HDPE air-blown fiber outer sheath (ABF) entering the TDU located inside the ER-MDF/TR-IDF:
   1. Minimum 1"x 3" (25 mm x 77 mm) in size and be made of a material able to withstand environmental conditions (e.g., extreme heat, underwater, wind, and dirt/dust).
   2. Can be made of stamped metal or a plastic type tag with a self- laminating cover for use with pre-printed labels and attached with a plastic tie wrap.
   3. The marker plate is to be placed approximately 12 inches (305 mm) outside of the sheath from the entry into the TDU and secured with tie-wraps.
   4. The marker plate label will be in the format of MH-45-D; where V stands for vault, MH for maintenance hole, and 45 is the last OSP vault/maintenance hole number TDU.
   5. The letter D shows which section of campus the vault is located in.
   6. Note: The microducts inside will then be broken out from the sheath inside the wall-mounted TDU, labeled, exit the TDU on the opposite side, placed in orange (minimum 1 ¼ inch (32 mm)) corrugated innerduct, and routed to the optical fiber enclosure.

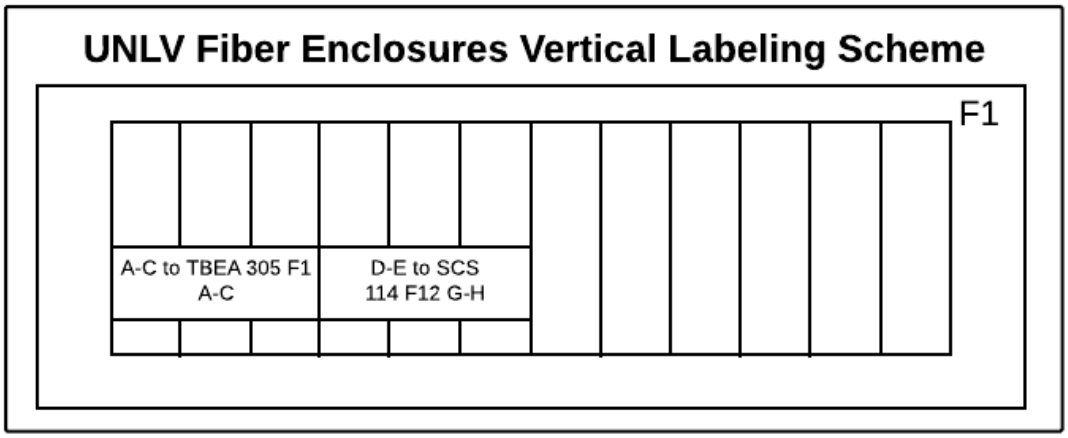
O. The individual microducts identifier inside the TDU (see **27 05 53** Fig 4: *UNLV ABF Microduct Labeling Scheme*):
   1. Use 3/4 inch (19 mm) wide label tape. Flag labels are not acceptable.
   2. Installer to label within six (6) inches (152 mm) the microduct(s) leaving the ABF outer sheath inside the TDU.
   3. The label is to be three lines;
      a. The The first line (line #1) displays the number of strands and type of fiber (UNLV/NDE specifies only OS2 single-mode)
      b. The second line to show the origin for this microduct
      c. The third line to show the destination for the microduct
   4. The enclosure information (lines #2 and #3) is in the following format:
      a. SCS 114 F1 A-C; where SCS is the building name
      b. 114 is the room the enclosure is located
      c. F1 is the enclosure number
      d. A-C are the enclosure cassette slots the strands are located in.
   5. The labeling scheme is to be used for test documentation and coincide port-to-port with the As-Built drawings.



27 05 53 Fig 4: *UNLV ABF Microduct Labeling Scheme*

P. Optical fiber termination and labeling identifiers inside the optical fiber enclosure:
   1. Optical fiber enclosures hinged metal or smoked plexiglass front access doors have various features that allow the placement of the cassette termination summary spreadsheet to be housed in a slot, affixed, or adhered to the inside of the hinged door.
   2. Label each blown fiber microduct with a self-adhesive wraparound 3/4 inch (19 mm) label indicating the origin location of the backbone cable:
      Row 1: "Bldg abbreviated name and room #"
      Row 2: "Fiber enclosure # and cassette letter"
      Row 3: "Type of optical fiber or SMF and # of strands"
   3. Fiber strand numbering to be consistent with the Consecutive Fiber Numbering (CFN) polarity sequence as identified in the latest version of ANSI/TIA 568.1-E. This fiber stand numbering sequence between each fiber link will be adhered to at each terminated end of the optical fiber cable; straight-thru termination 1-1, 2-2, 3-3 and so forth only. The rolling of fiber optic strands 1-2,2-1, 3-4, 4-3 is not acceptable.

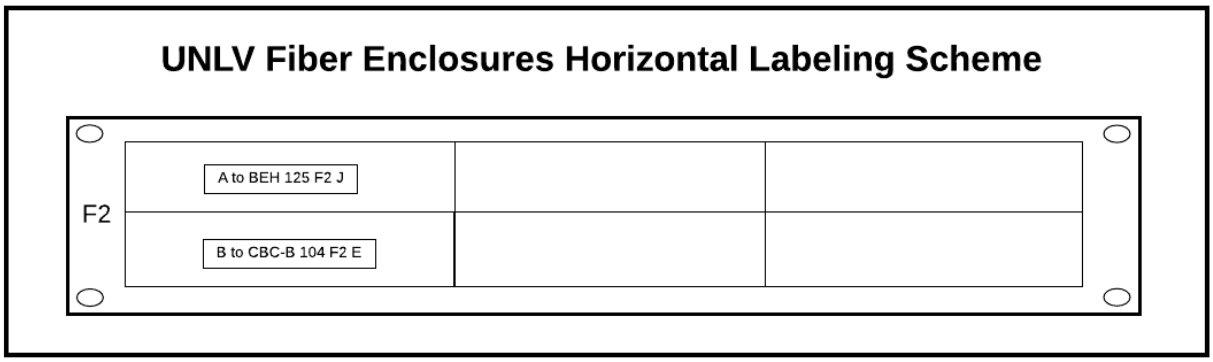
Q. Optical fiber enclosures labeling with vertically-mounted cassettes (See Section 27 05 53 Fig 5: *UNLV Fiber Enclosures Vertical Labeling System*):
   1. UNLV has standardized on optical fiber cassettes with pigtails for fusion splicing and not adapter plates.
   2. Fiber strand number #1 (blue) to occupy fiber port number #1; located in the upper most left position of the first duplex cassette.
   3. Fiber strand number #2 (orange) to occupy fiber port number #2 of the same LC duplex bulkhead on the same cassette. This number #2 port is immediate right of fiber port number #1 facing the front of the housing.
   4. Accordingly, the first "A" cassette in an optical fiber enclosure, in turn, is installed and labeled in the first slot on the left side facing the front of the housing. This first cassette contains fibers strands #1-24 having a row of 12 each duplex (LC) connectors.
   5. Note: from the rear view all is the opposite having cassette "A" on the far right and the port # 1 is the top right position.
   6. Each subsequent cassette will be alpha-sequence left-to-right with the next cassette labeled as "B" (fibers #25-48), the next "C' (Fibers #49-72) and so forth.
   7. For this example; the first 72-strand microduct terminates onto 24F cassettes "A", "B" and "C".



27 05 53 Fig 5: *UNLV Fiber Enclosures Vertical Labeling System*

R. Optical fiber enclosures labeling with horizontally-mounted cassettes (**27 05 53** Fig 6: *UNLV Fiber Enclosures Horizontal Labeling Scheme*):
   1. UNLV has standardized on optical fiber cassettes with pigtails for fusion splicing and not adapter plates.
   2. Fiber strand number #1 (blue) to occupy fiber port number #1; located in the upper most left top position of the first duplex cassette. This "A" cassette, in turn, is labeled and installed in the first top slot on the left side facing the front of the housing.
   3. Note: from the rear view the number 1 cassette is on the far right and the port #1 is the top right position.
   4. Fiber strand number #2 (orange) to occupy fiber port number #2 of the same LC duplex cassette. This number #2 port is immediately below fiber port number #1 facing the front of the housing.
   5. Notice that when comparing the vertical to the horizontally-mounted cassettes the #1 and #2 ports are flipped. Pay special attention if cross-connecting one to the other.

6. Notice that most manufacturers' cassettes maintain the same sequence with the vertical sequence as the master. If mounted horizontally, the "A" cassette will be mounted the same in the top left slot, however #1 (blue) port is below (not above) #2 port (orange).



27 05 53 Fig 6: *UNLV Fiber Enclosures Horizontal Labeling Scheme*

S. Optical splice shelf labeling:
   1. Mid-span splicing of any optical fiber on the UNLV campuses is not acceptable except for temporary emergency repairs. The only splicing permitted is the termination of fiber runs to the 12F/24F cassettes' pigtails mounted inside the optical fiber enclosures.

T. Busbars:
   1. Primary four inch (102 MM) height Busbars (PBB)-Telecommunications Main Grounding Busbar (TMGB) label with Equipment Room (ER)-Main Distribution Frame (MDF) room number; e.g. "PBB-TMGB for ER-MDF 101" or "TMGB for MDF 101"
   2. Secondary two inch (51 mm) Busbars (SBB)/Telecommunications Grounding Busbar label with Telecommunications Room (TR)-Intermediate Distribution Frame (MDF) room number; e.g. "SBB-TGB for TR-IDF 212" or "TGB for IDF 212"
   3. Busbar labeling to be highlighted on Electrical Drawings' As-Builts for each telecom room.

U. "Warning" (e.g. "Lasers") labels for indoor and outdoor cabinets, boxes, and enclosures:
   1. Clean substrate and use self-adhesive labels supplied by the manufacturer.
   2. Apply to the exterior of the door, cover, or other access.

V. Vault(V) and Maintenance Hole (MH)
   1. Ensure the covers are marked ("Communications"). Confirm first with UNLV/NDE and then permanently attach the metal label indicating the assigned number.

W. Indoor and outdoor manufacturer equipment identification labels; clean substrate, locate and use self-adhesive labels by the manufacturer's instructions.

3.5 Cleaning

A. Contractor/Sub to practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas.

3.6 Examination and Acceptance

A. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM will notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.7 Close-out Submittals

A. None are required except for visual inspection to ensure proper labels are used and identifiers content correct.

SECTION 27 05 00: COMMON WORK RESULTS FOR COMMUNICATIONS

——— End of Section 27 05 53 ———

Identification for Communication Systems

SECTION 27 10 00

STRUCTURED CABLING HARDWARE

Sections 27 10 20 .10 and .30

Copper System Testing and Documentation

PART 1: GENERAL

1.1 Summary

A. This Section presents the requirements for post-installation performance copper system testing and documentation, As-Built drawing documentation, warranty submittals, and acceptance by UNLV/NDE.

B. The Contractor/Sub is to provide all labor, materials, and equipment execution requirements required for the complete and proper installation of *Copper System Testing and Documentation* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).

C. Contractor/Sub to survey the work areas and provide all labor, materials, tools, field-test instruments and equipment required for the complete testing as called for in the project specifications and contract scope of Work (SoW).

D. In addition to the tests detailed in this document, the Contractor/Sub is to notify UNLV/NDE of any additional tests that are deemed necessary to guarantee a fully functional system. The Contractor/Sub is to carry out and record any additional measurement results at no additional charge to UNLV.

E. Certification tests are used to verify that the ICT structured cabling system (SCS) cabling system meets the transmission performance requirements of the cable/connector manufacturer as specified in the applicable standards and pre-bid submittal documentation.

F. Contractor/Sub to provide complete end-to-end testing for the awarded copper structured cabling system (SCS) based on the latest document standards and references.

G. First phase of testing documentation will have all tests in numerical order, separated by the assigned telecommunication rooms.

H. All test results to be available in both the PDF and the native tester manufacturer software and sent electronically. Test results to coincide port-to-port with As-Builts drawings.

I. Any concerns on a punch list test results documentation will need to be corrected before final submittals.

J. Second phase of the final testing submittal package will include final test documentation, As-Built drawings in AutoCAD .dwg format, the Contractor/Sub one (1) year parts and labor warranty, and the cable/connector manufacturer's 25-year warranty documentation identifying the particular project.

K. Testers to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.

1.2 Scope of Work (SoW)

A. This Section presents the requirements for post-installation performance testing and documentation, As-Built drawing documentation, and manufacturer warranties.
B. Final acceptance by UNLV/NDE is subject to the installation being complete in final walk-through, receipt of required final test adjustments to Computer Aided Designs (AutoCAD in .dwg format.) As-Built drawings and warranty submittals.

1.3 Related Documents and References

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".
B. In particular, the subsections of the master Division 27 00 00; *Communications Design Guidelines*, 27 11 00; *Communications Equipment Room Fittings,* and 27 15 00; *Communications Copper Horizontal Cabling* includes the following:
    1. Section 27 01 00; *Operation and Maintenance of Low-Voltage Communications Systems*
    2. Section 27 11 19; *Communications Copper Modular Patch Panels*
    3. Section 27 15 01 .13; *Communications Copper Horizontal Cabling Station Applications and POE*
    4. Section 27 15 01 .19; *Data Communications Copper Horizontal Cabling*
    5. Section 27 15 01 .20; *Wireless Data Communication Copper Horizontal Cabling*
    6. Section 27 15 43 .10; *Communications Copper Jack Information Outlets and Connectors*
    7. Section 27 15 43 .15; *Communications Fiber Connectors and Cassettes*
    8. Section 27 15 43 .25; *Work Area Faceplates/Wall Plates and Surface Mount Boxes*
C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
    1. Appendix A; *Codes, Standards, and Regulations*
    2. Appendix B; *Abbreviations and Acronyms*
    3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
    4. Appendix D; *Rack Elevation and Room Sizing Drawings*
D. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification, apply to this Section.
E. Testing copper UTP systems will meet the requirements in this Section and adhere to the current versions and practices of the:
    1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)
    2. BICSI *Information Transport Systems Installation Methods Manual* (ITSIMM)
    3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
    4. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*
    5. ANSI/TIA 568.1: *Commercial Building Telecommunications Standard, Part 1: General Requirements*
    6. ANSI/TIA 568.2: *Commercial Building telecommunications Standard, Part 2: Balanced Twisted-pair Cabling*
    7. ANSI TIA-758-B; *Customer-owned Outside Plant Telecommunications Cabling Standard*

8. ANSI/TIA-1152-A; *Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling*
9. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facilities*
10. ANSI/ICEA S-102-732-2009; *Standard for Cat 6 and 6A; 100 ohm Individually Unshielded Twisted-pair Indoor Cables - Incorporated into ANSI/TIA 568.2*
11. IEC 61935-1; *Specifications for the Testing of Balanced Twisted-pair and Coaxial Information Technology Cabling*
12. IEEE 802.3; *IEEE Standard for Ethernet*
13. IEEE 802.11; *IEEE Wireless Local Area Networks Working Group*
14. NFPA-70 *National Electric Code* (Publication year determined by AHJ)
15. NEC Article 720; *Circuits and Equipment Operating at Less Than 50 Volts*
16. TSB 155A; *Guideline for the Assessment Migration of Installed Cat 6 to Support 10GBase-T*
17. UL 910; *UL Standard for Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical Fiber Cables Used in Spaces Transporting Environmental Air*

1.4 Contractor/Sub Qualifications and Responsibilities

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.

B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).

C. UNLV/NDE preference is for the Contractor/Sub to assign the same two (2) or three (3) technicians to perform all the copper testing throughout the project.

D. It is preferable that the Contractor/Sub show proof of being trained and certified by the UNLV approved tester manufacturer.

E. At least one member of the testing team to be cable/connector manufacturer and BICSI certified at all times.

F. Contractor/Sub is to refer and have full understanding of the project drawings to confirm:
   1. Telecommunications Outlets (TO): Scaled drawings indicating location and proposed designation
   2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation
   3. Racks: Scaled elevation drawings indicating location and proposed designation
   4. Patch Panels: Enlarged scaled elevation drawings showing rack row, number, and proposed designations

G. When appropriate coordinate testing with other trades and the general contractor (GC).

1.5 Copper UTP Testing Criteria; Permanent Link

A. By definition, UNLV copper 100-ohm balanced 23-24 AWG UTP 4-pair testing will only be performed on:
   1. The inside plant (ISP) premises “permanent link” cabling always to have a plenum (CMP) fire-rating.
   2. The outside plant (OSP) “permanent link” which always needs to have an outdoor rated cabling.

B. The permanent link consists of one (1) of two (2) horizontal Category 6 or 6A, 4-pair cable terminated onto the RJ-45/110 jacks ports (568B wiring) at both the modular patch panel and the work area (WA) telecommunications outlet (TO).

C. Cat 6/Class E to be tested at 250 MHz and Cat 6A/Class EA at 500 MHz.

D. Maximum length is not to exceed 295 ft (90 meters).

E. Channel testing with patch cords 328 ft (100 meters) is non-applicable unless required in the specifications by the cable manufacturer..

F. Backbone/riser multi-pair testing is non-applicable.

G. Other categories of cable whether UTP, STP, FTP, and ScTP including Cat 3, Cat 5, Cat 5e and Cat 7 are non-applicable.

H. Each permanent link is assigned a unique ‘identification number’ or ‘ identifier’;
   1. “Room # ID” - “ER-MDF/TR-IDF #ID” - “Patch Panel # ID” - “Port #ID”
   2. Or, if required, a custom identifier for special applications (e.g. bollards WiFi)

I. Manufacturer warranty documentation and AutoCAD in .dwg format files to follow UNLV RCDD approved test results and redline As-Builts within 30 days of final submittals.

J. The mechanical performance of a permanent link is only achieved through the use of compliant components.

K. This criteria does not apply to hybrid DC power/optical fiber cables nor GPON architecture.

1.6 Pre-bid Submittals

A. Manufacturer product data sheet documentation with compliance to industry testing standards and proof of calibration for the particular tester(s) being used.

B. A copy of or reference guide from the tester manufacturer’s testing procedure for each of the structured cabling system (SCS) elements required for the project.

C. Show proof that at least one (1) member of the testing team is both cable/connector manufacturer and BICSI certified.

PART 2: PRODUCT

2.1 Performance Requirements

A. Tester manufacturer to be UL Listed and ISO 9000/9001 registered and be RoHS 2011/65/EU compliant.

B. Copper UTP certification tester to be in conformance to the current versions of ANSI/TIA 1152 (and IEC 61935-1) Level IIIe @ 500 MHz.

C. This ensures compliance with the current version of ANSI/TIA 568.2-D Cat 6/Class E (250 MHz) and Cat 6A/Class EA (500 MHz) as well as ISO/IEC 11801-1 parameters.

D. Any Level IIIe balanced twisted-pair field testers will be factory calibrated each calendar year - or years - as stipulated by the field tester equipment manufacturer.
E. The tester and all related testing components/test reference cords (TLCs) are to be in current calibration, firmware updated, and all components be of high-quality condition. Proof of compliance can be documented with a hard copy certificate prior to the start of testing or found in preliminary test results.
F. Multiple testers are encouraged. However, do not mix different manufacturers for the same copper UTP tests.

PART 3: EXECUTION

3.1 Summary

A. Testing to not interfere with the construction operations of other trades.
B. Main and remote devices to be synchronized and fully charged when testing begins.
C. Contractor/Sub to verify each cable run is assembled, installed, terminated, labeled, and is usable per industry best-practices prior to testing. Any testing performed on incomplete systems to be redone on completion of the work.
D. Cabling installation in telecommunications rooms to be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.
E. Note: even if a cable installation run passes the tests, UNLV/NDE may fail the cable run when an inspection/audit is conducted and found the cable run is not properly routed or supported. Any defects in cabling system installation will be repaired or replaced to ensure one hundred percent (100%) usable condition at no additional cost to UNLV.
F. After submittal of test result documentation and the associated As-Built drawings, UNLV will have the option to randomly pick five percent (5%) of the submitted cable plant installation for re-test. If more than two percent (2%) of the sample results differ in terms of the PASS/fail determination, the installation Contractor/Sub under supervision of the representative to repeat one hundred percent (100%) testing at no cost to UNLV.

3.2 Copper UTP Examination and Acceptance Testing Parameters

A. Polarity testing can be accomplished using a continuity tester for; continuity, opens, shorts, ground faults, crossed or reversed pairs. Full polarity documentation to be provided on Level IIIe testers or higher.
B. The frequency criteria for testing with a Level IIIe tester per ANSI/TIA 568.3-D for Cat 6/Class E is 250 MHz and Cat 6A/Class EA at 500 MHz.
C. Main and remote devices to be synchronized and fully charged when testing begins.
D. Set-up will include but not default to using only the current version of the ANSI/TIA 568 standards.
E. Test settings selected from the Options menu provided in the field testers will be compatible with the installed cable/connector manufacturer cable part number(s) under test. Note: This is particularly important for having the proper Nominal Velocity of Propagation (NVP) to accurately determine the proper length of cable.
F. Ensure that the DC loop resistance test is turned on as the ohms result can be used to determine support for PoE (max .2 ohms skew).

G. If testing for FTP/ScTP, the 14th test includes foil/ground wire continuity end-to-end.

H. Tester setup will include IEEE 'Compliant Network Standards' for:

1. Cat 6/Class E: 1GBase-T/802.3ab
2. Cat 6A/Class EA: 10GBase-T/802.3an

I. When testing for Wireless Access Points (WAPs) PoE ensure the tester is programmed for what is specified in the contract Scope of Work:

1. IEEE 802.3af PoE Type 1 (15.4W)
2. IEEE 802.3at PoE+ Type 2 (25.5W)
3. IEEE 802.3bt PoE++ Type 3 (60.0W)
4. IEEE 802.3bt PoE++ Type 4 (90 W)

J. When a certification test is operated in the autotest mode, one-hundred percent (100%) of the following parameters to PASS;

1. Continuity or **'wiremap**' check tests for opens, shorts, crossed and reversed pairs. Any discrepancies to be corrected before system testing is to continue. (plus screen/shield if present)
2. **Insertion loss**
3. **Length** (dependent on the NVP value)
4. **NEXT** loss measured from near-end
5. **NEXT** loss measured from far-end (formerly FEXT)
6. Power-sum near-end crosstalk (PSNEXT) loss measured from near-end
7. PSNEXT loss measure from far-end
8. Attenuation to crosstalk ratio from far-end (ACRF)
9. Power sum attenuation to crosstalk ratio far-end (PSACRF)
10. **Return loss**, measured from near -end
11. **Return loss**, measured from far-end
12. Propagation delay
13. Propagation delay skew
14. DC Loop resistance

Note: Those tests in **bold** are installation specific.

K. Test results to be submitted electronically in both PDF and native tester manufacturer software format. No hard copies.

L. No other test or equipment requirements are required for copper UTP permanent link testing compliance besides the Level IIIe certification test equipment.

M. UNLV/NDE reserves the right to inspect the Contractor/Sub's tester Set-up mode at any time to ensure compliance with the test parameters of this Section.

N. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM will notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.3 Cleaning

A. Contractor/Sub to practice good “sweep clean” housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas.
B. Once the telecommunication rooms are complete with terminated modular patch panels yet still be exposed to sanding, dust and debris, the Contractor/Sub is to use painter's blue tape or equivalent to cover the patch panel ports at no additional cost to UNLV/NDE. Only UNLV/NDE will remove the tape when cutover begins.

3.4 Close-out Submittals and Documentation

A. Test documentation
    1. Test results - based upon the cable/connector manufacturer part numbers and NVP - will be downloaded directly from the test unit or from a download file using an application from the test equipment manufacturer.
    2. Test results to be provided in both PDF and native tester manufacturer software format.
    3. Tests files to be sorted by ER-MDF/TR-IDF and in numerical order. And, test results match up port-to-port with As-Built drawings.
    4. Test results to include the minimum application of:
       Cat 6/Class E 1GBase-T per IEEE 802.3ab
       Cat 6A/Class EA 10GBase-T per IEEE 802.3an
    5. Within 30 days of the substantial completion of the project or prior to project closeout -- whichever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub’s one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.
    6. Electronic format copies only required. No hard copies
B. “Copper As-Built Drawings” - separate from “Optical Fiber As-Built Drawings”
    1. First phase in PDF format to compare test documentation port-to-port to PDF As-Built.
    2. PDF As-Builts to be on UNLV-provided floorplan sized to “E1” 30 X 42 inches (762 x 1067 mm).
    3. Electronic format copies only required. No hard copies
    4. “As-Built Data”: Identify all telecommunication outlets (TOs) by cable room number. Include cable pathways of; conduit > 2.0 inches (51 mm), pull boxes/junction boxes, cable trays routes and sizes, plus the telecommunication room’s layouts of racks, cabinets, and TDUs orientation.
    5. “As-Built Wifi/Security”; Identify all WiFi wireless access points (WAPs) plus security and test designated camera locations. Reference locations like “As-Built Data”.
    6. Use the appropriate symbol for each application from the project’s drawing symbol legend.
    7. Each permanent link address is assigned a unique ‘identification number’ or ‘ identifier’;
       "Work Area ID #” - “MDF/IDF ID #” - “Patch Panel (PP) ID #” - “Port ID #”
    8. When room on the As-Built drawings permits, the identifiers to first be listed on outside of the building’s perimeter, ‘boxed in’ with a red arrow pointing to the designated work area telecommunications outlet (TO). At no time is it to block the drawing’s room

number. Only when the port address listing is too congested on the outside perimeter of the building can they be listed within the building's inside perimeter.

9. Busbars labeling and location on the Electrical As-Built drawings.
10. Second phase is Computer Aided Design (AutoCAD in .dwg format) based upon UNLV provided drawings. Contractor/Sub to use the legend provided in the UNLV AutoCAD in .dwg format drawing for layered documentation to separate Data, Wifi/Security, and Pathways. Also used as a reference for scale.
11. Any AutoCAD in .dwg format to show conduit inter-building or intra-building > 2 inches (51 mm) to also be identified and labeled to their origin.
12. Electronic format copies only required. No hard copies

C. Warranty

1. Manufacturer warranty documentation specifying the project location
2. Provide conditions for maximum percentage of moves, adds, and changes (MACs)

SECTION 27 10 00: STRUCTURED CABLING HARDWARE

——— End of Sections 27 10 20 .10 and .30 ———

Copper System Testing and Documentation

SECTION 27 10 00

STRUCTURED CABLING HARDWARE

Sections 27 10 20 .20 and .30

Optical Fiber Cable Testing and Documentation

PART 1: GENERAL

1.1 Summary

A. This Section is specific to optical fiber cable testing and documentation. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for optical fiber cable testing and documentation.

B. The Contractor/Sub is to provide all labor, materials, and equipment execution requirements required for the complete and proper installation of *Optical Fiber Cable Testing and Documentation* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).

C. This document describes the equipment and to properly test and document optical fiber cabling systems.

D. In addition to the tests detailed in this document, the Contractor/Sub is to notify UNLV/NDE of any additional tests that are deemed necessary to guarantee a fully functional system. The Contractor/Sub is to carry out and record any additional measurement results at no additional charge to UNLV.

E. Certification tests are used to verify that the optical fiber cabling in ICT cabling structured cabling system (SCS) meets the transmission performance requirements of the cable/connect manufacturer as specified in the applicable standards and pre-bid submittal documentation.

F. At UNlV, the required certification test is Tier 1 testing using an optical loss test kit or OLTS; a 'combined' optical power meter and light source. One is required at both ends of the fiber segment being tested.

G. Certification testing requires dual wavelength (1310 nm and 1550 nm) and bi-drectionally.

H. Project specifications may require Tier 2 testing - which includes Tier 1 OLTS - to characterize and troubleshoot the signal profile using an optical time domain reflectometer or OTDR.

I. Contractor/Sub to provide complete end-to-end testing for the awarded optical fiber structured cabling system (SCS) based on the latest related document standards and references.

J. First phase of testing documentation will have all tests in numerical order:
    1. Inter-building test results will be separated by the buildings name
    2. Intra-building test results will be separated by the telecommunications rooms.

K. All test results to be in both PDF and native tester manufacturer software format and sent electronically. Test results to coincide port-to-port later with As-Builts drawings.

L. Any concerns on a punch list test results documentation will need to be corrected before final submittals.

M. Second phase of the final testing submittal package will include final test documentation, As-Built drawings in AutoCAD .dwg format, and cable/connector 25-year warranty documentation identifying the particular project.

1.2 Scope of Work (SoW)

A. This Section presents the requirements for post-installation performance testing and documentation, As-Built drawing documentation, and manufacturer warranty.
B. Final acceptance by UNLV/NDE is subject to the installation being complete in final walk-through, receipt of required final test adjustments to Computer Aided Designs (AutoCAD in .dwg format) As-Built drawings and warranty submittals.

1.3 Related Documents and References

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".
B. In particular, the subsections of the master Division 27 00 00; *Communications Design Guidelines*, 27 11 00; *Communications Equipment Room Fittings*, 27 13 00; *Communications Optical Fiber Backbone Cabling,* and 27 15 00; *Communications Copper Horizontal Cabling* includes the following:
    1. Section 27 01 00; *Operation and Maintenance of Low-Voltage Communications Systems*
    2. Section 27 11 16; *Communication Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides*
    3. Section 27 11 20; *Communications Optical Fiber Enclosures*
    4. Section 27 13 23 .01; *Intra-building Optical Fiber Backbone Cabling*
    5. Section 27 13 23. 02; *Inter-building Optical Fiber Backbone Cabling*
    6. Section 27 15 01 .20; *Wireless Data Communication Copper Horizontal Cabling*
    7. Section 27 15 43 .15; *Communications Fiber Connectors and Cassettes*
C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
    1. Appendix A; *Codes, Standards, and Regulations*
    2. Appendix B; *Abbreviations and Acronyms*
    3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
    4. Appendix D; *Rack Elevation and Room Sizing Drawings*
D. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification, apply to this Section.
E. All optical fiber testing procedures and testers will comply with the requirements of the current versions and practices in:
    1. BICSI *Telecommunications Distribution Methods Manual (*TDMM)
    2. BICSI *Information Transport Systems Installation Methods Manual* (ITSIMM)
    3. ANSI Z136.2; *Safe Use of Optical Fiber Communications Systems Utilizing Laser Diode and LED Sources*
    4. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
    5. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*
    6. ANSI/TIA-455 Series; *Standard Test Procedures for Testing Optical Fiber*
    7. ANSI/TIA 472; *General Specifications for Fiber Optic Cables*

8. ANSI/TIA-526-7A; *Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant*
9. ANSI/TIA 568.1; *Commercial Building telecommunications Standard, Part 1: General Requirements*
10. ANSI/TIA 568.3; *Commercial Building telecommunications Standard, Part 3: Optical Fiber Cabling Component Standard*
11. ANSI/TIA 598; *Optical Fiber Cable Color Coding*
12. ANSI/TIA 526-7; *Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant*
13. ANSI TIA-758-B; *Customer-owned Outside Plant Telecommunications Cabling Standard*
14. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facilities*
15. GR-20-CORE; *General Requirements for Optical Fiber Cable*
16. GR-196-CORE; *Optical Time Domain Reflectometer*
17. GR-409-CORE; *Telcordia General Requirements for Premises Fiber Optic Cable*
18. ISO /IEC 61280-4-2; *Fibre-Optic Communications Subsystem Test Procedures - Part 4-2 - Installed Cable Plant and Links - Single-mode Attenuation and Optical Return Loss Measurement*
19. IEC 61300-3-5; *Fibre Optic Interconnecting Devices and Passive Components - Basic Test and Measurement Procedures - Part 3-35: Visual Inspection of Fibre Optic Connectors and Fibre-stub Transceivers*
20. ITU-T G.652D; *Characteristics of Single-Mode Optical Fiber*
21. NFPA-70; *National Electric Code (NEC)*
22. TR 42.11; *Optical Power Loss of Installed Single-mode Optical Fiber Cable*
23. IEEE 802.3; *IEEE Standard for Ethernet*
24. NEC Article 770; *Optical Fiber and Raceways*
25. UL 910; *UL Standard for Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical Fiber Cables Used in Spaces Transporting Environmental Air*
26. UL 1651; *UL Standard for Safety Optical Fiber Cables*
27. Note: Multimode optical fiber is obsolete and being replaced by single-mode optical fiber on the UNLV campus.

1.4 Contractor/Sub Qualifications and Responsibilities

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).
C. UNLV/NDE preference is for the Contractor/Sub to assign the same two (2) or three (3) technicians to perform all the optical fiber testing throughout the project.
D. It is preferable that the Contractor/Sub show proof of being trained and certified by the UNLV approved tester manufacturer.

E. At least one member of the testing team to be the optical fiber cable manufacturer and BICSI certified at all times.
F. Contractor/Sub is to refer and have full understanding of the project drawings to confirm:
    1. Telecommunication Distribution Units (TDUs) exit/entry (to/from) in outside plant (OSP) pathways inclusive of vaults and maintenance holes.
    2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
    3. Racks: Scaled elevation drawings indicating location and proposed designation.
    4. Fiber Enclosure Panels: Enlarged scaled elevation drawings showing rack row, number, and proposed designations.
G. When appropriate coordinate testing with other trades and the general contractor (GC).
H. Always practice safety. Not to make any direct visual contact or inspection of any port being tested per ANSI Z136.2.

1.5 Optical Fiber Testing Criteria; Optical Fiber Link

A. By definition, An optical fiber link is a telecommunications link that consists of a single end-to-end optical circuit without connection to the active devices.
B. Optical fiber testing may be conducted for the following reasons:
    1. Pre-installation testing (spool testing if required on a contract Scope of Work (Sow) or for commissioning requirements)
    2. Acceptance testing for warranty (submittals and is mandatory)
    3. Preventive maintenance testing (warranty protocol if required)
    4. Troubleshooting (as needed)
C. Optical fiber cable to be all-dielectric and be a dedicated 'homerun' with no splices except for termination splicing on each end to the cassettes/plates.
D. Intra-building premises optical fiber is to have a plenum fire-rating (OFNP) after fifty ft. (15.2 meters) of entering a building whether the pathway is either a riser-rated or plenum-rated environment. The exception is if it is routed in rigid metallic conduit (RMC).
E. Optical fiber color coding to be in accordance with the current version of ANSI/TIA 598-D.
F. Tier 1 certification is a certification requirement and is defined as the measurement of the total insertion loss, length, and polarity of the optical cable cabling from one end of the link to the other.
G. The VFL or Visual Fault Locator used for continuity/polarity can be separate or incorporated into the OLTS or OTDR.
H. Tier 2 optical fiber testing includes Tier 1 OLTS testing and is used to define the graphical precise characterization of the fiber link. Tier 2 testing will be specified in the project specifications and is typically required for distances over 1,200 ft. (356 meters).
I. Both Tier 1 and Tier 2 require 'dual wavelength' testing at both 1310 nm and 1550 nm and bi-directional.
J. If requested, DWDM out-of-band - or depending on the laser type - for the "S" band may require testing at the 1625 nm wavelength.
K. All optical fiber runs to have an identifier showing its origin at both ends and to be used for referencing the cable test identification.
L. This criteria does not apply to hybrid DC power/optical fiber cables nor GPON architecture.

1.6 Pre-bid Submittals

A. Manufacturer product data sheet documentation with compliance to industry testing standards and proof of calibration for the particular tester(s) being used.
B. A copy of or reference guide from the tester manufacturer's testing procedure for each of the structured cabling system (SCS) elements required for the project.
C. Show proof that at least one (1) member of the testing team is cable/connector manufacturer certified.

1.7 Test Results: Strand Labeling example;

A. **Tier 1 OLTS:** Each individual strand will be labeled following the below standard:
    1. *[Strand count]* **Strand** *[Cable Type] - [source building acronym] [idf room]* ***F****[enclosure] [slot]* ***to*** *[destination building acronym] [idf room]* ***F****[enclosure] [slot] [Atten or OTDR]* ***Strand X*** *(where "x" is the individual strand tested)*
    2. A 72 strand single-mode cable was installed between the Science and Engineering Building (SEB) TR-IDF room #1132 - fiber enclosure #2 slot A-C and Chemistry (CHE) building IDF room #224 fiber enclosure #1 slot D-F.
    3. The label for each strand in the test result for Tier 1 OLTS attenuation (in dB) testing will be:
        a. 72 Strand SMF - SEB 1132 F2 A-C to CHE 224 F1 D-F (dB) Strand 1
        b. 72 Strand SMF - SEB 1132 F2 A-C to CHE 224 F1 D-F (dB) Strand 2
        ..... continue
        c. 72 Strand SMF - SEB 1132 F2 A-C to CHE 224 F1 D-F (dB) Strand 71
        d. 72 Strand SMF - SEB 1132 F2 A-C to CHE 224 F1 D-F (dB) Strand 72
        e. .... continue
B. **Tier 2 OTDR:** Each individual strand will be labeled following the below standard:
    1. The label for each strand in the test result for **OTDR** testing will be:
        a. 72 Strand SM - SEB 1132 F2 A-C to CHE 224 F1 D-F OTDR (dB) Strand 1
        b. 72 Strand SM - SEB 1132 F2 A-C to CHE 224 F1 D-F OTDR (dB) Strand 2
        c. ..... continue
        d. 72 Strand SM - SEB 1132 F2 A-C to CHE 224 F1 D-F OTDR (dB) Strand 71
        e. 72 Strand SM - SEB 1132 F2 A-C to CHE 224 F1 D-F OTDR (dB) Strand 72
        f. ..... continue

PART 2: PRODUCT

2.1 Performance Requirements

A. Tester manufacturer to be UL Listed and the manufacturer is ISO 9000/9001 registered and be RoHS 2011/65/EU compliant.

B. When using ABF fiber, the outer sheath jacket is permitted to be orange inside and outside. In the inside plant (ISP) or intra-building applications, standard optical fiber cable the outer jacket and patch cords to be yellow unless outside plant (OSP) inter-building applications are black.
C. Copper UTP certification tester to be in conformance to the current versions of ANSI/TIA 1152 (and IEC 61935-1) Level IIIe @ 500 MHz. Most manufacturers of these testers offer optical fiber adapters that convert from testing copper to an OLTS and OTDR thus using the same data reporting software on the base units.
D. Fiber optic testers, power meter and light loss sets, OLTS and OTDR to conform to ANSI/TIA 568.3-D, GR-196-CORE, and the procedures in ANSI/TIA 526-7A
E. Any Level IIIe balanced twisted-pair field testers using optical fiber adapters will be factory calibrated each calendar year - or years - as stipulated by the field tester equipment manufacturer. Proof of compliance can be documented with a hard copy certificate prior to the start of testing or found in preliminary test results.
F. Use the same optical fiber cable manufacturer part number(s) for the OLTS and the same manufacturer for the OTDR. However, either tester can be from different manufacturers.
G. Multiple testers are encouraged. However, do not mix different manufacturers for the same type of testing; OLTSs from the same manufacturer and OTDRs from the same manufacturer.
H. OLTS to provide:
    1. 1310 nm and 1550 nm +/- 20 nm wavelength test resolution.
    2. Measure range to be +10 to -60 dBm
    3. Accuracy to be at least +/- 5% 0 to -50 dBm and +/- 10% to -60 dBm
    4. Resolution to be up to 0.1 dB
    5. Optical test ports to be “SC” transmitting (TX) and interchangeable “LC” and “SC” receiving (RX) ports.
I. OTDR to provide:
    1. 1310 nm and 1550 nm wavelength test resolution. Optional 1625 nm or 1650 nm for DWDM and troubleshooting..
    2. Connector types “SC” transmitting (TX) and interchangeable “LC” and “SC” receiving (RX)
    3. Measure optical distance to splices, connectors, faults, and end of fiber.
    4. Measure Optical Return Loss (ORL) and Reflectance of splices, connectors, links or sections, the reflectance of connectors, and total fiber link attenuation bi-directionally.
    5. Dynamic range of display to be a minimum 35 db measurement range of 80 km @1310 nm and 35 dB measurement range of 125 km @ 1550 nm.
    6. (Between) Event Dead Zone and (After) Attenuation Dead Zone determined by each model feature - the determinate for suitable length launch cables.
J. Fiber Inspection Scope to provide:
    1. Automate PASS/FAIL to the IEC 61300-3-35 specification
    2. Graphical digital indication of problem areas
    3. Ability to save, label, and download PDF or JPEG photos of each connector endface.

PART 3: EXECUTION

3.1 Summary

A. Testing not to interfere with the construction operations of other trades.
B. Main and remote devices to be synchronized and fully charged when testing begins.

C. Contractor/Sub to verify each cable run is installed, terminated, labeled, and is usable per industry best-practices prior to testing. Any testing performed on incomplete systems to be redone on completion of the work. This is to ensure manufacturer warranty.
D. Cabling installation in telecommunications rooms to be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.
E. All tests performed on optical fiber cabling that use a laser or LED in a test set to be carried out with safety precautions in accordance with ANSI Z136.2.
F. Note: even if a cable installation run PASSES the tests, UNLV/NDE may fail the cable run when an inspection/audit is conducted and found the cable run is not properly routed or supported. Any defects in cabling system installation will be repaired or replaced to ensure one hundred (100 percent) usable condition at no additional cost to UNLV.
G. Cabling installation in telecommunications rooms to be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.
H. After submittal of test result documentation and the associated As-Built drawings, UNLV will have the option to randomly pick five percent (5%) of the submitted cable plant installation for re-test. If more than two percent (2%) of the sample results differ in terms of the pass/fail determination, the installation Contractor/Sub under supervision of the representative to repeat one-hundred percent (100%) testing at no cost to the UNLV.

3.2 Optical Fiber Examination and Acceptance Testing Parameters

A. OS2 and OS1A single-mode fiber will be tested with a one-hundred percent (100%) PASS rate.
B. Paired duplex fibers in multi-fiber cables to be tested to verify 'straight-through' polarity; 1>1, 2>2, 3>3 and so forth. The polarity of the paired duplex fibers can be verified using a visual fiber locator (VFL) with and documented using an OLTS.
C. Set-up mode:
    1. To include but not default to using only the current version of the ANSI/TIA 568.3-E and ANSI/TIA 526-7A standard.
    2. Test settings selected from the Options menu provided in the field testers will be compatible with the installed cable/connector manufacturer cable part number(s) under test.
    3. The test operators of which one is to be BICSI certified and an authorized technician by the cable/connector manufacturer.
    4. Date and time
    5. Testing site
    6. The fiber strand(s)
D. UNLV/NDE requires basic fiber link, point-to-point testing only. Channel 'Performance' or 'Configuration' testing with patch cords at both ends, between devices or mid-span fiber enclosures is non-applicable. However, channel testing for 40/100Base-LR-4 may be requested to measure budget loss including the 'hops' between the active equipment.
E. OLTS measurements to be performed with a stable launch condition; test reference cordage (TRCs) to have a minimum OD of 2.8-3.0 mm, UPC 'Grade A' precision zirconia ferrule, and to have a maximum insertion loss (IL) of 0.25 dB per mated pair and minimum return loss (RL) of > 0.55 dB.
F. Note: Proof of these TRC test parameters will be reviewed with the test results. Exceeding this criteria will require complete re-testing of all the ports.

G. OLTS Set-up parameters:
    1. Use only Method B or single-reference TRCs when using an OLTS:
    2. Industry test standard ANSI/TIA 568.3-D (that references ANSI/TIA 526-7A, and GR-196-CORE)
    3. Cable/Connector manufacturer's part number(s) with the assigned index of refraction
    4. Application: QSFP28-100GBase-LR/IEEE802.3ab/1310 nm
    5. Duplex UPC LC
    6. Maximum insertion loss per mated-pair: 0.35 dB
    7. Maximum insertion loss per splice: 0.02 dB
    8. Date and time
    9. Operators names (one who has to be both BICSI and cable/connector manufacturer certified)
    10. (Maximum 40/100GBase-LR4 channel budget loss: 6.7/6.3 dB @ maximum 10 km)

H. OTDRs measurements to be performed with a stable launch condition;
    1. Use only high-quality, low-loss, dual launch boxes (minimum 1000 meters but based upon tester manufacturer recommendations) having the same optical cable and connectors as being tested.
    2. Two are required; at both transmit and receiving end.
    3. Loopback testing is not permitted.

I. Tier 1 OLTS - and if required Tier 2 OTDR - require bi-directional 'dual wavelength' testing at both 1310 nm and 1550 nm.

J. Maximum attenuation loss of the single-mode OS1A and OS2 cable is:

Wavelength	OS1 (ISP)	OS1A (ISP OS2)	OS2 (OSP)
1310 nm	1.0 dB/km	0.4 dB/km	0.4 dB/km
1310 nm	0.3 dB/Mft	.12 dB/Mft	.12 dB/Mft
1550 nm	1.0 dB/km	0.4 dB/km	0.4 dB/km
1550 nm	0.3 dB/Mft	.12 dB/Mft	.12 dB/Mft

27 10 20 .20 & .30 Fig 1: *Maximum Loss for OS1A and OS2 SMF Fiber Cable*

K. Link attenuation budget allowance to be calculated = Connector/splice insertion loss at cassette (dB) + Cable attenuation (dB) + Connector/splice insertion loss at cassette (dB)

L. End-to-end cabling will be considered defective if it does not PASS tests and is to be replaced at no additional cost to UNLV.

M. If requested in the project specifications and in the contract Scope of Work (SoW), use an Inspection Scope to inspect the optical fiber LC endface to pass IEC 61300-3-35. May also request to take, save, and label photos for documentation.

N. No other test or equipment requirements are required for optical fiber link testing compliance besides Tier 1 OLTS, Tier 2 (Tier 1) plus OTDR, and (optional) digital Fiber Inspection Scope test equipment.

O. UNLV/NDE reserves the right to inspect the Contractor/Sub's tester Set-up mode at any time to ensure compliance with the test parameters of this Section.

P. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the

UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM will notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.3 Cleaning

A. Contractor/Sub to practice good “sweep clean” housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas.
B. Once the telecommunication rooms are complete with terminated optical fiber enclosures, yet still be exposed to sanding, dust and debris, the Contractor/Sub is to use painter's blue tape or equivalent to cover the open sides of the enclosure at no additional cost to UNLV/NDE. Only UNLV/NDE will remove the tape when cutover begins.

3.4 Close-out Submittals and Documentation

A. Test documentation
    1. Test results will be downloaded directly from the test unit or from a download file using an application from the test equipment manufacturer.
    2. Test results to be provided in both PDF and native tester manufacturer software format.
    3. Tester manufacturer, model, and serial number.
    4. Calibration date (to be current).
    5. Version of the tester firmware.
    6. Test results to verify that the total attenuation of all the passive components in the fiber link is within the design parameters per industry standards.
    7. Results can be either in the manufacturer software or in PDF format in numerical order with files separated by the telecommunications rooms.
    8. Manufacturer warranty documentation and AutoCAD in .dwg format files to follow UNLV/NDE RCDD approved test results and redline As-Builts within 30 days of final submittals.
    9. Electronic format copies only required. No hard copies.
B. “Optical Fiber As-Built Drawings” - separate from “Copper As-Built Drawings”
    1. First phase in PDF format to compare test documentation port-to-port to PDF As-Built.
    2. PDF As-Builts to be on UNLV-provided floorplan sized to “E1” 30 X 42 inches (762 x 1067 mm).
    3. Electronic format copies only required. No hard copies
    4. “As-Built Data'': Identify all inter-building and intra-building fiber link terminations in the fiber enclosures (And, any telecommunication outlets (TOs) by cable room number if any). Include cable pathways of; conduit > 2.0 inches (51 mm), pull boxes/junction boxes, cable trays routes and sizes, plus the telecommunication room’s layouts of racks, cabinets, and TDUs orientation.
    5. “As-Built Wifi/Security”; Identify all Wifi wireless access points (WAPs) plus security and test designated camera locations if any. Reference locations like “As-Built Data”.
    6. Use the appropriate symbol for each application from the project’s drawing symbol legend.

7. Each fiber link address, is assigned a unique 'identification number' or ' identifier' of both ends of the cable:
   (Origin); "Bldg Name" - ER-MDF/TR-IDF ID# - Fiber Enclosure ID# - Cassette/plate Letter - Port ID#" "**>**" or "to" (Destination); "Bldg Name" - ER-MDF/TR-IDF ID# - Fiber Enclosure ID# - Cassette/plate Letter - Port ID#".
   If going to a work area location:
   "Work Area ID #" - "ER-MDF/TR-IDF ID #" - "Fiber Enclosure ID #" - "Cassette/plate Letter - Port ID#"
8. When room on the As-Built drawings permits, the identifiers to first be listed on outside of the building's perimeter, 'boxed in' with a red arrow pointing to the designated work area telecommunications outlet (TO). At no time is it to block the drawing's room number. Only when the port address listing is too congested on the outside perimeter of the building can they be listed within the building's inside perimeter.
9. Busbars labeling and location on the Electrical As-Built drawings.
10. Second phase is Computer Aided Design (AutoCAD in .dwg format) based upon UNLV provided drawings. Contractor/Sub to use the legend provided in the UNLV AutoCAD drawing for layered documentation to separate Data, Wifi/Security, and Pathways. Also used as a reference for scale.
11. Within 30 days of the substantial completion of the project or prior to project closeout -- whichever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub's one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.
12. Any AutoCAD in .dwg format to show conduit inter-building or intra-building > 2 inches (51 mm) to also be identified and labeled to their origin.
13. Electronic format copies only required. No hard copies

C. Fiber Inspection Scope:
   1. If specified in the project specifications and in the contract Scope of Work (SoW), provide digital photos of each labeled optical fiber endface or those that were requested for re-examination.

D. Warranty
   1. Manufacturer warranty documentation specifying the project location.
   2. Provide conditions for maximum percentage of moves, adds, and changes (MACs).

SECTION 27 10 00: STRUCTURED CABLING HARDWARE

——— End of Sections 27 10 20 .20 and .30 ———

Optical Fiber Cable Testing and Documentation

SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

Section 27 11 10

Telecommunications Rooms and Backboards

PART 1: GENERAL

1.1 Summary

A. This Section is specific to telecommunications rooms and backboards for communications systems. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for either or a combination of telecommunications rooms and backboard communications systems components in either new or retrofit construction.

B. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of *Telecommunications Rooms and Backboards* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).

C. UNLV/P&C will design, approve, and manage the installation process. UNLV/NDE is providing the guidelines and auditing services for the design and build of *Telecommunications Rooms and Backboards.*

D. The Contractor/Sub to include in their bid price, communications cabling that has become abandoned as part of a renovation project, previous renovation projects, or temporary communications cables used during the construction process to be completely removed.

E. 'Telecommunications rooms' are 'critical operation centers' and defined into two categories:

1. Equipment Rooms (ER) - Main Distribution Frames (one each):
    a. Can be adjacent to or incorporate the Entrance Facility (EF) to function as the main servicing point for the building. This would include the Service Providers (SPs) demarcation point as well as other campus inter-building cabling entering the building.
    b. It is usually located on the ground floor but may also be located in the basement.
    c. Also operates as the main cross-connect traditionally referred to as the Main Distribution Frame (MDF) to the TRs-IDFs.
    d. The central location for the outside plant (OSP) inter-building cabling (stub-up) conduits which are to be situated in the corner nearest the outside wall(s).
    e. The ER-MDF may also function as the TR-IDF as a cross-connection to the floor's work area outlets.
    f. Typically will also contain the OSI Model of Networking Layer 2 switches and Layer 3 core router active devices based upon the network architecture and power backup system.
    g. May be larger than the TR-IDF to accommodate the additional services. Desired size requirements are 10 ft. x 12 ft. (3 meters x 3.6 meters). Check project specifications and drawings to confirm the size.

2. Telecommunications Room (TR) - Intermediate Distribution Frames (IDF):
    a. They are essentially the extended cabling hubs for the rest of the building floor area and function as a cross-connection to the respective floor's work area (WA) telecommunications outlets (TOs).
    b. Typically contains the Layer 2 active devices and on occasions Layer 3 devices based upon the network architecture and power backup system.
    c. Are connected to each other and the ER-MDF with minimum two (2) each 4-inch (102 mm) EMT conduit as well as the grounding system.
    d. Desired size requirements are 10 ft. x 10 ft. (3 meters x 3 meters). Check project specifications and drawings to confirm the size.

1.2 Related Documentations and References

F. The subsections listed in the *Table of Contents* are considered to be "Related Documents".
G. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications* and 27 10 00; *Structure Cabling Hardware* includes the following:
    1. Section 27 01 00; *Operation and Maintenance of Low-Voltage Communications Systems*
    2. Section 27 05 26; *Grounding and Bonding*
    3. Section 27 05 28; *Pathways for Communications Systems*
    4. Section 27 05 33; *Conduits and Back Boxes*
    5. Section 27 05 36; *Cable Trays*
    6. Section 27 05 41; *Firestopping System for Communications*
    7. Section 27 05 43; *Underground Ducts and Raceways for Communications Systems*
    8. Section 27 05 53; *Identification for Communication Systems*
    9. Section 27 11 16; *Communication Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides*
    10. Section 27 11 19; *Communications Copper Modular Patch Panels*
    11. Section 27 11 20; *Communications Optical Fiber Enclosures*
    12. Section 27 13 23 .01; *Intra-building Optical Fiber Backbone Cabling*
    13. Section 27 13 23. 02; *Inter-building Optical Fiber Backbone Cabling*
    14. Section 27 15 01 .13; *Communications Copper Horizontal Cabling Station Applications and POE*
    15. Section 27 15 01 .19; *Data Communications Copper Horizontal Cabling*
    16. Section 27 15 01 .20; *Wireless Data Communication Copper Horizontal Cabling*
H. Material and work specified to comply with the applicable requirements of the current revisions of the following:
    1. Appendix A; *Codes, Standards, and Regulations*
    2. Appendix B; *Abbreviations and Acronyms*
    3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
    4. Appendix D; *Rack Elevation and Room Sizing Drawings*
I. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification, apply to this Section.
J. The telecommunications rooms designs and installation will comply with the particular requirements of the current versions and practices in:
    1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)

2. BICSI *Information Transport Systems Installation Methods Manual* (ITSIMM)
3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
4. ANSI/BICSI 003-2019; *Building Information Modeling (BIM) Practices for Information Technology Systems*
5. ANSI/BICSI 006-2020; *Distributed Antenna System (DAS) Design and Implementation Best Practices.*
6. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*
7. ANSI/BICSI N3-20; *Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure*
8. ANSI/TIA 568.1; *Commercial Building telecommunications Standard, Part 1: General Requirements*
9. ANSI/TIA-569-E; *Commercial Building Standard for Telecommunications Pathways and Spaces*
10. ANSI/TIA 607-D; *Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises*
11. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facilities, Including Addendum 1: Updated References Accommodation of New Media Types*
12. ASTM E 119 - *Fire Tests of Building Construction Materials*
13. EIA 310-E; *Cabinets, Racks, Panels, and Associated Equipment*
14. IEC 61537; *International Standard for Cable Tray and Cable Ladder Systems*
15. ISO/IEC 11801-1 4th Edition; EN 50173-2: 2007 + A1: 2012 (CENELEC TC215); *Information Technology - Generic Cabling for Customer Premises (Sept, 2017) - Part 1: General Requirements and, Part 2: Office Premises*
16. NEC Article 250; *Grounding and Bonding of Electrical Systems*
17. NEC Article 392; *Cable Trays*
18. NEC Article 770; *Optical Fiber and Raceways*
19. NEMA 5-20R; 20 amp 125VAC Receptacle
20. NEMA L6-30R; 30 amp 250 VAC Receptacle
21. NEMA VE 1 & 2; *Metal Cable Tray Standards*
22. TIA TSB-190; *Guidelines on Shared Pathways and Shared Sheaths*
23. UL 6; *UL Standard for Electrical Rigid Metal Conduit*
24. UL 467; *UL Standard for Grounding and Bonding Equipment*
25. UL 797; *UL Standard for Safety Electrical Metallic Tubing*
26. UL 1950; UL Standard for Safety of Information Technology Equipment

1.3 Design Parameters

A. Location: UNLV campus buildings will have at least one (1) telecommunications room per floor depending on building size, footprint, and design.
B. Distance Limitation**:** Building design will have no permanent link horizontal cable runs to exceed 295 ft (90 meters).
C. Centralized: The telecommunications rooms are to be as close to the core of the building as possible. And, near the elevators if possible.

D. Stacked: Multi-story buildings' telecommunications rooms to be vertically aligned or 'stacked' If not feasible. Telecommunications rooms to be connected to each other with minimum two (2) each minimum size 4-inch (102 mm) EMT conduits.
E. Conduit:
    1. Minimum of two (2) each 4-inch (102 mm) EMT conduits or 'sleeves' to be provided from the ER-MDF to the other TRs-IDFs on the same floor on the higher levels.
    2. Both ends to have a 4-inch (102 mm) EMT set-screw threaded connector 'end-cap' to secure a plastic grommet.
    3. One end of the conduit run or sleeve to additionally have grounding collars.
F. Telecommunications only: The space is dedicated to telecommunications equipment and not shared with electrical/transformers, janitorial services, storage, or any other building services.
G. Room Size: Minimum preferred size is a minimum 10 ft x 12 ft (3 meters X 3.6 meters) for the ER-MDF and a minimum 10 ft. x 10 ft. (3 meters x 3 meters) for the TR-IDF.
H. Rule of Thumb; Provide minimum 0.75 sq. ft. (697 sq. cm) of equipment room floor space for every 100 sq. ft. (9 sq. meter) of user workstation area. Accordingly, this size room is designed to accommodate up to 10,000 sq. ft (900 sq meters) of usable office floor space having up to 200 each work areas (WAs).
I. Ceiling:
    1. Minimum ceiling height to be 8.5 ft. (2.6 m), above finished floor (AFF) and the lowest point to be 10 ft. (3 m) to accommodate tall racks and respective overhead raceways.
    2. Ceiling to be an unobstructed open ceiling in order to provide space over the equipment racks for suspended cable trays or horizontal ladder racks.
    3. Under no circumstances are drip pans for water pipes or HVAC units permissible within 5 ft. (1.5 meter) of the nearest equipment rack(s) or communications cabinet(s).
J. Floor drains: Floor drains from the room directly above need to be piped into the building's water drainage system.
K. False Ceilings and Windows: False ceilings not to be installed and no windows.
L. Cages: Most are dedicated rooms, but can be caged under special circumstances. Check with UNLV/NDE for review.
M. Electrical Telecommunications Outlets (dedicated):
    1. Two (2) each 30-amp 240 VAC outlets with NEMA L6-30 Rs. - single-gang.
    2. Four (4) each 20-amp 120 VAC outlets with NEMA 5-20 Rs. - double gang "quad".
    3. Mount one each single-gang 208 VAC and one double gang 110 VAC on opposite sides of the ladder racking and on each side of the 4-post rack front and rear. (4 total).
    4. Use only EMT conduit.
    5. These dedicated electrical boxes to be labeled with the electrical room#, panel#, and circuit breaker#.
N. Electrical 'Convenience" Outlets
    1. Convenience outlets" or those around the wall perimeters for general use - and not for telecommunications - to have the EMT conduit and electrical boxes installed either (1) inside the walls and be recessed and flush with the plywood, or (2) surface mounted on the outside of the plywood.
    2. Located every six (6) ft. (1.8 meter) around the perimeter of the room, but not behind the ladder racks or cabinets.
    3. Electrical boxes cut out to be 14 inches (330 mm) from bottom AFF and/or 18" (457 mm) from top AFF. Allow boxes to protrude out ¾ inch (19 mm) beyond the gypsum board to be flush-mounted to the plywood walls.

4. Side Clearance: Allow minimum three (3) ft (0.9 meter) of clearance in the aisle and 32 inches (812 mm) between the (proposed) rear of active devices or the 4-post rack (whichever is closest) and the wall.
5. Sleeve Protrusion: As A UNLV/NDE specification, any conduit trade sizes including 4-inch (102 mm) conduits metal or HDPE piping/conduit floor sleeves/stub ups to protrude a minimum three (3) inches (76 mm) . Each to have a threaded adapter to install a plastic grommet and cover with an end-cap. Those of metal will also need a grounding collar.
6. Cable Bend Radius: Minimum seven (7) inches (178 mm) clearance between the 4-inch (102 mm) conduits sleeves from the ceiling to top of racks or basket tray to maintain multiple cables bend radius.
7. Doors: Limited access having single or double 36 inches x 80 inches (914 mm - 1219 mm) lockable doors to open 90-180 degrees outward. No door sills and with locked security card access.
8. Other Trades:
    a. No piping, ductwork, mechanical equipment or power cabling to be allowed to pass through the equipment room.
    b. If necessitated, sprinkler pipes are to additionally have a drip system pans installed but not within 5 ft. (1.5 meter) of the nearest equipment rack or communications cabinet.
    c. Additionally, sprinkler heads to be provided with cages to prevent accidental operations.
    d. Floor drains from the room above need to be piped into the building's water drainage system.
9. Firestopping: All sleeves or devices entering the telecommunications room are to be properly firestopped both on the outside and inside of the pathway..
10. Floors:
    a. Carpets are not permitted in any telecommunications spaces.
    b. Cement floors to be treated with static free sealant that also prevents dust.
    c. Static-controlled vinyl composite tile (VCT) is the preferred floor cover and to have a rating greater than 100 lbs/sq. ft..
11. Environmental Control:
    a. Dedicated HVAC 24 hours a day, 365 days a year with an allocated thermostat to maintain a temperature between 64° to 75° F (18° C to 24°C)
    b. Maintain 30 to maximum 55 percent humidity factor
    c. There is to be at least one air exchange per hour to maintain positive pressure.
    d. Wall mounted units to have a dedicated and labeled electrical outlet along with a confined drain system.
    e. Ceiling mounted HVAC units are not recommended except for special circumstances that need UNLV/NDE approval for location and drip pan system design to be minimum 5 ft. (1.6 meter) from the nearest equipment rack or communications cabinet.
    f. Alternatively, provide a dedicated HVAC supply duct system for each telecommunications room and having its own thermostat.
12. Lighting:
    a. Mounted ceiling height of 8.5 ft. (2.4 meter) high and providing 356 lumens at 3 ft. AFF.

b. Minimum two (2) each 2 ft. X 4 ft. (0.6 m x 1.2 m) light fixtures to be placed parallel in front and rear of floor-mounted racks and/or cabinets and positioned so as to not have the racks or cabinets block the lights or create shadows.
c. To be on a separate circuit from the circuit feeds to the room's electrical convenience outlets.

13. EMI: Fluorescent lights (non-LED) to be a minimum 12 inches (305 mm) from any communication cable routes. No electrical transformers are allowed in the telecommunications rooms.
14. Bonding and Grounding:
    a. Per ANDI/TIA 607-D (J-STD-607-A), each telecommunications room to be equipped with a grounding busbar connected to the building's grounding system.
        i. The ER-MDF will house the telecommunications main grounding busbar (TMGB)-Primary Busbar (PBB) sized to ¼" thickness and minimum four (4) inches (102 mm) in height by X length.
        ii. The TRs-IDFs will house the telecommunications grounding busbar (TGB) - Secondary Busbar (SBB) sized to ¼" thickness and minimum two (2) inches in height by X length.
    b. Each to be labeled per assigned telecommunications room number.
    c. Each to be able to accommodate double hole, double-crimp #6 AWG grounding lug's hole pattern.
15. Dust: Dust is defined as more than 100 micrograms/cubic meter/24 hour period.
16. Walls or Backboards: All walls perimeters;
    a. Lined with 4 ft. x 8 ft. (1.2 m x 23 m) ¾" void-free A-C grade (or better) plywood. The plywood is to be fire retardant or treated with at least two coats of fire retardant paint on all exposed sides inside the telecommunications rooms.
    Note: This includes the room itself plus the entryway if applicable.
    b. If fire-rating is on the C-grade side, take and print a picture of the fire-rating for proof or cut out a section with the fire-rating stamp and secure either to a wall towards top of paneling.
    c. The bottom of the plywood to be mounted 6" above the finished floor (AFF) so that the top of the plywood is flush with the top of the wall-ceiling at 8 ft 6 inches (2.6 meters).
    d. Will need to cut out the wall perimeter plywood to expose these electrical outlets that will be flush with the plywood. Alternatively, use ¾ inch extension mud rings.
    e. Perimeter to be secured with the proper hardware (minimum ¼ inch in size and galvanized/treated) and placed within two (2) inches from the edges and positioned at maximum 24 inch (610 mm) centers. Secure center if there is any warp in the plywood. At no time will the head of the mounting screw protrude past the face of the plywood.
    f. Linear wall space used for anchoring equipment.
    g. Except for convenient electrical power outlets, no other electrical conduit (e.g. lighting), junction boxes or any other electrical transformer/inverter equipment may be mounted on or across any backboard.
    h. Used to house security system controllers.

17. Ladder Racking: All ladder racking configured to the project specification drawings. Details are in the next Section 27 11 16; *Communication Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Poke through Devices.*

1.4 Room Numbers

A. Unlv will be responsible for the obtaining and mounting of the telecommunications room numbers outside the doors and viewed from the hallway.

1.5 Pre-bid Submittals

A. Architectural drawings to include detailed and dimensional floor drawings of each telecommunications room complete with backboard installation, electrical, lighting, HVAC and ducting.

1.6 Contractor Qualifications

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).

1.7 Quality Assurance and Warranty

A. Electrical work to be in full compliance with the current version of inclusive or ANSI/TIA 607-D and NFPA-70 (NEC) as well as Division 26.
B. The telecommunications rooms will be installed in a neat and workmanlike manner. This includes:
    1. Layout Responsibility: Preparation and layout of the telecommunications rooms per the project draws will be under direct supervision of Contractor/Sub RCDD.
    2. Plywood is vertically aligned, properly secured, and abutted without gaps.
    3. Plywood is mounted 6 inches (152 mm) above the finished floor (AFF) and level (8 ft. or 1.8 meter)to the top of the wall-ceiling.
    4. Convenient electrical outlets to either be flush or surface mounted using EMT conduit.
    5. Lighting meets specifications, secured, and no shadows from the racks or cabinets.
    6. HVAC is installed per specifications. Working properly, with adequate and confined drainage.
    7. Doors open outward 90-180 degrees, no sills, and have security locks installed.
    8. Any writing, stickers, pencil/pen measurements, or graffiti on the walls will be removed.
    9. Overhead ceiling is clear of obstructions with access for ladder racking or cable tray.
    10. Any size conduits/sleeves of dedicated conduit home runs between the telecommunications closet and other rooms or other telecommunication rooms entering

from the wall or ceiling to be properly secured, and labeled as to their origin. Grounding collars required on the telecommunications room side, with plastic grommets installed.

11. Conduit floor conduits are located along the outside wall(s) corner and have a minimum four (4) inches (102 mm) AFF stub-up, capped and labeled as to their origin. Any metal inter-building conduit also has grounding collars installed.
12. Products to be furnished with manufacturer's instructions and mounting hardware.
13. SPECIAL NOTE: All completed pathway installations either in whole or in sections are to be inspected and approved by UNLV/NDE RCDD prior to any cables being installed.
14. Products to be UL Listed and be manufactured by an ISO 9000/9001 approved manufacturer and be RoHS 2011/65/EU compliant.
15. Firestopping is properly installed per manufacturer's specifications.

PART 2: PRODUCT

2.1 General

A. As specified in the Planning and Construction (UNLV/P&C) department's building construction project documentation and architectural drawings for the telecommunication rooms.
B. Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*

PART 3: EXECUTION

3.1 Cleaning

A. Contractor/Sub to practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas. This includes keeping inventoried material staging areas in the telecommunications rooms organized.
B. Once the telecommunication rooms are complete with terminated modular patch panels yet still be exposed to sanding, dust and debris, the Contractor/Sub is to use painter's blue tape or equivalent to cover the patch panel ports at no additional cost to UNLV/NDE. Only UNLV/NDE will remove the tape when cutover begins.
C. Upon completion of a project, all debris, empty boxes, excess material inventory, installation equipment and tools are to be removed leaving the premises clean, neat, and orderly. Floors are to be cleaned and vacuumed.
D. This final cleaning includes using a clean HEPA filter vacuum cleaner to remove dust and debris from all installed conduit and electrical outlets, HVAC units, lighting covers, equipment, racks, cabinets, wall mount TDUs and security cabinets, wire managers and the floor itself.

3.2 Examination and Acceptance

A. As specified in the Planning and Construction (UNLV/P&C) department's building construction project documentation and architectural drawings.

B. Comply with the installation requirements in Section 27 05 28; *Pathways for Communications Systems* for underground and buried pathways.
C. All methods of construction that are not specifically described or indicated in the contract documents will be subject to the control and approval of UNLV/NDE.
D. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM will notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.3 Close-out Submittals

A. If requested, providing written proof that the telecommunications room(s) and backboard installation PASSED the authority having jurisdiction (AHJ) inspection.

SECTION 27 11 00: COMMUNICATIONS EQUIPMENT ROOM FITTINGS

——— End of Section 27 11 10 ———

Telecommunications Rooms and Backboards

SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

Section 27 11 16

Communications Cabinets, Equipment Racks, Brackets, Cable Management, and Ladder Racking, and Radius Guides

PART 1: GENERAL

1.1 Summary

A. This Section is specific to communications cabinets, equipment racks, brackets, cable management, ladder racking and radius guides specified by UNLV/NDE. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for either or a combination of communications cabinets, equipment racks, brackets, cable management, ladder racking, and radius guides in either new or retrofit construction.

B. Communications cabinets, equipment racks specified byUNLV/CTS for audio-visual (A/V) applications are exempt from this Section 27 22 16 and refer to Section 27 40 00.

C. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of *Communications Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking and Radius Guides* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).

D. This Section is distinctive to:
    1. Floor-mounted distribution frames; 2-post and 4-post open-frame equipment racks and closed frame distribution cabinets.
    2. Wall-mounted swing distribution frames for closed frame cabinets.
    3. Hinged wall brackets for mounting modular patch panels.
    4. Cable management:
        a. Horizontal wire managers are one sided and positioned in front, below, and in-between modular patch panels, optical fiber enclosures, and active devices
        b. Vertical wire managers are double-sided and positioned between and on both sides of floor mounted distribution frames of 2- and 4-post equipment racks.
        c. Exempt from communications cabinets
    5. Steel ladder racking.

E. The universal color of equipment racks, cabinets, other enclosures, wire managers, and steel ladder racking is black.

F. Standard distribution frames width is 19 inch (482 mm) wide. Note: 23 inch (584 mm) is non-applicable.

G. Zone 4 or seismic applications non-applicable.

H. Wall-mounted swing communication cabinets may serve as a small telecommunications room horizontal or intermediate cross-connect facility when specified.

I. Each to be bonded and grounded per ANSI/TIA 607-D and NFPA-70 (NEC).

1.2 Related Documentations and References

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".

B. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications*, 27 10 00; *Structured Cabling Hardware*, 27 11 00; *Communications Equipment Room Fittings*, 27 13 00; *Communications Optical Fiber Backbone Cabling,* and 27 15 00; *Communications Copper Horizontal Cabling* includes the following:
   1. Section 27 01 00; *Operation and Maintenance of Low-Voltage Communications Systems*
   2. Section 27 05 26; *Grounding and Bonding*
   3. Section 27 05 28; *Pathways for Communications Systems*
   4. Section 27 05 36; *Cable Trays*
   5. Section 27 05 53; *Identification for Communication Systems*
   6. Sections 27 10 20 .10 and .30; *Copper System Testing and Documentation*
   7. Sections 27 10 20 .20 and .30; *Optical Fiber Cable Testing and Documentation*
   8. Section 27 11 10; *Telecommunications Rooms and Backboards*
   9. Section 27 11 19; *Communications Copper Modular Patch Panels*
   10. Section 27 11 20; *Communications Optical Fiber Enclosures*
   11. Section 27 15 01 .19; *Data Communications Copper Horizontal Cabling*

C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
   1. Appendix A; *Codes, Standards, and Regulations*
   2. Appendix B; *Abbreviations and Acronyms*
   3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
   4. Appendix D; *Rack Elevation and Room Sizing Drawings*

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

E. The telecommunications rooms designs will comply with the particular requirements of the current versions and practices in:
   1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)
   2. BICSI *Information Transport Systems Installation Methods Manual* (ITSIMM)
   3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
   4. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*
   5. ANSI/BICSI N3-20; *Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure*
   6. ANSI/TIA 568.1-E; *Commercial Building telecommunications Standard, Part 1: General Requirements*
   7. ANSI/TIA/TIA-606-D; *Administration Standard for Commercial Telecommunications Infrastructure*
   8. ANSI/TIA 607-D; *Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises*
   9. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facilities, Including Addendum 1: Updated References Accommodation of New Media Types*
   10. EIA 310-E; *Cabinets, Racks, Panels, and Associated Equipment*

11. IEC 61537; *International Standard for Cable Tray and Cable Ladder Systems*
12. ISO/IEC 11801-1 4th Edition; *EN 50173-2: 2007 + A1: 2012 (CENELEC TC215); Information Technology - Generic Cabling for Customer Premises*
13. NEC Article 250; *Grounding and Bonding of Electrical Systems*
14. NEC Article 392; *Cable Trays*
15. NEMA VE 1 and 2; *Standard for Manufacturing, Performance, and Testing for Cable Trays Systems*
16. TIA TSB-190; *Guidelines on Shared Pathways and Shared Sheaths*
17. UL 467; *UL Standard for Grounding and Bonding Equipment*
18. UL 1950; *UL Standard for safety of Information Technology Equipment* (Jul, 2002)

1.3 Pre-bid Submittals

A. Provide product data sheets and installation instructions for each type of product.
    1. Include construction details, material descriptions, dimensions of individual components and profiles, color and finishes for equipment racks and communication cabinets.
    2. Include rated capacities, operating characteristics, and ancillary accessories and specialties that may deem applicable.
B. Architectural drawings to include detailed floor drawings and elevation drawings:
    1. Equipment racks and cabinets with cable management measured locations in the telecommunications room.
    2. Grounding: Indicate location of equipment grounding lug and the equipment equipment rack and communications cabinet 1-inch (25 mm) rack bonding busbar (RBB).

1.4 Contractor/Sub Qualifications

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).
C. Does not need to be an manufacturer authorized installer of the manufacturer's equipment racks and/or communication cabinets.

1.5 Quality Assurance

A. All pathways will be installed in a neat and workmanlike manner.
B. Strictly adhere to all current version of Building Industry Consulting Service International (BICSI), Telecommunications Industry Association (TIA), and National Fire Protection Agency (NFPA-70),
C. Products to be furnished with manufacturer's instructions and mounting hardware.
D. Products to be UL Listed and be manufactured by an ISO 9000/9001 approved manufacturer and be RoHS 2011/65/EU compliant.
E. Communication cabinets to be tamper resistant, provide proper ventilation, and meet the UL 1950 fire requirements for fire containment and ingress of foreign particles.

PART 2: PRODUCT

2.1 General

Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*

2.2 Distribution Frame Equipment Racks Specifications

A. Free-standing 2-post aluminum open frame equipment rack:
   1. Two L-shaped top angles, two L-shaped base angles, and two C-shaped equipment-mounting channels.
   2. The equipment rack will be assembled with manufacturer-supplied nut and bolt hardware.
   3. The base angles for both 2-post equipment racks will be pre-punched for attachment to the floor.
   4. Equipment vertical mounting channels will be punched on the front and rear three (3) inch (76 mm) wide flange with the EIA/ECA-310-E universal mounting hole pattern:
   5. Machine-threaded with #12-24 roll-formed thread pattern spaced at EIA 1RU or 1 ¾ inch.
   6. Dedicated bonding points for proper grounding and bouncing to ANSI/TIA 607-D-D.
   7. Free standing equipment racks to be 7 ft. (84 inches or 2,134 mm) and 45 RUs in height.
   8. The RU spacing will be printed vertically along the outer side of the channel starting with “45RU” on top and descending towards the bottom.
   9. Equipment racks to be equipped with a 1" wide 49 each 2-hole pattern on a horizontal rack grounding busbar (RBB) with grounding lug to accommodate minimum #6 AWG stranded ground wire.
   10. Made to accommodate the mounting of 19 inch (483 mm) panels and equipment.
   11. To be approximately 23.4-24.00 inches (597-600 mm) wide with 17.72-inches (450-mm) between rails.
   12. Dedicated bonding points for proper grounding and bouncing to ANSI/TIA 607-D.
   13. Painted with a polyurethane black powder-coat, semi-gloss paint.
   14. 2-post equipment racks rating: 800 lbs - 1,000 lb. (363 - 453 kg) of equipment.

B. Free-standing 4-post steel equipment open frame rack:
   1. Two L-shaped top angles, two L-shaped base angles, and two C-shaped equipment-mounting channels.
   2. The equipment rack will be assembled with manufacturer-supplied nut and bolt hardware.
   3. Steel 4-post equipment racks are an open-access frame with the RU channel built into the inside front brackets of the frame.
   4. Equipment vertical mounting channels will be punched on the front and rear three (3) inch (76 mm) wide flange with the EIA/ECA-310-E universal mounting hole pattern.
   5. Free standing equipment racks to be 7 ft. (84 inches or 2,134 mm) and 45 RUs in height.
   6. One (1) EIA equipment ‘rack unit’ or RU is measured at 1.75 inch (45 mm) between mounting holes.

7. Steel 4-post equipment racks to have 3/8" square-punch holes and will include minimum 40 each #12-24 x 1⁄2" mounting screws and 40 each snap-in #12-24 cage nuts.
8. Made to accommodate the mounting of 19 inch (483 mm) panels and equipment.
9. The RU spacing will be printed vertically along the outer side of the channel starting with "45RU" on top and descending towards "1RU" at the bottom.
10. Equipment racks to be equipped with a 1" wide 49 each 2-hole pattern on a horizontal rack grounding busbar (RBB) with grounding lug to accommodate minimum #6 AWG stranded ground wire.
11. Painted with a polyurethane black powder-coat, semi-gloss paint.
12. To be approximately 23.4-24.00 inches (597-600 mm) wide with 17.72-inches (450-mm) between rails.
13. Dedicated bonding points for proper grounding and bonding to ANSI/TIA 607-D.
14. 4-post equipment racks rating: 2,000 lb. (907 kg) of equipment and a maximum depth of approximately 29.5-30.00 inches (749 - 762 mm).

2.3 Communications Cabinet Specifications

A. Free-standing aluminum communications cabinet:
   1. Front door to be either smoked plexiglass or solid steel, with locking, flush latches and concealed hinges. The choice is dependent on the environment application. Verify on the Telecommunications drawings as to the type to be specified..
   2. Options to allow for split doors and side panels ventilated and unventilated.
   3. The equipment rack will be assembled with manufacturer-supplied nut and bolt hardware.
   4. Painted with a black polyurethane powder-coat, textured paint and finished inside and outside.
   5. For those communication cabinets from the same manufacturer - floor or wall-mounted - and assigned to the same project, key latches to be keyed alike.
   6. Metal barriers options available to separate wiring of different systems and mounting of vertical surge protection modules.
   7. Accessories to include:
      a. Solid or louvered metal doors or plexiglass front doors.
      b. Adjustable feet or wheels where required for freestanding equipment
      c. Options for fans, vented roofs, and side panels.
      d. Ability to mount dual vertical PDUs.
   8. Cable entry knock-outs with rubber grommets or brushes to be located on the top, sides, and bottom.
   9. Front rack to be adjustable front-to-back to allow for active device sizing and mounting requirements for respective patch cord-to-door clearances.
   10. Equipment vertical mounting channels will be punched on the front and rear three (3) inch (76 mm) wide flange with the EIA/ECA-310-E universal mounting hole pattern.
   11. Vertical rails to be pre-tapped for #12-24 screws or nutplates spaced @ 1.75 inches (25 mm) or 1 RU.
   12. Free standing communication cabinets to be 7 ft. (84 inches or 2,134 mm) and 45 RUs in height. Labeled in descending order from the top to bottom.
   13. One (1) EIA equipment 'rack unit' or RU is measured at 1.75 inch (45 mm) between mounting holes.

14. Communication cabinets to be equipped with a 1" wide 49 each 2-hole pattern on a horizontal rack grounding busbar (RBB) with grounding lug to accommodate minimum #6 AWG stranded ground wire.
15. Painted with a polyurethane black powder-coat, semi-gloss paint.
16. To be approximately 23.4-24.00 inches (597-600 mm) wide with 17.72-inches (450-mm) between rails.
17. Dedicated bonding points for proper grounding and bonding to ANSI/TIA 607-D.
18. Adjustable legs.
19. Cable entry knock-outs with rubber grommets or brushes to be located on the top, sides, and bottom.
20. Optional add-on features including solid or louvered doors and top, fans, grounding and bonding capabilities, or adjustable and locking wheels..

B. Wall-mount pivotal steel communication cabinets and equipment racks:
1. The free-standing NEMA 250 Type 4/IEC 60529 IP65 rated pivotal communications cabinets to be constructed with galvanized-steel having removable side panels with front and rear hinged doors is to be used in both interior and exterior applications.
2. To be maximum 24 inches (610 mm) wide.
3. Standard cabinet heights; 24 inches (610 mm) to 48 inches (1219 mm) and depth of 20 inches (508 mm) to 26 inches (660 mm).
4. Outside plant version to have a minimum NEMA 250 Type 4/IEC 60529 IP65 rating.
5. Size may vary depending on the telecommunications location considerations and applications.
6. Minimum static load capacity for a wall-mount communications cabinet is 400 lbs (182 kg) and 70 lbs (32 kg) for a wall-mount open swing frame.
7. Each to have keyhole style slots on back supports to allow for more level and plumb mounting.
8. To be made of welded steel construction.
9. Vertical front rails to be pre-tapped for #12-24 screws or nutplates spaced @ 1.75 inches (25 mm) or 1 RU.
10. Lockable latching handles.
11. Designed for active or passive cooling systems.
12. Painted with a black or gray powder-coat, textured paint and finished inside and outside.
13. Reversible swing capacity.
14. Cable entry knock-outs with rubber grommets or brushes to be located on the top, sides, and bottom.
15. Optional add-on features including solid or louvered doors and top, fans, grounding and bonding capabilities.
16. Wall-mount cabinets to have a provision for mounting to an accessory mobile base for use as a floor-standing unit. Mobile base to be available separately.
17. Dedicated bonding points for proper grounding and bouncing to ANSI/TIA 607-D and NFPA-70 (NEC).

2.4 Hinged Wall Brackets

A. 2RU hinged wall bracket:
1. 19 inches (483 mm) wide X 2RU (3 ½ Inches (89 mm) in height X six (6) - seven (7) inches (152 mm - 178 mm) depth.

2. One (1) EIA equipment 'rack unit' or RU is measured at 1.75 inch (45 mm) between mounting holes.
3. Typical application for a 2RU 48-port modular patch panel.
4. No horizontal cable managers necessary.
5. Vertical rails to be pre-tapped for #12-24 screws or nutplates spaced @ 1.75 inches (42 mm) or 1 RU.

2.5 Cable Management

A. Conform to industry and UL standards and comply with the applicable cable/connector manufacturer warranty (bend radius) parameters.
B. Horizontal "rod" or lace cable managers rear:
    1. Metal rod or manufacturer custom plastic platform with built-in cable guides.
    2. Designed to manage 1 RU or 24 terminated cables.
    3. Screw-on with #12-24 screws or snap-on manufacturer provided rear wire manager.
C. Vertical cable managers:
    1. Double-sided seven (7) inch - nine (9) inch (178 -2297 mm) wide and rear-ring depth of six (6) to seven (7) inches (152 -178 mm).
    2. Hard-plastic mounting plate with evenly spaced pass-through with rounded edges holes to allow front-to-rear cabling access.
    3. To have the means to attached to the 2- or 4-post equipments racks.
    4. Flexible, rounded, and evenly-spaced plastic fingers or guides.
    5. Baked-polyester powder black coat finish.
    6. Dual-hinged metal or plastic cover to clip on installed gates or fingers allowing patch cord and cabling access without removing the cover.
D. Horizontal "finger" cable managers front:
    1. One-sided (facing the front) in 19 inch (483 mm) 1RU and 2RU versions.
    2. A metal or hard-plastic mounting plate.
    3. Flexible, rounded, and evenly-spaced plastic fingers.
    4. Durable baked-polyester powder coat semi-gloss finish.
    5. Dual-hinged metal or plastic cover to clip on installed gates or fingers allowing patch cord and cabling access without removing the cover.
    6. Front ring depth minimum 4.0 inches (90 mm).
    7. Available in 1RU and 2 RU versions using #12-24 mounting screws.

2.6 Steel Ladder Racking

General

1. "Ladder"rack type design having nine (9) inch (229 mm) rung spacing and a black powder spray semi-gloss finish.
2. Materials are to be steel rungs having a continuous, smooth tig or mig weld to the side rails to protect cable insulation and handling by the installers.
3. Side rails and rungs to be of a box construction will meet the NEMA Class 10 having the capacity to carry a uniformly distributed load of 50 pounds (22.67 kg) per ft. on six (6) ft.

(1.8 meter) support spans. A safety factor of x 1.5 requires support brackets every four (4) ft. (1.22 meters).

4. Minimum size is 18 inches (457 mm) wide by 1 ½ inches (38 mm) in height X 10 ft. (3 meter) length commonly referred to as "sticks".
5. Width of 12 inches (305 mm) based upon project specifications or by subsequent approval of UNLV/NDE, in turn, based upon the cable pathway application and cable density.
6. If used outside the telecommunications rooms, special-order colors may be specified based upon exposed ceiling color coordinations.
7. Radius drops are required for drop off into equipment racks or communication cabinets, sized to the width of the ladder rack, and from the same manufacturer of the ladder rack.
8. Dedicated bonding points for proper grounding and bouncing to ANSI/TIA 607-D.

PART 3: EXECUTION

3.1 Entrance Facilities (EF)

A. Contact the telecommunications service providers when needed to arrange for the installation of the demarcation point housing(s) and pathways.
B. Comply with requirements in Section 27 05 28; *Pathways for Communications Systems* for materials and installation parameters for inter-building outside plant (OSP) underground buried cabling systems.
C. Cabling installation in telecommunications rooms to be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.

3.2 General

A. 2-post or 4-post equipment racks or communications cabinets to be placed with a minimum of 36 inch (914 mm) clearance from the walls on both sides, aisle ways, and front of the rack(s)/cabinet(s) measured from the vertical cable managers. If the telecommunications room is small and does not provide for this allowance, ensure at least one side to have the 36 inch (914 mm) clearance and the rear of the 4-post a minimum of 24 inches (610 mm).
B. Equipment racks and communications cabinets grounded to the telecommunications ground bus bar in accordance with the current version of Section 27 05 26; *Grounding and Bonding for Communications Systems* of this document inclusive or ANSI/TIA 607-D and NFPA-70 (NEC).
C. Ensure the flush-mounted lockable key latches on the communication cabinets are working properly. If multiple units are installed, ensure that they are keyed alike and the keys are interchangeable.
D. Extra hardware not used for installing modular patch panels, cable managers and the like to be bagged and left with the equipment rack/communications cabinet upon completion of the installation.
E. Coordinate the installation of communications cabinets and equipment racks with other trades as not to disrupt the construction schedule of other trades.
F. Coordinate location of power receptacles on the ladder racking for the electricians.

3.3 Installation Guidelines for Free-standing Open Frame 2- and 4-post Equipment Racks and Communication Cabinets

A. Assemble equipment racks and cable management per manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
B. 2-post equipment racks single or in a row, maintain a minimum of 32 inches (813 mm) from the wall behind to the rear edge of any electronic device.
C. Mounting on raised floors requires a section of Unistrut angle iron that is sized and placed underneath the 2X2 floor panel beneath the communication cabinet or equipment racks; arrange Unistrut and secure between the two (2) mounting bolts then use thick fender washers and lock washers to tighten.
D. Floor-mounted equipment racks are to be securely attached to the concrete floor in four places; (minimum) two on each front and rear floor angle. If possible, use hardware and instructions supplied by the manufacturer.
    1. Recommended drilling ⅜ x 2 inch (51 mm) hole for a drop in anchor grommet.
    2. Caution to be taken not to drill more than 2.0 inches (51 mm) deep into the concrete so as not to penetrate the rebar or pre-stressed rods.
    3. Install the ⅜ inch x 1 ½ - 1 ¾ inch (38mm - 44 mm) long anchor bolts with ⅜ inch flat and locking washers.
E. Grounding lugs on each distribution frame equipment racks or communications cabinets to be located towards the top and positioned to route to secure the #6 AWG telecommunications bonding backbone interconnecting bonding connector (TBBIBC) onto the ladder racking to terminate onto the telecommunications room grounding busbar.
F. The 1-inch (25 mm) horizontal rack grounding busbar (RBB) to be located;
    1. On the backside of the aft vertical channels of a 2- or 4-post equipment rack.
    2. Bond the busbar to the equipment rack grounding lug which, in turn, is bonded to the ladder racking that is bonded to the telecommunications busbar.
G. Attach vertical wire managers on each side.
H. Ensure that ladder racking radius drops are aligned vertically with the routes into the left-right vertical cable managers.

3.4 Installation Guidelines for Free-standing Communication Cabinets

A. Assemble communication cabinet and accessories per manufacturer's instructions.
B. The 1-inch (25 mm) horizontal rack grounding busbar (RBB) to be located;
    a. On the backside on the aft side of the communication cabinet's rear vertical channels
    b. Bond the busbar to the communications cabinet grounding lug which, in turn, is bonded to the ladder racking that is bonded to the telecommunications busbar.
C. Level and plumb cabinets with adjustable legs or locking wheels.
D. Identify and install the knockouts as required for cable routing.
E. Ensure the basket tray, ladder racking, and fiber runner pathways are properly aligned vertically to the communication cabinets location(s).

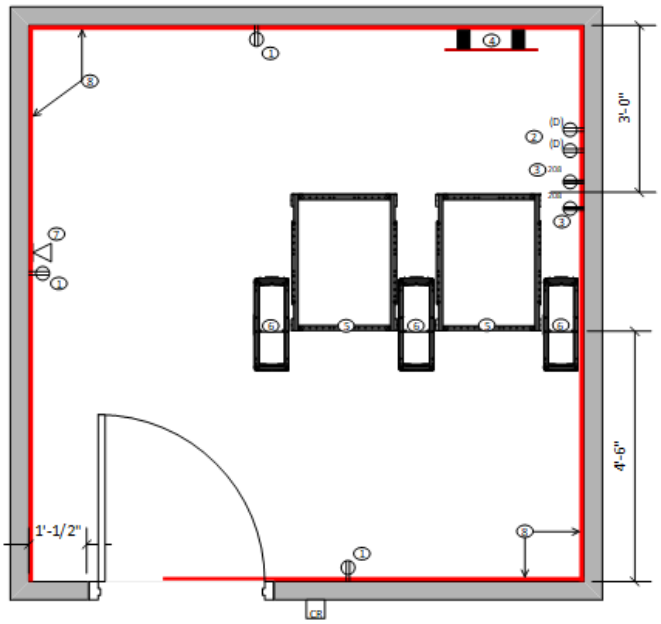
3.5 Installation Guidelines for Wall-mount Pivotable Communication Cabinets

A. Be mounted on a ¾ inch (19 mm) AC void-free fire-rated plywood wall backboard unless for outside plant (OSP) applications (like garages).
B. Ensure the unit is level and plumb and the swing is in the correct orientation.
C. Install with consideration for the cable pathway to optimize cable routing and less exposure to the cable.
D. Ensure the flush-mounted lockable key latches on the communication cabinets are working properly. If multiple units are installed, ensure that they are keyed alike and the keys are interchangeable.
E. Determine in advance the electrical power and grounding considerations.

3.6 Installation Guidelines for Cable Management

A. Provide horizontal cable managers facing the front;
    1. 2RU underneath each optical fiber enclosure
    2. 1RU between and underneath each modular patch panel
    3. 2RU on top of the first switch, between and underneath each switch
    4. Have built-in, clip-on hinged covers without fasteners to cover the fingers.
B. Provide horizontal cable manager rod or manufacturer platforms with cable guides on the rear supporting 1 RU of (24 each) terminated copper UTP cables. Use black ½" Velcro™ to secure cables, not tie-wraps, to ensure proper bend radius.
C. Provide seven (7) inch (178 mm) wide X six (6) inches (153 mm) double-sided vertical cable managers;
    1. On the sides and in-between 2- or 4-post equipment racks.
    2. Have built-in, clip-on hinged covers without fasteners to cover the fingers 27 11 26 Fig 1: *TR-IDF Room Layout*:

TR-IDF Room Layout



This is for initial design only.

OIT shall provide room layout and rack elevations to Planning and Construction for use in design.

Room size may vary depending on the number of data cables run to the MDF.

Reference current UNLV OIT Wiring Specifications for full room requirements.

KEYNOTES	
Number	**Description**
①	Non-Dedicated 20 Amp Receptacle
②	Dedicated 20 Amp NEMA 5-20 Receptacle
③	Dedicated 30 Amp NEMA L6-30 Receptacle
④	Secondary Grounding Busbar
⑤	4-post Network Rack
⑥	8-inch Vertical Manager
⑦	2-port Data outlet (location to be verified by NDE)
⑧	Fire-treated backer board, 3/4", 4' x 8', bottom at 8" AFF

Space Type: Support: IDF Room

Square Footage: 100 minimum

Adjacency: Central to served area

Natural Lighting: No

Artificial Lighting: Service w/glare Reduction

Acoustical Issues: N/A
Communications: As shown

Flooring: Sealed concrete or low dissipative VCT

Audio/Visual: N/A

Fixed Equipment: Network Rack - anchored to floor

Heating and Cooling: Dedicated HVAC. Provide discrete support cooling system

Access: Proximity with backup keyed access

Ceiling: N/A

Casework: N/A

Walls: Semi-gloss paint

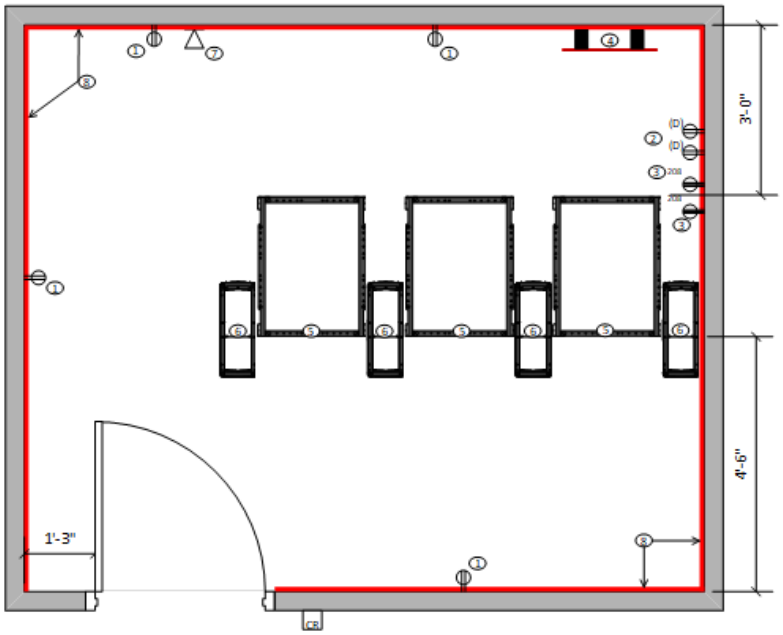
Other Requirements: Access to cable trays.

Sleeve 4" conduits into room – exact location and number to be coordinated with IT.

Ladder rack to be installed at 90" AFF and shall be 18" wide. Layout to be determined by OIT

27 11 26 Fig 1: *TR-IDF Room Layout*

ER-MDF Room Layout



This is for initial design only.

OIT shall provide room layout and rack elevations to Planning and Construction for use in design.

Room size may vary depending on the number of data cables run to the MDF.

Reference current UNLV OIT Wiring Specifications for full room requirements.

KEYNOTES	
Number	**Description**
①	Non-Dedicated 20 Amp Receptacle
②	Dedicated 20 Amp NEMA 5-20 Receptacle
③	Dedicated 30 Amp NEMA L6-30 Receptacle
④	Secondary Grounding Busbar
⑤	4-post Network Rack
⑥	8-inch Vertical Manager
⑦	2-port Data outlet (location to be verified by NDE)
⑧	Fire-treated backer board, 3/4", 4' x 8', bottom at 8" AFF

Space Type: Support: MDF Room

Square Footage: 120 minimum

Adjacency: Central to served area

Natural Lighting: No

Artificial Lighting: Service w/glare Reduction

Acoustical Issues: N/A
Communications: As shown

Flooring: Sealed concrete or low dissipative VCT

Audio/Visual: N/A

Fixed Equipment: Network Rack - anchored to floor

Heating and Cooling: Dedicated HVAC. Provide discrete support cooling system

Access: Proximity with backup keyed access

Ceiling: N/A

Casework: N/A

Walls: Semi-gloss paint

Other Requirements: Access to cable trays.

Sleeve 4" conduits into room – exact location and number to be coordinated with IT.

Ladder rack to be installed at 90" AFF and shall be 18" wide. Layout to be determined by OIT

27 11 16 Fig 2: *ER-MDF Room Layout*

3.7 Installation Guidelines for Hinged Wall Brackets

A. Be mounted on a ¾ inch (19 mm) AC void-free fire-rated plywood backframe unless for outside plant (OSP) application like garages.
B. Ensure it is level and plumb before tightening wood screws.

3.8 Installation Guidelines for Ladder Racking

A. Bonding each section of adjoining ladder rack sections:
    1. To be bonded with a double-hole double crimp jumper of #6 AWG stranded wire at a minimum on one side of the ladder rack sections.
    2. Stay consistent on the same sides for longer runs.
    3. Remove any paint before securing the jumpers and use properly sized 'star' washers with self-tapping screws.
B. Confirm ladder rack, tray, racks/cabs are bonded and grounded to the telecommunication rooms busbar PBB/TMGB or SBB/TGB per Division 27 05 26: *Grounding and Bonding for Communication Systems.*
C. Ladder racking to be mounted per manufacturer load-bearing instructions; flat side on top and channel sides secured on the bottom with J-bolts. Do not make a trough of the ladder racking.
D. Allow a minimum of seven (7) inches (178 mm) between the ladder racking and any 4-inch (102mm) conduit sleeves (measured from the end of the adapter collar and plastic grommet) protruding from the ceiling.
E. Ladder racking mounted and supported to be supported by the telecommunications room plywood walls; use angle or "elbow" support brackets from the same manufacturer with properly sized anchors, spaced at a minimum every five (5) ft. (1.52 meters), underneath adjoining butting sections, and per manufacturer's instructions.
F. Use equipment racks brackets to secure ladder racking to the equipment racks.
G. Use butt splice connecting hardware brackets for adjoining two sections.
H. Ensure the ladder racking is at the same height and level throughout the telecommunications room.
I. If painted, remove paint and clean the area where the two-hole double-crimp jumper is required to bond between each section or 'sticks'. Use appropriate sized self-tapping screws with lock washers.
J. If anodized or annealed - unless stipulated by manufacturer instructions - no jumpers are required between sections if using manufacturer approved splice connectors.
K. Both painted and anodize ladder rack/cable tray assemblies to be bonded with #6 AWG telecommunications bonding conductor (TBC) to the telecommunications busbar on one end only. Use only double-hole double-crimp lugs.
L. For tall ceilings, the use of ceiling mounted threaded rod may be required as a means of designing a suspension by using support clamp brackets or Unistrut with washers and nuts.
M. Install properly sized radius drops for each equipment rack and communications cabinet.
N. Black rubber end caps required on all exposed ends of the ladder racking.

3.9 Identification Schedule

A. Labeling identifier of the telecommunication room 4-inch (102 mm) conduit stub-up as to their origin.
B. Facing front left to right; place ¾ inch (19 mm) self-laminating adhesive label in the center top “L” bracket “RACK 1” and then “RACK 2” and so forth for multiple equipment racks.
C. Any communications cabinets to have the same pattern; “CABINET 1” and so forth for multiple cabinets.
D. UNLV/NDE may require a custom labeling system that will be noted in the project specifications.

3.10 Cleaning

A. Keep the telecommunications clean; practice good "sweep clean" housekeeping and remove trash on a daily basis.
B. Fiber troughs “Runners”, if any, to be thoroughly cleaned out inside troughs that may require vacuuming with HEPA filter vacuum cleaner.
C. Comply with Section 27 01 00 Part 3; EXECUTION 3.5: At end of the telecommunication rooms buildout, Contractor/Sub agrees to thoroughly clean and vacuum all dust and debris; this includes but not limited to the equipment racks, cabinets, TDUs, and wire managers "fingers", all exposed conduit and electrical boxes, equipment rack and wall mount enclosures, lighting, top of racks, and HVAC ducting.
D. Upon project completion, remove equipment, materials, and debris, leaving the area in undamaged, clean condition.

3.11 Examination and Acceptance

A. Equipment rack and communications cabinets to be placed per project specifications floor drawings, plumb, aligned with each other and square to the room. Equipment racks to be properly secured to the floor using the four (4) each mounting holes.
B. Cabling installation in telecommunications rooms to be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.
C. Communication cabinets to be level and plumb. Doors, side panels, channels, and top properly assembled, no gaps, and bonded with the Telecommunications Equipment Bonding Conductor (TEBC) to the telecommunications room grounding busbar (TBB).
D. Locking flush latches work properly; locking and unlocking the door and multiple cabinets are all keyed alike.
E. Equipment racks are to have the 1-inch (25 mm) Rack Bonding Busbar (RBB) mounted on the aft top side of the rear channel posts.
F. Communication cabinets to have the 1-inch (25 mm) Rack Bonding Busbar mounted on the top aft side of the rear channel posts or whatever means is more practical.
G. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a ‘punch list’ to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C

PM. In turn, the UNLV/P&C PM will notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.12 Close-out Submittals

A. Product data sheets should be the same as the pre-bid Submittals.
B. Within 30 days of the substantial completion of the project or prior to project closeout -- which ever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub's one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.

SECTION 27 11 00: COMMUNICATIONS EQUIPMENT ROOM FITTINGS

——— End of Section 27 11 16 ———

Communications Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides

SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

Sections 27 11 19 and 20

Communications Copper Modular Patch Panels and Optical Fiber Enclosures

PART 1: GENERAL

1.1 Summary

A. This Section is specific to modular patch panels and optical fiber enclosures for communications systems. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for either or a combination of modular patch panels and optical fiber enclosures communications systems components in either new or retrofit construction.
B. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of *Modular Patch Panels and Optical Fiber Enclosures* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).
C. This Section is specific to:
    1. Copper 2RU 48-port modular patch panels field configurable for both digital IP voice and data applications
    2. Optical fiber enclosures for intra- and inter-building connectivity
D. The universal color for modular patch panels and optical fiber enclosures is black.
E. Standard width required for modular patch panels and optical fiber enclosures compatible to fit 19 inch (482 mm) wide equipment racks and communications cabinets with matching color of black (except gray for wall mount swing cabinets).
F. The only bonding requirement would be providing a grounding lug for optical fiber conductive (OFC) cable. In turn, the cabinet to be bonded to the 1 inch (25 mm) rack bonding busbar (RBB) with #6 AWG stranded cable.
G. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
H. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.

1.2 Related Documentations and References

A. The subsections listed in the *Table of Contents* are considered to be “Related Documents”.
B. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications*, 27 10 00; *Structure Cabling Hardware*, 27 13 00; *Communications Optical Fiber Backbone Cabling,* and 27 15 00; *Communications Copper Horizontal Cabling* includes the following:
    1. Section 27 01 00; *Operation and Maintenance of Low-Voltage Communications Systems*
    2. Section 27 05 26; *Grounding and Bonding*

3. Section 27 05 28; *Pathways for Communications Systems*
4. Section 27 05 36; *Cable Trays*
5. Section 27 05 53; *Identification for Communication Systems*
6. Sections 27 10 20 .10 and .30; *Copper System Testing and Documentation*
7. Sections 27 10 20 .20 and .30; *Optical Fiber Cable Testing and Documentation*
8. Section 27 11 10; *Telecommunications Rooms and Backboards*
9. Section 27 11 16; *Communication Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides*
10. Section 27 13 23 .01; *Intra-building Optical Fiber Backbone Cabling*
11. Section 27 13 23. 02; *Inter-building Optical Fiber Backbone Cabling*
12. Section 27 15 01 .13; *Communications Copper Horizontal Cabling Station Applications and POE*
13. Section 27 15 01 .19; *Data Communications Copper Horizontal Cabling*
14. Section 27 15 01 .20; *Wireless Data Communication Copper Horizontal Cabling*

C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
   1. Appendix A; *Codes, Standards, and Regulations*
   2. Appendix B; *Abbreviations and Acronyms*
   3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
   4. Appendix D; *Rack Elevation and Room Sizing Drawings*

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

E. The modular patch panels and optical fiber enclosures will comply with the requirements of the current versions and practices in;
   1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)
   2. BICSI *Information Transport Systems Installation Methods Manual* (ITSIMM)
   3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
   4. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*
   5. ANSI/TIA 568.1; *Commercial Building telecommunications Standard, Part 1: General Requirements*
   6. ANSI/TIA-568.2-D; *Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling*
   7. ANSI/TIA 568.3-E; *Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Component Standard*
   8. ANSI/TIA-569-E; *Commercial Building Standard for Telecommunications Pathways and Spaces*
   9. ANSI/TIA/TIA-606-D; *Administration Standard for Commercial Telecommunications Infrastructure*
   10. ANSI/TIA 607-D; *Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises*
   11. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facilities*
   12. ANSI/ICEA S-102-732-2009; *Standard for Cat 6 and 6A; 100 ohm Individually Unshielded Twisted-pair Indoor Cables*

13. EIA 310-E; *Cabinets, Racks, Panels, and Associated Equipment*
14. ISO/IEC 11801-1 4th Edition; *EN 50173-2: 2007 + A1: 2012 (CENELEC TC215); Information Technology - Generic Cabling for Customer Premises (Sept, 2017) - Part 1: General Requirements and, Part 2: Office Premises*
15. NFPA-70 *National Electric Code*
16. NEC Article 250; *Grounding and Bonding of Electrical Systems*
17. UL 467; *UL Standard for Grounding and Bonding Equipment*
18. UL 969A; *UL Standard for Marking and Labeling Systems*
19. UL 1479*; UL Fire Tests of Through Penetration Firestops*

1.3 Pre-bid Submittals

A. Provide product data sheets and installation instructions for each type of product. This is to include material descriptions, dimensions of individual components, profiles, color (black) and finishes that comply with this Division 27 document.
B. Architectural drawings to include elevation drawings of the equipment racks and communications cabinets with the mounting and placement of the optical fiber enclosures, modular patch panels and cable management.

1.4 Contractor/Sub Qualifications

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).
C. Contractor/Sub required to be a manufacturer authorized installer of the modular patch panels (and work area outlets and connectors) and/or optical fiber enclosures.
D. Contractor/Sub also required to be a manufacturer authorized installer of the cable being installed and terminated.

1.5 Quality Assurance and Warranty

A. Installed Cat 6A/Class EA balanced UTP and optical fiber cabling systems, pathways, and distribution facilities will adhere to manufacturer instructions for warranty purposes, contract drawings and specifications, applicable codes, standards and regulations.
B. Install modular patch panels and optical fiber enclosures on the equipment rack or communications cabinets as defined in the elevation drawings for each telecommunications room.
C. Provide a Cat 6A/Class EA balanced UTP cabling systems and terminate onto the modular patch panels and field test to the requirements of ANSI/TIA-568.0-E, ANSI/TIA-568.1-E and ANSI/TIA-568.2-D.

D. Provide the standard and/or ABF optical fiber systems and field test to the requirements of ANSI/TIA-568.0-E, ANSI/TIA-568.1-E and ANSI/TIA/EIA-568.3-E.
E. Only solid-conductors and not stranded copper cable is to be terminated.
F. Installed products will be free of defects in material and workmanship.
G. Both modular patch panels and enclosures mounting holes/slots are spaced for EIA spacing @ 1.75 inches (44 mm) or "1 RU" (rack space) and to be installed in a neat and workmanlike manner using black #12-24 screws.
H. Products to be furnished with manufacturer's instructions and mounting hardware.
I. Provide the 25-year manufacturer warranty for the particular project.
J. Products to be UL Listed and be manufactured by an ISO 9000/9001 approved manufacturer and be RoHS 2011/65/EU compliant..
K. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.

PART 2: PRODUCT

2.1 General

Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*

2.2 Copper Modular Patch Panels:

A. General
   1. Materials to be of the high-quality and features as indicated in the pre-bid submittals.
   2. Panel frames to be black-powder coated with textured finish minimum 14 gauge steel with rolled edges top and bottom for proper stiffness.
   3. Silk-screened white labeled ports #1-#12/#13-#24 top row and #25-#36/#37-#48 bottom row, and an white area on each designated for the (2-row) port identifiers.
   4. Use of a single standard or 4-pair custom 110-style Insulation Displacement Contact (IDC) termination 'punch down' tool.
   5. Designed for terminating 4-pair, balanced 100-ohm UTP 23-24 AWG cable onto tapered 110-style IDCs that can be configured to 568B wiring.
   6. Contacts to be flat and have a minimum 50 microns of gold to accept a minimum 500 mating cycles without signal degradation.
   7. To accept a clip-on or mounted rear cable management lacing bar to provide cable strain relief.
   8. Modular patch panels terminated cable trajectory to be in compliance with connector manufacturer instructions (straight out or 90-degrees).
   9. The 2 RU 48--port modular patch panel - fully PCB loaded or unloaded/open - the faceplates and modular Keystone-style jacks to be from the same connector manufacturer. Cable to be either from the same connector manufacturer or an approved and documented equivalent business partner.
   10. Cat 6/Class E modular patch panels able to support IEEE 802.3ab 1GBase-T.
   11. Cat 6A/Class EA modular patch panels able to support IEEE 802.3an 10GBase-T.
   12. Cat 6A/Class EA to support WiFi IEEE 802.3bt for PoE++ Type 3 (60W).

13. UL Listed 1863
14. The "Cat 6" or "Cat 6A/Class EA" designation rating of the modular patch panel to be visible from the front side when installed. Rear side preferred, but not mandatory.
15. High density 1RU 48-port 2RU configurations are not acceptable without express authorization from UNLV/NDE.

B. Fully loaded 48-port modular patch panel
   1. Standard is the 2 RU 48-port IDC PCB flat version with un-keyed FCC-compliant 8P8C RJ-45 female jacks on individual jacks mounted pins up/tab down.
   2. Rated to support and be connector manufacturer-approved Category 6A UTP (unless a retrofit for Cat 6 is required).
   3. Fully-loaded PCB style boards to be fully enclosed front and rear for physical protection.
   4. Contacts to be flat and have a minimum 50 microns of gold to accept a minimum 500 mating cycles without signal degradation.
   5. IDC contact to have tapered pair-splitting features to aid in wire insertion and minimize pair un-twists.
   6. Contacts to be flat and have a minimum 50 microns of gold to accept a minimum 500 mating cycles without signal degradation.
   7. Built-in hinged dust covers are acceptable.
   8. Krone LSA™ and Nortel BIX™ IDCs are not acceptable.
   9. Jacks to be mounted pins up/tab down.
   10. Stuffer caps to have retention snap to ensure conductor strain relief after termination.

C. Unloaded or open 48-port modular patch panel
   1. Standard is the 2 RU 48-port unloaded or open port modular patch panel.
   2. To snap-in Keystone style black unkeyed 8P8C RJ-45 female FCC-compliant modular jacks
   3. Individual jack housings to be fully encased to protect the PCB or printed circuit board and ultrasonically welded for tamper resistance.
   4. Krone LSA™ and Nortel BIX™ IDCs are not acceptable.
   5. Jacks to be mounted pins up/tab down.
   6. Built-in hinged dust covers are acceptable.
   7. Stuffer caps to have retention snap to ensure conductor strain relief after termination.
   8. Note: The last patch panel in the telecommunications room equipment rack or communications cabinet to be the unloaded/open type.

2.3 Optical Fiber Enclosures:

A. General
   1. Fiber patch panels to provide termination and interconnectivity for the campus optical fiber architecture network.
   2. Used to house pre-terminated standard "LGX-style" 12-strand fiber 6-ports or 'high-density' 24-strand fiber 12-ports single-strand, Telcordia-approved, fiber cassette modules. These fully-enclosed 'snap-in' cassette modules house duplex UPC-polished LCs housed with a pigtail for fusion splicing onto standard or ABF or traditional optical fiber trunks.
   3. Note; If Corning Compatible Connector Housings are used, they need to accommodate LGX style compatible modules
   4. Standard LC "6-pack" or "12-pack" duplex feed-through LC adapter plates are non-applicable.

5. Rear of optical fiber enclosure to have cable tie-down features to accept various OD diameters of backbone optical fiber cables.
6. When viewed vertically, each duplex port is identified from the front view with fiber "1" top left side (blue strand) and fiber "2" (orange strand) right side. This continues downward to "3-4", "5-6" and so forth to "11-12" (rose/acqua) = 24 fiber strands.
7. When viewed horizontally, each duplex port is identified from the front view with fiber "1" far left bottom (blue strand) and fiber "2" (orange strand) far left top. This continues across to "3-4", "5-6" and so forth to "11-12" (rose/acqua)= 24 fiber strands.
8. Be cautious when cross-connecting horizontally-mounted cassettes to vertically -mounted cassette ports so as not to possibly roll the patch cord polarity.
9. Inner rear tray post area to secure optical fiber service loop.
10. Hinged front and rear clear or smoked-plexiglass access doors.
11. Cassettes to have alpha identifiers with first “A”, followed in sequence by “B”, “C”, and so forth.
12. To be available in:
    a. 1RU horizontal cassette mount; three (3) modules X 12 or 24 = 36 or 72 fiber strands. One row only of horizontally-mounted cassettes left to right; “A - B - C”.
    b. 2RU horizontal cassette mount; six (6) modules X 12 or 24 = 72 or 144 fiber strands. Two rows of horizontally-mounted cassettes top row left to right; “A - B - C” and second lower row “D - E - F”.
    c. 4RU vertical cassette mount; twelve (1) modules X 12 or 24 = 144 or 288 fiber strands. One row of vertically mounted cassettes left to right; “A - B - C - D - E - F - G - H - I - J - K - L”.

PART 3: EXECUTION

3.1 Installation Guidelines for Copper Modular Patch Panels:

A. First modular patch panel to begin after optical fiber enclosure(s).
B. If two equipment racks, modular patch panels to be mounted on the left equipment rack (and the active devices on the right equipment rack).
C. If three equipment racks, modular patch panels to be split evenly as possible between equipment Rack #1 and #3 (with the active devices between in Rack #2).
D. Install 1 RU horizontal cable manager between and the bottom of each modular patch panel.
E. Mount a rear cable wire lacing bar or manufacturer cabling guide bar to support the 48 ports of terminated Cat 6 Class E/Cat 6A Class EA ports using black Velcro™.
F. Modular patch panels not to accept FCC compliant 6-position (RJ-11) plugs.

3.2 Installation Guidelines for Optical Fiber Enclosures:

A. Mount optical fiber enclosures on top of equipment racks or communication cabinets above modular patch panels.
B. Allow 1RU empty space or gap immediately above each optical fiber enclosure.
C. If two equipment racks, optical fiber enclosure to be mounted on the top left equipment rack (and the active devices on the right equipment rack).

D. If three equipment racks, optical fiber enclosures to be split evenly as possible between equipment Rack #1 and #3 and mounted on top of each (with the active devices between in Rack #2).
E. Install 2RU horizontal cable cable manager at the bottom of each optical fiber enclosure.
F. If applicable, optical fiber conductive (OFC) - or armored cable - and the ABF shielded outer sheath to be properly bonded to the enclosure's ground lug per manufacturer instructions. In turn, the enclosure needs to be bonded to the 1 inch (25 mm) rack bonding busbar RBB).

3.3 Cleaning

A. Contractor/Sub to use painters tape to cover exposed modular patch panel and switch ports if dust, drilling, and sanding is prevalent or planned.
B. Keep the telecommunication rooms clean; practice good "sweep clean" housekeeping and remove trash on a daily basis.

3.4 Identification Schedule

A. Copper Modular Patch Panels:
    1. Affix a 1/2 inch (12-14 mm) self-laminating adhesive black-on-white label with "P1" on the first modular patch panel and "P2", "P3" for each successive patch panel
    2. Place on the far left side centered between the mounting holes/slots.
    3. Each permanent link is assigned a unique 'identification number' or ' identifier';
       "Work Area ID #" - "MDF/IDF ID #" - "Patch Panel (PP) ID #" - "Port ID #"
       Or, if required, a custom identifier for special applications (e.g. bollards WiFi).
B. Optical Fiber Enclosures:
    1. Install the housing and the assigned module cassettes.
    2. Affix a ½ inch (12-14 mm) self-laminating adhesive black-on-white label with "F1" on the first modular patch panel and "F2", "F3" for each successive optical fiber enclosure.
    3. Optical fiber enclosures are to be labeled front and rear.
    4. Place on the far left side centered between the mounting holes/slots.
    5. Place the ½ inch (25 mm) alpha letter sequentially on each of the module cassettes.
    6. Using machine generated labels; identify each of the module cassettes' fiber strands in alpha-sequence left-to-right and its origin. For example: "A" (Fibers #1-24), "B" (Fibers #25-48), the next "C' (Fibers #49-72) and so forth.
    7. Match the identifier label for each ABF fiber microduct to the corresponding module cassette.
    8. Affix two (2) labels to both the inside of the front door when opened downwards and the outside when closed:
       Row 1: "Bldg abbreviated name - room #"
       Row 2: "Fiber enclosure #F - cassette letters"
       Row 3: "Type of optical fiber or SMF - # of strands"
    9. Fiber strand numbering to be consistent with the Consecutive Fiber Numbering (CFN) sequence as identified in the latest version of ANSI/TIA 568.2-D. This fiber stand numbering sequence between each fiber link will be adhered to at each terminated end of the optical fiber cable; straight-thru termination 1-1, 2-2, 3-3, and so forth only. The rolling of fiber optic strands 1-2,2-1, 3-4, 4-3 is not acceptable

3.5 Examination and Acceptance

UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM will notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.6 Close-out Submittals

A. None are required. Testing with the modular patch panels and optical fiber enclosures will be incorporated into the test results in accordance with 27 10 20.10 and .30; *Copper System Testing and Documentation* and 27 10 20.20 and .30; *Optical Fiber Cable Testing and Documentation.*
B. Within 30 days of the substantial completion of the project or prior to project closeout -- which ever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub's one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.

SECTION 27 11 00: COMMUNICATIONS EQUIPMENT ROOM FITTINGS

——— End of Sections 27 11 19 and 20 ———

Modular Patch Panels and Optical Fiber Enclosures

SECTION 27 13 00

COMMUNICATIONS BACKBONE CABLING

Sections 27 13 23 .01 and .02

Communication Intra- and Inter-building Optical Fiber Backbone

PART 1: GENERAL

1.1 Summary

A. This Section is specific to communication intra- and inter-building optical fiber backbone for communications systems. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for either or a combination of communication intra- and inter-building optical fiber backbone systems components in either new or retrofit construction.

B. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of *Communication Intra- and Inter-building Optical Fiber Backbone* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).

C. The Contractor/Sub to include in their bid price, communications cabling that has become abandoned as part of a renovation project, previous renovation projects, or temporary communications cables used during the construction process to be completely removed.

D. This Section is specific to optical fiber intra- and inter-building optical fiber backbone using 8.3/125 µm single-mode fiber OS1A (Indoor) OS2 (Indoor/outdoor) optical-rated glass.

E. The inter-building optical fiber backbone cabling system provides the interconnections between the communications equipment rooms - main distribution frames (ER-MDF) entrance facilities (EF) between buildings.

F. Whereas the intra-building optical fiber backbone cable provides the interconnections between the equipment rooms - main distribution frames (ER-MDF) and the telecommunications rooms - intermediate distribution frames (TRs-IDFs) in the telecommunications cabling system infrastructure.

G. Splitters and fusion-splicing mid-span or between fusion-spliced termination points is not acceptable except for emergency purposes.

H. Installation work and materials will conform to each detail in the rules and requirements of the National Fire Protection Association, the locally enforced National Electrical Code (NEC) by the authority having jurisdiction (AHJ), current manufacturing standards, and State regulations.

I. The inter-building (between) or outside plant (OSP) 'campus standard' is Air-blown/jetted (ABF) fiber having 19-cell micro-ducts with a minimum 48 fiber strands of 8.3/125 µm single-mode optical glass.

J. Other reduced tube/cell counts will be used in other applications. This includes branch circuits breaking out from a telecommunications distribution unit (TDU) inside a maintenance hole (MH) and/or vault (V).

K. 'Inside/outside' ABF outer sheath jacketing with a fire-rating is preferred. If not, then the ABF outer sheath jacketing to transition to a fire-rated jacketing inside a TDU within 50-ft. (15.2 meters) of entering a building. The exclusion per the NEC is if it is routed inside rigid metallic

conduit (RMC) which includes intermediate metallic conduit (IMC) or galvanized rigid conduit (GRC) all the way to the entrance facility (EF) or as a pass-through the building. NOTE**:** Electrical metallic tubing (EMT) is not acceptable.

L. Check project specifications for rodent-proof requirements which includes:
    1. Rodent-resistant pullover flex-braided plastic or metal sox or,
    2. Armored shield jacketing is classified as optical fiber conductive (OFC).
M. The intra-building (within) or inside plant (ISP) 'premises' standard is 900 um tight-buffer 'distribution' single-strand non-breakout optical fiber cable always having a plenum rating (optical fiber nonconductive plenum or OFNP).
N. Unless specified in the project specifications, UNLV typically does not have any applications for the following anywhere on campus:
    1. Fiber To The Desk (FTTD) or other horizontal applications.
    2. Ribbon or rollable fiber cable
    3. Loose tube fiber distribution cable
    4. Loose tube or tight-buffer fiber breakout style cable
    5. Optical fiber conductive (OFC) or armored cable
    6. Splitters or multi-plexers
O. Single-mode fiber is terminated onto optical cassettes with pigtails for splicing.
P. Cassettes to be mounted in equipment rack or communications cabinet-mounted optical fiber enclosures
Q. Vertical runs of backbone cables inside telecommunications rooms to be secured and fashioned onto vertically-mounted ladder racks in an orderly manner and dressed appropriately.
R. Backbone cables spanning more than three (3) floors to be supported at the top of the cable run with wire mesh Kellum™ grips on the third floor and every alternating floor.
S. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant..
T. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.

1.2 Confined Spaces and Hazardous Assessment Protocol

A. In the bid process project overview, UNLV/NDE along with UNLV/P&C and UNLV/FMS project managers (PM) will conduct a visual walkthrough inspection of the identified pathways of the project inclusive of the maintenance holes (MHs) and vaults (Vs).
B. Open inspection without entry to a OSHA defined 'confined space' is permissible for top-view inspection only. A 'pre-entry checklist' will be distributed to each bidder to complete during the walk-through and to keep for their records.
C. Should any poisonous spiders, snakes, frogs, rodents or whatever it takes be prevalent, UNLV/FMS will contact the exterminator before entry can be conducted.
D. UNLV/P&C will include in the request for quotation (RFQ)
    1. The prerequisite that the Contractor/Sub provide in their submittals their in-house confined space protocol (as required)
    2. They are also to include the assigned on-site technicians confined space certifications
    3. Contractor/Sub to submit an addendum to the RFQ bid with extra costs associated with this confined space entry protocol. Be aware that if multiple maintenance holes (MHs)

and vaults (Vs) are open, they have to be manned and equipped with rail guards, personnel, blowers, tripod crank retrieval, and more.

4. This documentation will be reviewed and must be approved by UNLV/FMS before the Contractor/Sub can conduct business in any maintenance hole (MH) or vault (V).

E. The low-volt contractor will provide a projected schedule of maintenance hole (MH) /vault (V) work to be completed. This schedule will be forwarded by UNLV/P&C to UNLV/FMS project manager and UNLV/NDE.

F. Once the project is awarded the Contractor/Sub needs to go to the website;
UNLV Permit Required Confined Space Entry Program
(https://www.unlv.edu/sites/default/files/page_files/27/RMS-ConfinedSpaceEntryProgram.pdf)

1. Fill out the "Confined Space Entry Notification Permit Request" form based upon their provided schedule:
Confined Space Entry Notification
(https://rms.unlv.edu/forms/permitRequest/index.php?p=8).
2. Allow a minimum 24-hour advanced notice.
3. Have your schedule and checklists on-site and readily available for inspection by UNLV/FMS.

G. The Contractor/Sub will also be issued with a second checklist for those items required for OSHA defined confined space entry and safety protocol.

1.3 Related Documentation and References

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".

B. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications*, 27 10 00; *Structured Cabling Hardware*, 27 11 00; *Communications Equipment Room Fittings,* and 27 15 43; *Communications Work Area Faceplate/Telecommunications Outlets, Surface Mount Boxes, and Connectors* includes the following:

1. Section 27 01 00; *Operation and Maintenance of Low-Voltage Communications Systems*
2. Section 27 05 28; *Pathways for Communications Systems*
3. Section 27 05 36; *Cable Trays*
4. Section 27 05 43; *Underground Ducts and Raceways for Communications Systems*
5. Section 27 05 53; *Identification for Communication Systems*
6. Sections 27 10 20 .20 and .30; *Optical Fiber Cable Testing and Documentation*
7. Section 27 11 16; *Communication Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides*
8. Section 27 11 20; *Communications Optical Fiber Enclosures*
9. Section 27 15 43 .15; *Communications Fiber Connectors and Cassettes*

C. Material and work specified to comply with the applicable requirements of the current revisions of the following:

1. Appendix A; *Codes, Standards, and Regulations*
2. Appendix B; *Abbreviations and Acronyms*
3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
4. Appendix D; *Rack Elevation and Room Sizing Drawings*

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

E. Optical fiber intra- and inter-building optical fiber backbone cables to comply with the requirements of the current versions and practices in:

1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)
2. BICSI *Information Transport Systems Installation Methods Manual* (ITSIMM)
3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
4. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*
5. ANSI/TIA-455 Series; *Standard Test Procedures for Testing Optical Fiber*
6. ANSI/TIA 472; *General Specifications for Fiber Optic Cables*
7. ANSI/TIA-526-7A; *Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant*
8. ANSI/TIA 568.1; *Commercial Building Telecommunications Standard, Part 1: General Requirements*
9. ANSI/TIA 568.3-E; *Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Component Standard*
10. ANSI/TIA 569-E; *Telecommunication Pathways and Spaces*
11. ANSI/TIA 598-D; *Optical Fiber Cable Color Coding in Cable Addendum for Additional Colors*
12. ANSI/TIA 604-FOCIS 10; *Fiber Optic Connector Intermateability Standard*
13. ANSI/TIA-606-C *Administration Standard for Telecommunications Infrastructure*
14. GR-20-CORE; *General Requirements for Optical Fiber Cable*
15. GR-326-CORE; Telcordia/Ericsson *Generic Requirements for Single-mode Optical Connectors and Jumper Assemblies*
16. GR-356-CORE; *Generic Requirements for Optical Cable Innerduct, Associated Conduit, and Accessories*
17. GR-409-CORE; *Telcordia General Requirements for Premises Fiber Optic Cable*
18. ICEA S-104-696; *Indoor/Outdoor Optical Cable*
19. IEC 874-10; *Sectional 10 Specification Fiber Optic Connectors*
20. GR-3155-CORE; Telcordia/Erickson *General Requirements for Single/Bundled Microducts and In-Living (ILU) Cable Pathways*
21. IEC 61280-4-2; *Fibre-Optic Communications Subsystem Test Procedure - Part 4-2: Installed Cable Plant - Single-mode Attenuation and Optical Return Loss Measurement*
22. ISO/IEC 61300-3-5; *Fibre Optic Interconnecting Devices and Passive Components - Basic Test and Measurement Procedures - Part 3-35: Visual Inspection of Fibre Optic Connectors and Fibre-stub Transceivers*
23. ITU-T G.652D; *Characteristics of Single-Mode Optical Fiber*
24. ITU-T-G.671; *Transmission Systems and Media, Digital Systems and Networks*
25. National Fire Protection Agency (NFPA) – 70 (*National Electrical Code*)
26. NFPA 262; *Standard Method of Test in Flame Travel and Smoke of Wire and Cables for use in Air-Handling Spaces*
27. National Electrical Safety Code (NESC)

28. TIA-492 CAAB; *Detail Specification for Class IVa Dispersion-Unshifted Single-mode Optical Fibers*
29. TSB 140; *Additional Guidelines for Field-Testing Length, Loss, and Polarity of Optical Fiber Cable*
30. UL 444; *Standard for Safety Communication Cables*
31. UL 969A; *Marking and Labeling Systems*
32. UL 1651; *Standard for Safety Optical Fiber Cables*
33. UL 1666: *Safety Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in (Riser) Shafts*
34. UL 910; *UL Standard for Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical Fiber Cables Used in Spaces Transporting Environmental Air*

1.4 Pre-bid Submittals

A. Provide product data sheets and installation instructions for each type of cable to be installed within the contract Scope of Work (SoW).
B. Contractor/Sub to provide documentation as an authorized cable manufacturer along with the certifications of the assigned on-site technicians installing the cabling. The percentage of certified technicians on-site is dictated by the cable manufacturer for warranty purposes.
C. Architectural drawings to identify each optical fiber cable type and location, TDUs, fiber end-link locations, and related pathway routes.

1.5 Contractor/Sub Qualifications

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).
C. Successfully performed at least three projects of low voltage cable installation with similar size and Scope of Work (SoW) within two years of the date of the job they are bidding on. If requested, provide proof of performance with a brief job description, start and end dates, and contact information.
D. The Contractor/Sub provides all labor, materials, tools and equipment required for the complete installation of the optical fiber cabling system without any additional costs to UNLV.
E. The Contractor/Sub to provide proof that their on-site personnel have the necessary training and certification(s) to satisfy the testing requirements to industry standards.

1.6 Quality Assurance and Warranty

A. SPECIAL NOTE: All completed pathway installations either in whole or in sections are to be inspected and approved by UNLV/NDE RCDD prior to any cables being installed.

B. Installed cabling will be free of defects in material and workmanship.
C. Installation will be under the direct supervision of the assigned Contractor/Sub's BICSI-certified supervisor(s)-lead(s) who, in turn, reports to the assigned RCDD project manager.
D. Both to be versed in the preparation of the shop drawings, cabling administration drawings, and field-testing program.
E. Testing to be performed by one member of the installation team to be a BICSI certified and cable manufacturer-certified.
F. All intra- and inter-building cabling to be installed in a neat and workmanlike way.
G. Install the standard and/or ABF optical fiber systems to the requirements of ANSI/TIA 568-C.0, ANSI/TIA/EIA 568-C.3, and field test to ANSI/TIA 526-7A as stated in Section 27 10 20.20 and .30
H. Provide an optical fiber cable testing plan and subsequently, the test results and As-Builts to the satisfaction of UNLV/NDE.
I. Subsequently, provide the 25-year manufacturer warranty for the particular project.
J. Products to be furnished with manufacturer's instructions.
K. Products to be UL Listed and be manufactured by an ISO 9000/9001 approved manufacturer and be RoHS 2011/65/EU compliant..

PART 2: PRODUCT

2.1 General

Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*

2.2 Optical Glass

A. OS1A and OS2 8.3/125 µm
B. Glass to be Class IVa dispersion-unshifted single-mode optical fiber complying with ANSI/TIA 492CAAB
C. Compliant with ITU-T G.652 D, ITU-T G.671, GR-20-CORE, and GR-356-CORE.
D. Able to support QSFP28-100GBase-LR4 per IEEE 802.3ab @1310 nm (on UPC polish duplex LC) and backwards compatible to 40G, 10G and 1000Base-XX IEEE Ethernet applications.
E. Maximum attenuation for both wavelengths @ 1310 nm/ 1550 nm 0.5 dB/Km.
F. Maximum channel budget loss for 40/100GBase-LR4 6.7 dB/6.3 dB @ max. 10 Km (0.15 /Mft)
G. Suitable for -30℃ (-22℉) to +75 ℃ (+167 ℉) environments.
H. Usable life expectancy 25 years.

2.3 Project Conditions

A. Contractor/Sub is responsible for verifying actual footage and distances as identified on project drawings.
B. Contractor/Sub to take full responsibility for any damage to pathways and cabling due to the delivery and the installation of outside plant (OSP) cables and connecting materials in wet raining environments.

2.4 Cabling Jacket Performance Requirements

A. ABF outer sheath to be:
    1. Indoor/outdoor rated using high-density polyethylene (HDPE) in color orange.
    2. Contain water-blocking components for additional fiber protection from accidental water exposure.
B. Traditional optical fiber cable to be yellow in color.
C. Both ABF and traditional optical fiber to be all-dielectric unless armored (OFC) for rodent protection.
D. Cable cordage jacket, fiber, unit, and group color to be according to TIA-598-D.
E. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1016 mm).
F. Standard distribution cable to have 900 um tight-buffered 24-plus fiber strands wrapped around a central strength member in a “S”-”Z” fashion or grouped in subsections.
G. Listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA-70 (NEC) for the following types in varied fire-rated and non-fire-rated pathways:
    1. OFNP: Optical Fiber Nonconductive Plenum-rated complying with NFPA 262 and UL-910
    2. OFNR: Optical Fiber Nonconductive Riser-rated complying with UL 1666
    3. OFCP: Optical Fiber Conductive Plenum-rated complying with NFPA 262 and UL-910
    4. OFCR: Optical Fiber Conductive Riser-rated complying with UL 1666
H. UNLV has no common application for low-smoke zero-halogen (LSZH) nor all-dielectric self-supporting (ADSS) cabling unless specified in a request for proposal (RFP).

2.5 Optical Fiber Cassettes

A. Traditional distribution and ABF optical fiber runs to terminate onto pre-terminated individual UPC duplex LC 12- or 24- fiber cassettes with 250 um pigtails for splicing.
B. Cassette to house and secure the fusion splices while maintaining cable wrap bend radius.
C. Cassettes to ‘snap into’ the cradle sleeves of the same manufacturer’s optical fiber enclosure; horizontally into 1RU and 2RU or vertically in 4RU housings.
D. Follows the color code of ANSI/TIA-598.D-1.

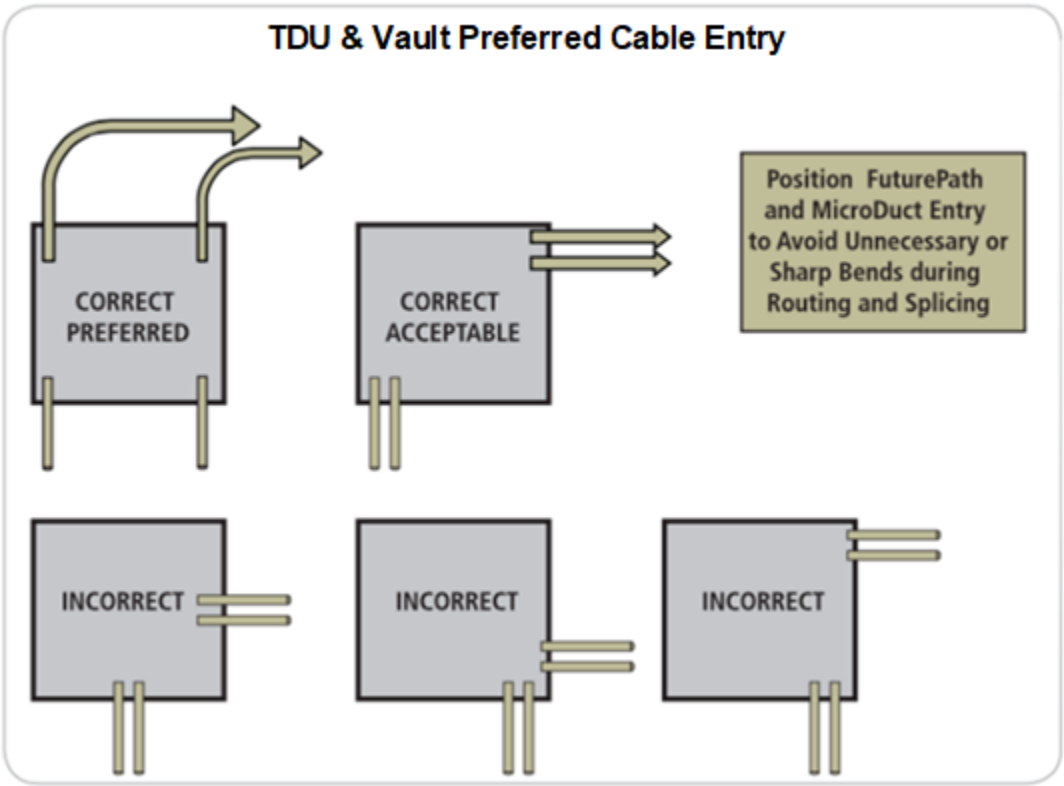
PART 3: EXECUTION

3.1 Pathway Preparation and Cable Installation Guidelines

A. Practice only OSHA-approved safety procedures when working in hand holds, vaults, and maintenance environments; inclusive of tripods, sniffers, blowers, and cattle guards where applicable.
B. Outside plant (OSP) inter-building and providers transition point(s) determined and labeled properly.

C. Maintenance Holes/Manholes (MH) and Vaults' (V) TDUs and related 4-inch (102 mm) conduit pathways have been cleared and identified for cabling entering the building.
D. As specified on project drawings, OSP traditional and ABF blown cable may have to be either shielded, armored, or use of a pull-over "rodent resistant" screen mesh sox.
E. All installed conduit - and prior to installing cable - to be free of debris, clean, dry, unobstructed, labeled with destination (both ends) and if applicable, firestopped.
F. Check specifications for the installation of corrugated innerduct or fabric mesh.
G. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice optical fiber mid-point between terminations. Remove and discard cable if not in compliance or damaged during installation and replace with new cable at no additional cost to UNLV.
H. All OSP conduit runs will need to pass the mandrel test; cleaned with sponge-like chase, and minimum 1/2" 1250 lbf mule tape left inside conduit and secured on both ends. The mule tape is required with or without installed ABF cable and/or innerduct or fabric mesh already installed inside the conduit
I. ABF fiber can be installed by itself in 4-inch (102 mm) conduit along with a chase mule tape. This will allow for the retrofit of fabric sleeve innerduct when required.
J. When the ABF cabling is routed into a TDU, ideally the design to have the turns outside the box. However, if necessary by circumstances, the turn can take place on the far opposite side/corners as depicted in **27 13 23 .01 and .02** Fig 1: *TDU & Vault Preferred Cable Entry*. At no time will the turns take place in the middle or near side corners.

27 13 23 .01 and .02 Figure 1: *TDU & Vault Preferred Cable Entry*



27 13 23 .01 and .02 Fig 1: *TDU & Vault Preferred Cable Entry*

K. ABF outer sheath is to be secured onto the TDU with Kellum Grips™ mounted on the outside. This is to prevent any shrinkage of the sheath from pulling out of the TDU and exposing the microducts. Refer to the ABF manufacturer for specific guidelines and third-party part numbers.

L. Per NEC; Any OSP-rated cabling traditional or ABF to transition to a proper fire-rating within 50 ft. (15.24 meters) of entering the building unless (a) indoor/outdoor rated cable, or (b) installed in rigid metallic conduit (RMC = GRC and/or IMC). The exception is if it's indoor/outdoor rated.

M. Pulling cable to comply with the current TIA, BICSI, and manufacturer standards for both bend radius and pulling tension.

N. Industry best-practices set a minimum 20X bend radius for pulling optical cable and ABF outer sheaths and 10X for storage.

O. Any unspooled cable during an installation to be coiled in a "Figure 8" design to avoid twists.

P. Provide a 10-ft. (3 meter) service loop for inter-building applications inside the equipment room-main distribution frame (ERs-MDFs). Once the ABF cables have entered the room, they are routed into a wall-mounted TDU where the microducts are exited into corrugated innerduct.

Q. This 10 ft. (3 meters) service loop requirement also applies to intra-building traditional optical fiber cabling between the equipment room-main distribution frame (ER-MDF) and associated Telecommunications Rooms-Intermediate Distribution Frames (TR-IDF).

    1. Try to maximize the ladder racking pathway and route the innerduct with the microducts cables or the traditional optical fiber into a “U” shape above and behind the equipment rack(s)/communications cabinet(s).
    2. Alternatively, if there is limited space, create a coil service loop on the ladder racking, but opposite the side of the room from the positions of the equipment rack(s)/communications cabinet(s).
    3. If the cable(s) is routed underneath from raised floor or at floor level and, room permitting, secure the service loop inside the lower portion of the equipment racks/communications cabinets.

R. Route ABF outer sheath cabling along the outside walls of the maintenance hole (MH) or vault (V). Secure to the racking or step rungs if available. Allow sufficient freeplay to ensure enough fiber slack for possible re-configuration of the micro-ducts inside the TDU.

S. Install intra-building cables in installed raceways, cable trays, basket trays, or metal conduit per Section 27 05 28 *Pathways for Communications Systems.*

T. Install cabling in telecommunications rooms using cable guides or Velcro™ to the ladder racking.

U. Cables not to run through structural members or in contact with pipes, ducts, or other potentially damaging materials from other trades.

V. The Contractor/Sub is responsible for any difficulties or damage to the cable during placement. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable at no additional cost to UNLV.

W. UNLV considers all areas intra-building to be plenum rated environments so all optical fiber cable to be plenum-rated (OFNP).

X. Use only silicon-based or hydra-lube pulling lubricants. Yellow 77 is not permitted and will void the installation.

Y. Monitor cable pull tensions per cable manufacturer guidelines, but not to exceed:
    1. 600 lbf for traditional outside plant (OSP) rated cables
    2. 100-200 lbf for traditional inside plant (ISP) premises distribution cables
Z. Firestop considerations with any penetration(s) through a fire-rated wall per Section 27 05 41; *Firestopping Systems for Communications.*
AA. If applicable, comply with requirements in Section 27 05 26; *Grounding and Bonding for Communications Systems* for grounding OFC cable conductors.

3.2 Terminations

A. Unless authorized by UNLV/NDE, no splicing of optical fiber is permissible midspan or between building termination points in the MDFs/IDFs - inclusive of handheld, maintenance holes, and vault TDUs.
B. Terminations will be completed using no epoxy/no polish connectors. For individual fibers use factory-terminated pre-polished connectors having pigtail stubs for fusion splicing.
C. All traditional or ABF fiber runs will be terminated onto UPC duplex LC 12- or 24- fiber cassettes with pigtails for fusion splicing.
D. Follow the optical fiber enclosure manufacturer's instructions for cable preparation and service loop routing.
E. Cassettes to be slide-n-lock mounted in an optical fiber enclosure from the same manufacturer.
F. No cable run is to be left unterminated unless specifically instructed by UNLV/NDE.
G. Fiber strand numbering to be consistent with the Consecutive Fiber Numbering (CFN) sequence as identified in the latest version of ANSI/TIA 568. This fiber stand numbering sequence between each fiber link will be adhered to at each terminated end of the optical fiber cable; straight-thru termination 1-1, 2-2, 3-3 and so forth only. The rolling of fiber optic strands 1-2,2-1, 3-4, 4-3 is not acceptable.

3.3 Backbone Testing and Acceptance

A. UNLV/NDE to visually inspect (in phases) cable placement, cable termination, (grounding and bonding if applicable), and labeling of all components before testing is to begin. Should any cable be found to be routed incorrectly, bruised, kinked, scored, deformed, or abraded the Contractor/Sub is to remove and discard cable and replace it with new cable at no additional cost to UNLV.
B. Adhere to the guidelines of Section 27 10 20.20 and .30; *Optical fiber Cable Testing and Documentation.* The following is just an overview.
C. Recommended that any spooled cable(s) of optical fibers be verified prior to system installation using an OTDR dual-wavelength one-directional. If the Contractor/Sub installs faulty cable(s) without testing, the Contractor/Sub is liable to replace without any additional cost to UNLV. Additionally, the replacement process is not to disrupt the construction schedule without penalty for delay.
D. Optical fiber cables (and termination hardware) to be one-hundred percent (100%) tested for defects in the installation and verified cabling system performance under installed conditions according to the requirements of ANSI/TIA-568.3-D.
E. For both intra- and inter-building applications, Tier 1 performance testing is mandatory. OLTS testing parameters to meet requirements of ANSI/TIA-568.3-D using one (1) reference cord test method, bi-directional, and 'dual wavelength' testing at both 1310 nm and 1550 nm.

F. For inter-building outside plant (OSP) applications, Tier 2 performance testing may be requested using both Tier 1 OLTS and OTDR testing for longer distances as specified by the cable manufacturer. However, in special circumstances UNLV/NDE may consider using the OTDR testing parameters to review the tested fiber link profile and to ensure it meets the requirements of ANSI/TIA-568.3-D. This includes using compatible launch boxes on each end of the optical fiber link being tested, bi-directional, and 'dual wavelength' testing at both 1310 nm and 1550 nm.
G. Test Reference Cords (TRCs) to meet ANSI/TIA 526-7A with a minimum OD of 2.8-3.0 mm, LC 'Grade A' precision zirconia ceramic UPC ferrule, maximum insertion loss (IL) < 0.25dB and minimum return loss (RL) > 0.55 dB or better.
H. Test results with manufacturer part numbers and IEEE 802.3 application will be downloaded directly from the test unit or from a download file using an application from the test equipment manufacturer.
I. Test results to verify that the total attenuation of all the passive components in the fiber link is within the design parameters of the cable/connector manufacturer and per industry-recognized standards.
J. The optical fiber links to PASS all installation and performance tests as mandated by the cable manufacturer. End-to-end cabling will be considered defective if it does not PASS tests and inspections.
K. Remove and replace cabling at no additional cost to UNLV where test results indicate that it does not comply with specified requirements.
L. Results can be either in the manufacturer software or in PDF format in numerical order with files separated by the telecommunication rooms.
M. Electronic format copies only required. No hard copies
N. Per the contract Scope of Work (SoW), provide photos of each labeled optical fiber endface or those if requested for examination at no additional charge to UNLV..
O. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to effect the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM will notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.4 Cleaning

A. Installed maintenance holes (MH)/ vaults (V), handhole(HH)/pull boxes (PB) will be clean of all debris, leftover material, garbage, dirt and gravel, tools and equipment, and the like.
B. Contractor/Sub to practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas. This includes keeping inventoried material staging areas clean and organized.
C. Extra care given to the proper disposal of fiber shards.

3.5 Identification Schedule

A. Adhere to the guidelines of Section 27 05 53; *Identification for Communications Systems*. The following is just an overview.

B. The ABF outer sheaths will have a water-proof 1 x 3 inch (25-76 mm) plastic snap-on label secured with tie-wraps. The label on the entry side is to identify its last handheld, maintenance hole, or vault "From," origin and its ">" or "To" current location. Whereas the label for the exit side identifies its current location ("From") and its next destination ("To") which might be the ER-MDF or Entrance Facility (EF) identifier.
C. Each sleeves/tubes microducts inside the TDU connecting the entry and exit ABF outer sheaths to be labeled with self-laminating wrap-around waterproof ink-jet labels showing its "From" origin ; "Bldg"- "ER-MDF/TR-IDF #" - Fiber Patch # - and Cassette/Adapter Alpha # ">" or "To" destination; "Bldg"- "ER-MDF/TR-IDF #" - Fiber Patch # - and Cassette/Adapter Alpha # .
D. Suggest cleaning the outside of the tube microducts and traditional optical fiber cable with ninety-nine percent (99%) isopropyl alcohol or Strickler solvent to ensure the labels have less chance of peeling off.
E. Traditional optical fiber cable and ABF cable are terminated and labeled in the same manner in the optical fiber enclosure:
    1. UNLV has standardized on optical fiber cassettes (with pigtails for fusion splicing) and not adapter plates.
    2. The first “A” cassette in an optical fiber enclosure is installed and labeled in the first slot on the left side facing the front of the housing. This first cassette contains fibers strands #1-24 having a row of 12 each duplex UPC LC connectors.
    3. Each subsequent cassette will be alpha-sequence left-to-right with the next adapter plate or cassette labeled as “B” (fibers #25-48), the next “C’ (Fibers #49-72) and so forth.

3.6 Close-out Submittals

A. Test documents/results and As-Builts for both intra- and inter-building cable runs separated by the building's telecommunications rooms and then numerical order in PDF and native tester manufacturer software format. The completed installation is to be approved by UNLV/NDE.
B. Within 30 days of the substantial completion of the project or prior to project closeout -- which ever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub’s one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.
C. Contractor/Sub to provide:
    1. A one-year parts and labor warranty against defective workmanship and cable system component failure.
    2. The associated cable manufacturer’s 25-year warranty for the project.
D. Hand drawings are not acceptable.
E. Network equipment including voice, data, A/V, security and WiFi services will not be provisioned until receipt of accepted test results and preliminary As-Built drawings.
F. In the record AutoCAD .dwg format drawing, several layers and/or group filters will be created or updated which will be used to document the below. It will include, but is not limited to:
    1. Conduit (existing and newly installed)
    2. Cable Path
    3. Vaults and Pull Boxes (existing and newly installed)

4. Microduct Distribution Boxes (existing and newly installed)
5. Microducts (existing and newly installed)
6. IDF/MDF Locations (existing and newly constructed)
7. End devices (Wireless Access Points, Security and Testing Cameras)
8. Any additional layers or information requested by NDE
9. Fiber Path
10. Fiber Enclosures (existing and newly installed)

G. Provide conditions for Warranty's maximum percentage of moves, adds, and changes (MACs)

SECTION 27 13 00 - COMMUNICATIONS BACKBONE CABLING

– – – End of Sections 27 13 23 .01 and .02 – – –

Communication Intra- and Inter-building Optical Fiber Backbone

SECTION 27 15 00

COMMUNICATIONS COPPER HORIZONTAL CABLING

Sections 27 15 01 .13, .19, .20

Communications Horizontal (Copper) Cabling, Station Applications, Wireless, and PoE

PART 1: GENERAL

1.1 Summary

A. This Section is specific to communications (copper) horizontal cabling for station work area (WA) applications, power over ethernet (PoE), and Wireless (WiFi). It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for installing, terminating, testing, and labeling horizontal copper cabling in either new or retrofit construction.

B. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of *Communications Horizontal (Copper) Cabling, Station Applications, Wireless, and PoE* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).

C. The Contractor/Sub to include in their bid price, communications cabling that has become abandoned as part of a renovation project, previous renovation projects, or temporary communications cables used during the construction process to be completely removed.

D. The only copper applications for outside plant (OSP) inter-building applications is for outside-rated 4-pair UTP cabling for wireless security and WiFi applications.

E. At no time will splicing be allowed.

F. UNLV typically does not have any applications for:
   1. Multi-pair backbone cabling
   2. Analog phone application
   3. Splitters and taps
   4. Cat 7/Class F cable inclusive of foil/screen (F/FTP, S/FTP, S/UTP) cabling types at the time of the release of UNLV/NDE Division 27.
   5. Note: Some Cat 6A/Class EA cable incorporates a foil skip wrap or F/UTP but is not subject to bonding and grounding requirements per the manufacturers.
   6. Midspan splicing is not permissible anywhere on campus.

G. Installation work and materials will conform to each detail in the rules and requirements of the National Fire Protection Association, the locally enforced National Electrical Code (NEC) by the authority having jurisdiction (AHJ), current manufacturing standards, and State regulations.

1.2 Communications Horizontal Copper UTP Structured Cabling System (SCS) Defined

A. The communications horizontal copper UTP cabling structured cabling system is defined as:
   1. Cat 6 4-pair, 100-ohm, balanced, unshielded twisted-pair (U/UTP).

B. The hardware requirements of conduit and outlet boxes for outdoor cameras are the same as outdoor wireless, but both with stricter clearance and outdoor-rated considerations.

C. Cat 6/Class E UTP plenum-rated copper UTP cable for adding to existing Cat 6/Class E cabling in buildings. However, all existing cabling still needs to meet current fire code or will need to be replaced by Cat 6A CMP fire-rated UTP cabling.
D. Cat 6A/Class EA UTP plenum-rated copper UTP cable is the standard for new and retrofit/upgrade installations.
E. Minimum two each cable runs to each telecommunications outlet (TO)
F. A copper UTP cable run install is 'permanent link' only without ('channel') patch cords.
G. The mechanical performance of a permanent link is only achieved through the use of compliant components.
H. Maximum distance is 295 ft. (90 meters).
I. Terminations between the UNLV standard 2 RU 48--port flat modular patch panel and the 4-port station application henceforth referred to as the work area (WA) telecommunications outlet (TO).
J. Cat 6A/Class EA patch panels can be loaded with a 48-port PCB version or blank for inserting modular jacks. Note: The last patch panel to be installed is required to be a blank panel.
K. Telecommunication 4-port outlet (TO) faceplate two each top ports are designated for termination while the two each lower ports for two blank color-matching inserts.
L. Does not take into consideration EPON nor single-pair industrial ethernet applications at the time of the release of this Division 27 V1.3.
M. Modular patch panels to be located into telecommunication rooms and mounted onto equipment racks, communications cabinets, wall-mount-pivotal cabinets, or hinged-wall brackets and with appropriate cable management.
N. Consolidation Points (CP) and Multi-User Telecommunications Outlet Assemblies (MUTOA) are non-applicable unless specifically authorized by UNLV/NDE.
O. The 2 RU 48--port modular patch panel - fully PCB loaded or blank - the faceplates and modular Keystone-style jacks to be from the same connector manufacturer. Cable to be either from the same connector manufacturer or an approved and documented equivalent business partner.

1.3 Wireless Access Point (WAP) IEEE 802.3xx and Power over Ethernet (PoE)

A. Data cabling for Wireless Access Point (WAP) locations is treated as a standard station work area (WA) application. The designated communications horizontal copper UTP of (CMP) Cat 6A is able to support the follow Power over Ethernet (PoE) Wireless applications:
    1. IEEE 802.3af PoE Type 1 (15.4W)
    2. IEEE 802.3at PoE+ Type 2 (25.5W)
    3. IEEE 802.3bt PoE++ Type 3 (60W) - compliance testing to this minimum
    4. IEEE 802.3bt Poe++ Type 4 (90W)
    5. Power over HDBase TTM (PoH) (95W)
    6. Cisco Universal Power over PoE (90W)
B. The UNLV/NDE standard as of the release of this Division 27 is IEEE 802.3at PoE+ Type 2 (25.5W).
C. Testing for this Type 2 (25.5W) only requires DC resistance testing per ANSI/TIA-1152 standard.
D. Data cabling for security (and testing) cameras requiring PoE is treated the same as a standard station application for wireless. Typical PoE requirement is 30W and with heater 60W.

P. UNLV/NDE may require testing separately for higher grade Types that, in turn, require higher wattage requirements for Power over Ethernet (PoE). A separate tester or adapter for this to be in compliance to TIA TSB-162-A standards.

1.4 Related Documentations and References

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".
B. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications*, 27 10 00; *Structured Cabling Hardware*, 27 11 00; *Communications Equipment Room Fittings*, 27 13 00; *Communications Optical Fiber Backbone Cabling,* and 27 15 43; *Communications Work Area Faceplate/Telecommunications Outlets, Surface Mount Boxes, and Connectors* includes the following:
    1. Section 27 05 28; *Pathways for Communications Systems*
    2. Section 27 05 29; *Hangers, J-Hooks, and Supports*
    3. Section 27 05 33; *Conduits and Back Boxes*
    4. Section 27 05 36; *Cable Trays*
    5. Section 27 05 40; *Modular Furniture Pathways and Poke-through Devices*
    6. Section 27 05 41; *Firestopping System for Communications*
    7. Section 27 05 53; *Identification for Communication Systems*
    8. Sections 27 10 20 .10 and .30; *Copper System Testing and Documentation*
    9. Section 27 11 10; *Telecommunications Rooms and Backboards*
    10. Section 27 11 16; *Communication Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides*
    11. Section 27 11 19; *Communications Copper Modular Patch Panels*
    12. Section 27 15 43 .10; *Communications Copper Jack Information Outlets and Connectors*
    13. Section 27 15 43 .25; *Work Area Faceplates/Wall Plates and Surface Mount Boxes*
C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
    1. Appendix A; *Codes, Standards, and Regulations*
    2. Appendix B; *Abbreviations and Acronyms*
    3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
    4. Appendix D; *Rack Elevation and Room Sizing Drawings*
D. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification, apply to this Section.
E. Horizontal cabling, POE, station applications, and Wireless to comply with the requirements of the current versions and practices in:
    1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)
    2. BICSI *Information Technology Systems Installation Manual* (ITSIMM)
    3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
    4. ANSI/BICSI 008-2018; *Wireless Local Area Network (WLAN) System Design and Implementation Best Practices*
    5. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*

6. ANSI/BICSI N2-17; *Practices for the Installation of Telecommunications and ICT Cabling to Support Remote Power (PoE) Applications*
7. ANSI/BICSI N3-20; *Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure*
8. ANSI/TIA 568.1; *Commercial Building Telecommunications Standard, Part 1: General Requirements*
9. ANSI/TIA-568.2-D; *Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling*
10. ANSI/TIA 569-E; *Telecommunication Pathways and Spaces*
11. ANSI/TIA-606-C; *Administration Standard for Telecommunications Infrastructure*
12. ANSI/TIA 607-D; *Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises*
13. ANSI/TIA-1152-A; *Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling*
14. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facilities*
15. ANSI/ICEA S-102-732-2009; *Standard for Cat 6 and 6A; 100 ohm Individually Unshielded Twisted-pair Indoor Cables* - Incorporated into ANSI/TIA 568.2-D
16. IEC 61935-1; *Specifications for the Testing of Balanced Twisted-pair and Coaxial Information Technology Cabling*
17. IEEE 802.3; *IEEE Standard for Ethernet*
18. IEEE 802.11; *IEEE Wireless Local Area Networks Working Group*
19. National Fire Protection Agency (NFPA) – 70 (*National Electrical Code*)
20. NEC Article 250; *Grounding and Bonding of Electrical Systems*
21. NEC Article 720; *Circuits and Equipment Operating at Less Than 50 Volts*
22. NFPA 262; *Standard Method of Test in Flame Travel and Smoke of Wire and Cables for use in Air-Handling Spaces*
23. National Electrical Safety Code *(NESC)*
24. UL 6; *UL Standard for Electrical Rigid Metal Conduit*
25. UL 910; *UL Standard for Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical Fiber Cables Used in Spaces Transporting Environmental Air*
26. UL 969A; *Marking and Labeling Systems*
27. UL 1666: *Safety Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in (Riser) Shafts*

1.5 Pre-bid Submittals

A. Provide product data sheets and installation instructions for each type of cable to be installed within the contract Scope of Work (SoW).
B. Contractor/Sub to provide documentation as an authorized cable/connector manufacturer along with the certifications of the assigned on-site technicians installing the cabling. The percentage of certified technicians on-site is dictated by the cable manufacturer for warranty purposes.
C. Architectural drawings to identify each building's floor plan telecommunications outlet (TO) locations for data, WiFi, security and testing cameras, as well as the pathways and routes from the assigned telecommunications rooms.
D. Twisted pair testing plan.
E. Labeling schedule.

1.6 Contractor/Sub Qualifications

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).
C. Successfully performed at least three projects of low voltage cable installation with similar size and Scope of Work (SoW) within two years of the date of the job they are bidding on. If requested, provide proof of performance with a brief job description, start and end dates, and contact information.
D. The Contractor/Sub provides all labor, materials, tools and equipment required for the complete installation of the optical fiber cabling system without any additional costs to UNLV.
E. The Contractor/Sub to provide proof that their on-site personnel have the necessary training and certification(s) to satisfy the testing requirements to cable manufacturer warranty requirements and industry-recognized standards.
F. Contractor/Sub to attend weekly status report meetings:
    1. Provide updates detailing the work that has been completed and inspected
    2. Field quality assurance practices
    3. RFIs/issues encountered
    4. 3-week schedule of work

1.7 Quality Assurance and Warranty

A. SPECIAL NOTE: All completed pathway installations either in whole or in sections are to be inspected and approved by UNLV/NDE RCDD prior to any cables being installed.
B. Installed cabling will be free of defects in material and workmanship.
C. Installation will be under the direct supervision of the assigned Contractor/Sub's BICSI-certified supervisor(s)/lead(s) who, in turn, reports to the assigned RCDD project manager.
D. Both to be versed in the preparation of the shop drawings, cabling administration drawings, and field-testing program.
E. Testing to be performed by one member of the installation team to be a BICSI certified and cable manufacturer certified.
F. All intra-building premises cabling to be installed in a neat and workmanlike way.
G. Install the horizontal copper UTP cabling and terminations, and field test to the requirements of ANSI/TIA 568-C.0, ANSI/TIA/EIA 568.2-D, and field test per Section 27 10 20.10 and .30.
H. Provide a copper UTP testing plan and subsequently, the test results and As-Builts to the satisfaction of UNLV/NDE.
I. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
J. Products to be furnished with manufacturer's instructions and mounting hardware.
K. Subsequently, the Contractor/Sub provides a one (1) year Parts and Labor Warranty along with the connector manufacturer's 25-year warranty for the particular project.

L. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.
M. UNLV/NDE recommends a UNLV/NDE RCDD inspection of the pathways before any cabling is installed. This is to prevent any improper pathway infrastructures and having to remove cabling to correct the situation.

PART 2: PRODUCT

2.1 Communications Horizontal Copper UTP Cable Characteristics

A. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.
B. The standard fire-rating for communications horizontal copper UTP cable at all times is plenum or CMP-rated and in compliance with UL 910.
C. Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*
D. Cat 6A/Class EA UTP copper, 100-ohm balanced, solid 23-24 AWG 4-pair cable to be available from the same manufacturer for the following two (2) applications;
    1. The inside plant (ISP) premises "permanent link" cabling and always to have a plenum (CMP) fire-rating jacketing. Maximum OD 0.29 inch (7.3 mm)
    2. The outside plant (OSP) "permanent link" which always needs to have an outdoor rated jacketing. Indoor/Outdoor rating preferred.

2.2 Modular Patch Panel and Station Connector Modular Connector PCB Characteristics

Standard data ports for both the telecommunications outlet's faceplates and the modular patch panels to be:

1. Able to terminate unshielded and be designated for Cat 6A/Class EA 4-pair UTP cable termination having solid 23-24 AWG conductors.
2. Female 8-position by 8 conductor (8P8C) un-keyed RJ-45 jacks wired/terminated to 568B standard.
3. Use of a standard 110-style Insulation Displacement Contact (IDC) termination 'punch down' tool. Multiwire/crimp specialty tools supplied by the same connector manufacturer are permissible.
4. Each jack to be single-unit construction with "Keystone" style snap-in mount.
5. Hinged dust covers are acceptable.
6. Stuffer caps to have retention snap to ensure conductor strain relief.
7. Jack housings to be fully encased to protect the PCB or printed circuit board and ultrasonically welded for tamper resistance.
8. Connector pins to be flat having an industry-standard 50 mil of gold plating that allows for a minimum 500 mating cycles.
9. Black and be UL Listed 1863.
10. Cat 6/Class E to be able to support 1GBase-T application per IEEE 802.3ab
11. Cat 6A/Class EA to be able to support 10GBase-T application per IEEE 802.3an
12. Krone LSA™ and Nortel BIX™ IDCs are not acceptable

2.3 Station Application: Modular Faceplate Characteristics

A. Flush-mount 4-port, vertical, single-gang faceplate designed to mount onto a single-gang mud ring affixed to a "5-square" 2 ¾ inch deep electrical box.
B. To accommodate Cat 6/Cat 6A modular Keystone-style jacks.
C. Snap-in upper and lower clear plastic windows to accommodate station port machine-printed paper insert identifiers.
D. Made of high-impact PVC or stainless steel depending on the UNLV/P&C project specifications and related environment.
E. Color determined by UNLV/P&C project specifications. Usually beige/almond/ivory.

2.4 Wireless Access Points (WAP) Characteristics

A. The mounting and/or housing of the wireless access points (WAPs or APs) is dependent upon the manufacturer, type/wattage requirements for coverage, interior or exterior applications, and with or without antennas.
B. Ensure all necessary brackets, mounts, and hardware are supplied for each WAP.
C. Ensure each WAP is properly labeled by UNLV/NDE and matches the location on the drawing (for MAC addresses). Determine which WAP is to have a dome or enclosure.
D. For all OSP inside and outside garage applications use only outdoor-rated Cat 6A/Class EA UTP cable.
E. The primary design goal is to combine IDF(s) into secured room(s). However;
F. If any IDF cabinetry is inside the garage parking lot and is not in a secured isolated area, situated near or facing a parking place, bollards will be installed for protection. UNLV/NDE to determine quantity and locations that may limit parking space size. Location(s) will be marked with paint or tape. Permanently-mounted cement wheel stops or the like may not be used as a substitution.

PART 3: EXECUTION

3.1 Summary

A. Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of the communications horizontal (copper) cabling system inclusive of the station applications (telecommunication outlets or TOs), Power over Ethernet (PoE) to Wireless Access Points (WAP) and security cameras.
B. Cabling installation in telecommunications rooms to be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.
C. Contractor/Sub to verify each cable run is installed, terminated, labeled, and is usable per industry best-practices prior to testing.
D. Communications horizontal copper cabling that must cross power cables or conduits to cross at 90-degree angle and not to make any physical contact.

E. At no times will copper horizontal cabling be routed in plastic wall-mount nor non-metal plastic "speed bump" floor-mount raceways.
F. Even if a cable installation run passes the tests, UNLV/NDE may fail the cable run when an inspection/audit is conducted and found the cable run is not properly routed or supported. Any defects in cabling system installation will be repaired or replaced to ensure 100 percent usable condition at no additional cost to UNLV.
G. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable at no additional cost to UNLV.
H. If in the project specifications, maintain old-to-new retro port documentation for "cut sheets" in a spreadsheet and not handwritten. Must be made available within 2-days of the request.
I. UNLV/NDE recommends a UNLV/NDE RCDD inspection of the pathways before any cabling is installed. This is to prevent any improper pathway infrastructures and having to remove cabling to correct the situation.

3.2 Communications Horizontal Copper UTP Installation Guidelines in the Telecommunication Rooms

A. In cold-weather conditions, bring cable to room temperature before de-reeling. Heat lamps are not to be used for heating the cable. Subsequently, installing any kinked or cracked cable will need to be replaced at no additional cost to UNLV.
B. Install cabling in the telecommunication rooms with horizontal and vertical cable manager guides with terminating hardware and interconnection equipment.
C. Allow for 10 ft. (3 meters) of cable slack inside the telecommunications rooms: Use first the extra ladder racking for storage by creating one or multiple "U" shape(s) in the dressed cabling bundle(s). Only if necessary create a large figure "8" loop but not a tight circle loop.
D. Attempt best efforts to route work area (WA) cables into modular patch panels top-to-bottom designated by room numbers in sequential order.
E. Not to exceed 95 each Cat 6A/Class EA cables in sleeves entering a telecommunications room.
F. Allow a minimum seven (7) inches (178 mm) between the end of the sleeve and the top of the ladder racks.
G. If lubricant is needed for conduit pathway pulls, use only silicon-based or hydra-lube pulling lubricants. Yellow 77 is not permitted and will void the installation.

3.3 Communications Horizontal Copper UTP Termination Guidelines in the Telecommunication Rooms

A. Install lacing bars wire managers on the rear of the modular patch panels to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by the manufacturer.
B. Utilize Velcro™ cable wraps in all telecommunication rooms, data centers, J-Hook systems, ladder rack and cable tray systems. Tie-wraps and electrical tape are not to be used. Tie-wraps permitted only for securing ABF outer sheath inside the telecommunication room communications cabinet or below in raised-floor environments.
C. The horizontal UTP cables inside the telecommunication rooms are to be professionally organized and sorted, dressed, and aligned similar to a 'cigarette pack'.
D. Velcro™ to be installed soft side against the cables, cut side hidden from view, and be consistent with each telecommunications room; evenly spaced, aligned, plumb and level both vertically and horizontally. Use plenum-rated Velcro in plenum-rated environments.

E. Ensure terminations are at 180 degrees to the jack. Use first the connector manufacturer instructions for cable preparation and color code (568B) termination. This includes properly removing the central pair separator. By default, UNLV/NDE guidelines require no more than 1/8" (3 mm) of un-twisting and no more than 1/4" (6 mm) of un-jacketing.
F. Requires a 110-style punch down tool for termination. Use the lower setting for PCB applications.
G. Route the terminated cables on the rear of the modular patch starting with a "J" appearance; terminated cable to protrude straight out from the modular patch panel for minimum one (1) inch (25 mm) or until affixed to the lacing bar with Velcro™ before being routed to the vertical cable managers. Angled 'banjo string' terminations are not acceptable.
H. The 48 terminated cables has two options:
    a. The preferred method is to split right and left; Ports #1-12 and #25-36 will be routed to the right vertical cable manager (viewed from the rear of the equipment rack or communications cabinet) while ports #13-24 and #37-48 will be routed to the left vertical cable manager.
    b. The optional method is based upon cable congestion is to route the top row #1-24 to the left or right vertical cable manager and the lower row #25-48 to the opposite side vertical cable manager.
I. Termination using a male 8P8C RJ-45 plug with a 'feed through' double-sided RJ-45 'in-line coupler' or adapter is not acceptable.

3.4 Communications Horizontal Copper UTP Installation Cable Run Guidelines to the Work Area (WA) Telecommunications Outlet (TO).

A. The UNLV/NDE standard is to pull two (2) each Cat 6A/Class EA CMP cables to each work area (WA) telecommunication outlet (TO) location (the second is a spare). The only exception to pulling only one cable has to be approved by UNLV/NDE RCDD or in specifications typically used for badge readers.
B. Place communication horizontal UTP cables in pathways and spaces dedicated for communications cables.
C. This permanent link is not to exceed 295 ft. (90 meters).
D. Cables not in conduit or basket trays to use metal J-hooks:
    1. J-hook's (with "bat wings" for the stringers), wall-mounted metal, and plenum-rated plastic J-Hooks to have retainer clips
    2. To be spaced horizontally @ 4-5' max. or less to manage and secure the cable run.
    3. Drooping not to exceed six (6) inches (152 mm)
    4. Plenum-rated plastic saddle hooks/Caddy 4" or 6" W cable supports are permitted
    5. Bridal rings not permitted
    6. Red colors for fire/alarm applications only
E. Cables are not permitted to lie atop drop ceiling tiles or T-bars. By code, cables to be supported by J-hooks or support brackets secured on their own ceiling stringers separate from the drop ceiling support stringers.
F. Use only plenum rated Velcro™ in plenum rated environments inclusive of drop ceilings (marron in color).

G. Cable not to be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Not to use or touch other trades materials for use as cable pathways or pipes and ductwork being used as a trapeze for support.
H. Pull one additional "Mule Tape" or ¼" nylon rope pull-string chase when pulling cables through any conduit larger than one (1) inch (25 mm) and having no more than four (4) cables.
I. Nine (9) inch (229 mm) yellow drop-wire stand-offs secured with a clip to the T-bars are permitted by UNLV/NDE for special circumstances only.
J. HVAC ducting to have minimum four (4) inches (102 mm) clearance measured from the side of the basket tray or top side of the J-hook. If this becomes an issue in the field, UNLV/NDE will determine what practical alternatives are necessary to adjust the clearances.
K. Maximum bend radius for UTP is 4X the OD of the cable and no less than one (1) inch (25 mm).
L. Maximum pulling tension is 25 lbf (110 Newtons).
M. Comply with recommendations from BICSI's Telecommunications Distribution Methods Manual and TIA-569-E for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment. Rule of thumb is minimum six (6) inches (152 mm) from most EMI sources and 12 inches (305 mm) away from fluorescent lights fixtures/transformers.
N. Professionally dressed horizontal distribution cable bundles to be maintained; grouped together without twists and having no 'banjo string' or 'straglers' pairs sticking out of the cable bundle. Use Velcro™, if necessary, between J-hooks to keep cable bundles confined but not over tightened.
O. Service loops/cable slack only permitted at the work area (WA) outlet and in the telecommunications room. Service loops/cable slack are not permitted anywhere in-between these termination points specifically not in the horizontal cable run.
P. The height of a work area (WA) telecommunication wall outlet (TO) to be level with adjoining electrical outlet and the same color. When the telecommunication wall outlet (TO) is in solo locations, cut-out to be 14" AFF (bottom) / 18" (top) AFF.
Q. Use faceplates designed for the particular modular furniture.
R. Cables routed to the work area (WA) telecommunication outlets (TOs) are to be placed in minimum 1-inch (25 mm) EMT conduit between the walls and having a 45- or 90-degree stub-out on top towards the pathways going to the assigned telecommunications room. For masonry or solid wood walls, vertically route and secure the conduit on the surface along with the surface mounted 5-square electrical boxes.
S. Use only 5-Square 2 ¾ inch deep boxes for work area outlets (WA), junction boxes and as pull boxes. Double-gang for 6-10 cables. Outside plant (OSP) boxes with grommets and faceplates to be outdoor weather-proof rated. For Inside/Outside applications - inclusive of below top floor parking lots and garages - UNLV/NDE and UNLV/P&C will determine if a clear plastic weatherproof outlet cover assembly is required.
T. Inside the 5-square box, allow just enough slack to be able to terminate/re-terminate the modular connectors inside.
U. Allow a minimum 12 inches (305 mm) of UTP cable slack in a single-loop and secured on top near the stub-out abiding the 4X bend radius and without kinking the cable.

V. Cables routed to floor poke-through devices to follow the same ceiling-installed guidelines. Secure the minimum 12 inch (305 mm) cable slack to the poke-through device with Velcro™ in one large service loop.
W. If transitioning from wire mesh basket tray to other supports like J-hooks or conduit ensure that the cables are not touching any metal basket tray spokes top edges;
    a. Use a plastic radius guide or equivalent affixed to the top side(s) of the tray so that the cables are not being pulled on installed directly atop of the metal spokes. (Use innerduct cut to length, slit evenly, and snapped onto the sides of the basket tray if an approved radius guide is unavailable).
    b. Use manufacturer's rounded outside/inside corner spoke assembly or plastic radius guide inserts when cable is transitioning around "T" or 90-degree basket tray intersections.
    c. Route cables away from vertically-supported threaded rods or use appropriate plastic radius guides.
X. No horizontal communication cable is to be left un-terminated or 'coiled' in the ceiling unless authorized by UNLV/NDE (and labeled) for future use.
Y. Note: Unless specified in the project specifications, dedicated home-run conduit runs are not a UNLV requirement. If applied, use only one (1) inch (25 mm) EMT conduit for maximum four (4) cables and maximum two (2) each 90-degree bends or requiring a pull box.

3.5 Communications Horizontal Copper UTP <u>Termination Guidelines at the Work Area (WA)</u> Telecommunications Outlet (TO).

A. Ensure terminations are at 180 degrees to the jack. Use first the connector manufacturer instructions for cable preparation and color code (568B) termination. This includes properly removing the central pair separator. By default, UNLV/NDE guidelines require no more than 1/8" (3 mm) of un-twisting and no more than 1/4" (6 mm) of un-jacketing.
B. Each vertical 4-port faceplate to accept two (2) each Cat 6A/Class EA UTP 23-24 AWG cables.
C. Requires a 110-style punch down tool for termination. Use the lower setting for PCB applications.
D. The top two ports are designated for terminations. Attempt to ensure the 'odd' number is in the upper left-hand corner. The lower two ports to receive snap-in blanks of the same color as the faceplate.
E. Termination using a male 8P8C RJ-45 plug with a 'feed through' double-sided RJ-45 adapter is not acceptable.
F. Other style RJ-type including 6P6C RJ-11 plugs are not acceptable and not to be plugged into a 8P8C RJ-45 jack that would cause inside pin interface damage.
G. Mount faceplate onto the 5-square 2 ¾ inch deep electrical box whether flush or surface-mount.

3.6 Firestopping

A. Comply with TIA 569-D and Section 27 05 41; *Firestopping Systems for Communications* for membrane or through penetrations through fire-rated walls, floors, and ceilings.

3.7 Wireless Access Point (WAP) IEEE 802.3xx and Power over Ethernet (PoE) Installation Guidelines

A. General

1. The Contractor/Sub is responsible for determining that all required connectivity pathways and cable are in place. Resolve any unclear issues or conflicts with the UNLV/NDE before beginning any installation of wireless access point (WAP) devices.
2. UNLV/NDE to furnish the WAP equipment, bracket, patch and drop cords, locks and required mounting devices.
3. UNLV/NDE will deliver all packaged WAP devices and associated mounting and device patching materials to the Contractor/Sub. Contractor/Sub then accepts full responsibility for all materials delivered and to protect all devices and equipment from damage or theft.
4. In the event that quantities delivered by the UNLV/NDE do not meet the requirements of the contract Scope of Work (SoW) for any given floor, building, or group of buildings, the Contractor/Sub to immediately notify the UNLV/NDE for remediation and direction.
5. Contractor/Sub to supply all tools, ladder, lifts and other associated materials, equipment, and/or consumables required to complete the installations.
6. The Contractor/Sub to make field adjustments and resolve conflicts between construction drawings, specifications, and field conditions before beginning any installation.
7. Install WAP devices and associated hardware per manufacturer's specifications, instructions, and recommendations. Use accompanying construction drawing set, cable records and UNLV/NDE documentation to determine mounting locations and configurations.
8. Note: UNLV/NDE will coordinate with the Contractor/Sub to ensure the exact locations for the WAP in reference to the drawings before drilling preparation begins;
9. In order to ensure a successful deployment outcome, certain criteria and design parameters to be met. The deployment plan calls for the Contractor/Sub to place and activate devices. UNLV/NDE will provide the Contractor/Sub with the following.
    a. Pre-labeled WAP
    b. Mounting bracket and hardware
    c. External antennas (if applicable)
    d. Special patch cord (if applicable)
    e. Accountable materials receipt accepting delivery of WAP
10. WAP and or jack labels may not be altered, removed or exchanged without approval from the UNLV/NDE.

B. Intra-building Premises Applications:

1. Data cabling at wireless access point (WAP) locations to be terminated in electrical boxes that are mounted parallel to the ceiling, above the drop-ceiling grid panels.
2. Two (2) each Cat 6A/Class EA UTP data cables to be directly routed from the telecommunication rooms' modular patch panels to the work area (WA)

telecommunications outlet (TO) and be terminated onto 8P8C Cat-6A/Class EA rated RJ-45 jacks. These jacks are then "Snap-in" mounted into the upper two (2) ports of a four (4)-port faceplate.

3. Mount the faceplate onto a single-gang-to-double-gang mud ring secured to the 5-square 2 ¾ inch deep electrical box .
4. This permanent link is not to exceed 295 ft. (90 meters).
5. The 5-square 2 ¾ inch deep electrical boxes to have a minimum clearance of 14 inches X 14 inches x 8 inches (356 mm X 356 mm X 203 mm).
6. For premises (ISP) drop ceiling WAP locations; the electrical box to be secured directly above drop ceiling WAP preferably within 12 inches (102 mm) of the WAP designated position. Drawings and specs will determine the WAP mounting options including: (a) secured to the drop ceiling T-bar with a small access hole through the tile for the patch cord, (b) Using a UNLV-approved WAP housing manufacturer that is cut and fits into the tile or replaces the tile, and (c) mounted in the ceiling above the drop ceiling
7. The WAP itself may be mounted above the drop ceiling or onto a panel of the drop ceiling. Access to the electrical box is typically with a modular Cat 6A/Class EA UTP modular patch cord not to exceed four (4) ft. (1.2 meter).
8. Wireless locations that are placed in hard-lid ceilings, cables to be terminated inside of the electrical box having 'floating' jacks inside. Use a blank faceplate to cover the electrical box. The electrical boxes at these locations to be 5-square boxes with a depth of 2 ¾ inches. Each box to maintain the minimum 4X bend radius of the cable.
9. Installation to be performed by the low-voltage contractor.
10. Any unused UNLV owned material and/or WAP devices to be promptly returned to UNLV upon completion of work.

C. Inter-building Outside Plant (OSP) applications

1. Only use 5-square 2 ¾ inch deep electrical boxes for the WAP Work Area (WA).
2. For OSP building wall locations, the electrical box to be located directly in-line on the inside of the building's wall with a drilled pathway directly to the WAP on the outside of the wall.
3. For OSP applications, no plastic mounting hardware is to be used. Use appropriate hardware for the environment and surface being mounted to.
4. Recent design configurations may require all or a select number of WAP locations to be secured in an enclosed lockable, hard-plastic, NEMA-rated cabinet not disrupting any RF signaling. Check project drawings and specifications.
5. Verify the proper mounting of the OSP WAPs with 11.5 inch (292 mm) antennas; typically the antennas are vertical two up and two down. The mounting key-holes to have the large hole on bottom with the narrower slot on top. Also, the brand name to be viewed horizontally and not upside down nor sideways. All will be level, neat and securely installed.

6. For inside/outside garage pillar or wall locations, check elevation drawings; locate the electrical box inside the specified plastic enclosure along with the WAP.
7. Without an enclosure, locate the electrical box within 24 inches (610 mm) of the WAP. If exceeding this 24 inches (610 mm) distance because of structural considerations, location is not to exceed 36 inches (914 mm) between the electrical box and the WAP.
8. For OSP outside parking lot wall locations with a dome, locate weatherproof electrical boxes inside the dome.
9. For OSP outside parking lot pole locations without a dome, locate the weatherproof electrical box within 12 inches (305 mm) of the AP; AP to be located on the pole 10'-12' (3 - 3.7 meters) AFF.
10. For inside/outside parking lot applications - defined as those locations below the top floor of a parking lot or inside the garage - use only weatherproof electrical boxes mounted within 12 inches (305 mm) of the WAP. Standard electrical boxes not permissible.
11. For inside garage applications there are two (2) each. options; (a) use only weatherproof electrical boxes mounted within 12 inches (305 mm) of the WAP as stated for parking lot applications, or (b) use standard electrical boxes but will need to install a clear or smoked plastic water-tight hinged cover over the outlet faceplate ports.
12. For the OSP building WAPs where the electrical outlet is inside the building inline with the WAP on the outside, and
13. For all inside and outside parking lot wall and pole applications; install only double-gang weatherproof blank stainless steel cover (that can be painted) and have a gasket seal.
14. Terminated and "float" 2 ea. 4-pair terminated RJ-45 jacks (568B) inside electrical box. No faceplates permitted.
15. Use only a 'liquid-tight' connector and secure to the bottom of the electrical box. This is the access port for the WAP patch cord to connect to one of the two floating RJ-45s inside the electrical box (lowest cable port number required).
16. For any flush-mounted electrical box garage wall or pillar application, install a 2 ½ inch (63.5 mm) "Square Box Extension Ring" with knock-outs to accommodate the liquid-tight connector so it can be secured to the bottom knockout.
17. This permanent link is not to exceed 295 ft. (90 meters).
18. Note: The weather-resistant manufacturer patch cord threaded port to be on the bottom. When routed properly with a service loop this creates a drip loop in case of water migration.
19. For outside plant (OSP) applications, the patch cord from the WAP to the faceplate is inserted through the 'liquid-tight' connector.
20. Create a service loop with the patch cord and dress with Velcro™. Then secure the patch cord to the wall or pole using wall clamps or grommets.
21. Any electrical box or extension ring's uncovered holes/knockouts to be filled with metal inserts or plugs.
22. Installation of the WAPs will be performed by the low-voltage contractor.

3.8 Cleaning

A. Contractor/Sub to practice good “sweep clean” housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas. This includes keeping inventoried material staging areas in the telecommunications rooms organized.
B. Once the telecommunication rooms are complete with terminated modular patch panels yet still be exposed to sanding, dust and debris, the Contractor/Sub is to use painter's blue tape or equivalent to cover the patch panel ports at no additional cost to UNLV/NDE. Only UNLV/NDE will remove the tape when cutover begins.
C. Upon completion of a project, all debris, empty boxes, excess material inventory, installation equipment and tools are to be removed leaving the premises clean, neat, and orderly. Floors are to be cleaned and vacuumed.
D. This final cleaning includes using a clean HEPA filter vacuum cleaner to remove dust and debris from all installed conduit and electrical outlets, HVAC units, lighting covers, equipment, racks, cabinets, wall mount TDUs and security cabinets, wire managers and the floor itself.

3.9 Communications Horizontal Copper UTP Identification Criteria

A. Identify system components, wiring, and cabling complying per current version of ANSI/TIA-606. Comply with UNLV/NDE requirements for identification specified in Section 27 05 53; *Identification for Communications Systems.*
B. Machine-label all horizontal cables within four (4) inches (102 mm) of the modular patch panel and the work area (WA) telecommunications outlet box (TO). Use black-on-white flexible vinyl wrap-around labels to match the port identifiers on the modular patch panel per UNLV/NDE guidelines:

"Work Area ID #” - “MDF/IDF ID #” - “Patch Panel (PP) ID #” - “Port ID #”

C. Label the modular patch panel ports to coincide with the same port-to-port labeling of the work area (WA) faceplate (clear window inserts) ports.

3.10 Communications Horizontal Copper UTP Examination and Acceptance Testing Parameters

A. Testing is predicated on the proper installation of the horizontal UTP copper cable runs and terminations at both ends of the cable - the modular patch panel side and the station side telecommunications outlet (TO).
B. UNLV/NDE to visually inspect (in phases) cable placement, cable termination, grounding and bonding (if applicable), and labeling of all components before testing is to begin. Should any cable be found to be routed incorrectly, or bruised, kinked, scored, deformed, or abraded the Contractor/Sub is to remove and discard cable and replace it with new cable at no additional cost to UNLV.
C. The frequency criteria for testing with a Level IIIe tester per ANSI/TIA 568.3-D for Cat 6/Class E is @ 250 MHz and Cat 6A/Class EA is @ 500 MHz.
D. Test settings selected from the Options menu provided in the field testers will be compatible with ANSI/TIA 568 and the installed cable/connector manufacturer cable part number(s) under test.
E. Tester setup will also include IEEE 'Compliant Network Standards' for either:

1. Cat 6/Class E: 1GBase-t/802ab
2. Cat 6A/Class EA: 10GBastT/802an

F. When testing for Wireless Access Points (WAPs) PoE ensure the tester is programmed for what is specified in the contract Scope of Work (SoW): The UNLV/NDE current standard is Type 2 or 25.5W is but next generation will be Type 3 or 60.0W that needs to be in compliance to:

1. IEEE 802.3af PoE Type 1 (15.4W)
2. IEEE 802.3at PoE+ Type 2 (25.5W)
3. IEEE 802.3bt PoE++ Type 3 (60.0W)
4. IEEE 802.3bt PoE++ Type 4 (90 W)

G. When a certification test is operated in the autotest mode, one-hundred percent (100%) of the following parameters is to PASS;

1. Continuity or **'wiremap'** check tests for opens, shorts, crossed and reversed pairs. Any discrepancies to be corrected before system testing is to continue. (plus screen/shield if present)
2. **Insertion loss**
3. **Length** (dependent on the NVP value)
4. **NEXT** loss measured from near-end
5. **NEXT** loss measured from far-end (formerly FEXT)
6. Power-sum near-end crosstalk (PSNEXT) loss measured from near-end
7. PSNEXT loss measure from far-end
8. Attenuation to crosstalk ratio from far-end (ACRF)
9. Power sum attenuation to crosstalk ratio far-end (PSACRF)
10. **Return loss**, measured from near -end
11. **Return loss**, measured from far-end
12. Propagation delay
13. Propagation delay skew
14. DC Loop resistance

Note: Those tests in **bold** are installation specific.

H. Category 6/Class E and 6A/Class EA twisted pair cables to be tested with a one-hundred percent (100%) PASS rate. *PASS is not acceptable. End-to-end cabling will be considered defective if it does not pass tests and inspections.

I. Remove and replace cabling where test results indicate that they do not comply with specified requirements at no additional cost to UNLV.

3.11 Close-out Submittals

A. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C

PM. In turn, the UNLV/P&C PM will notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

B. Test results will be provided in both PDF and the native tester manufacturer software format.
C. Tests files to be sorted by buildings, then their respective ER-MDF/TRs-IDFs and in numerical order. Test result to match up port-to-port with As-Built drawings in PDF format.
D. Within 30 days of the substantial completion of the project or prior to project closeout -- which ever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub's one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.

COMMUNICATIONS HORIZONTAL CABLING

– – – End of Sections 27 15 01 .13, .19, .20 – – –

Communications Horizontal (Copper) Cabling, Station Applications, Wireless, and PoE

SECTION 27 15 00

COMMUNICATIONS HORIZONTAL CABLING

Sections 27 15 43 .10, .15, .25

Communications Copper Jack Information Outlets and Connectors,

Communications Fiber Connectors and Cassettes,

Work Area Faceplates/Wall Plates and Surface Mount Boxes

PART 1: GENERAL

1.1 Summary

A. This Section is specific to communications (copper) horizontal cabling for work area (WA) information or telecommunications outlets (TOs), surface mount boxes, faceplates, optical fiber connector and cassettes. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for either or a combination of installing/terminating the work area (WA) telecommunications outlets (TOs) in new or retrofit construction:
   1. Communications horizontal copper cabling terminating onto 8P8C modular, un-keyed RJ-45 jacks inserted into the 4-port faceplate at the telecommunications outlet (TO) and the open-style modular patch panel.
   2. Optical fiber backbone cable terminated or fusion-spliced onto pre-terminated optical fiber cassettes with pigtails having duplex UPC LC connectors.
   3. Note: Adapter plates are non-applicable.

B. The Contractor/Sub is to provide all labor, materials, and equipment required for the complete and proper installation of *Communications (Copper) Horizontal Cabling for Work Area (WA) Information or Telecommunications Outlets (TOs), surface mount boxes, Faceplates, Optical Fiber Connector and Cassettes* within the contract Scope of Work (SoW) for the UNLV/NDE ICT structured cabling system (SCS).

1.2 Communications Horizontal Copper UTP Structured Cabling System (SCS) and Components Defined

A. The communications horizontal copper UTP cabling structured cabling system is defined as:
   1. 4-pair, 100-ohm, balanced, unshielded twisted-pair (UTP).
   2. Cat 6A/Class EA UTP plenum-rated copper UTP cable and related terminations are the standard for new installations whereas Cat 6/Class E UP plenum-rated copper UTP may be used for retrofit installations and has to be authorized by UNLV/NDE.
   3. Minimum two each cable runs to each work area (WA) information outlet referred to as the telecommunications outlet (TO).
   4. The telecommunications outlet (TO) is defined as the (4-port) faceplate mounted onto a 5-square 2 ¾ inch deep electrical (single-gang) box mud ring or a (deep) surface mount box.

5. A copper UTP cable run install is a 'permanent link' only without ('channel') patch cords between the modular patch panel and the telecommunications outlet (TO).
6. Maximum distance is 295 ft. (90 meters).
7. Permanent link terminations between the UNLV standard 2RU 48-port flat modular patch panel and the 4-port station application henceforth referred to as the work area (WA) telecommunications outlet (TO).
8. Telecommunication 4-port outlet (TO) faceplate's two each top ports are designated for termination while the two each lower ports are used for two blank color-matching inserts.
9. The modular jacks are modular 8P8C RJ-45 jacks having 110 IDC with wiring to the 568B standard and being able to accommodate 23-24 AWG UTP cable.
10. At the time of the release of this Division 27 Specification, V1.3, it does not take into consideration EPON, single-pair industrial ethernet applications, nor horizontal optical fiber to the desk (FTTD). All are non-applicable.
11. 'Faceplate' is also referred to as a 'wall plate'.
12. Krone LSA™ and Nortel BIX™ IDCs are not acceptable.

B. The 48-port modular patch panel - fully PCB loaded or open/blank - the faceplates and modular Keystone-style jacks to be from the same connector manufacturer for full building rewires or new building installations. Keystone-style jacks may be from different connector manufacturers for small cable moves, adds, and changes (MACs). Cable to be either from the same connector manufacturer or an approved and documented equivalent business partner.

1.3 Communication Intra- and Inter-building Optical Fiber Backbone and Components Defined

A. Using 8.3/125 µm single-mode fiber OS1A (Indoor) OS2 (Indoor/outdoor) optical-rated glass.
B. The inter-building optical fiber backbone cabling system provides the interconnections between the communications equipment rooms - main distribution frames (ER-MDF) entrance facilities (EF) in the telecommunications cabling system infrastructure.
C. UNLV campus standard cabling for inter-building optical cable type is Air-Blown/jetted optical Fiber (ABF) with 19-cell micro-ducts and a minimum 2RU 48-fiber strands each of 8.3/125 µm single-mode optical glass.
D. Whereas the intra-building optical fiber backbone cable provides the interconnections between the equipment rooms - main distribution frames (ER-MDF) and the telecommunications rooms - intermediate distribution frames (TRs-IDFs) in the telecommunications cabling system infrastructure.
E. The UNLV campus standard for intra-building premises cabling is traditional distribution, non-breakout, tight buffer 900 µm optical fiber cable although ABF fiber may be applicable. Check project specifications for riser-rating OFNR (optical fiber nonconductive riser-rated) or plenum-rated OFNP (optical fiber nonconductive plenum-rated).
F. Unless stipulated in the project specifications, armored optical fiber conductive riser-rated (OFCR) or plenum-rated (OFCP) and any related housings needing grounding and bonding are not applicable.
G. Both intra- and inter-building backbone cabling terminate/fusion splice onto pre-terminated optical fiber pigtail cassettes having duplex single-mode UPC LC connectors.

1.4 Related Documentations and References

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".
B. In particular, the subsections of the master Division 27 05 00; *Common Work Results for Communications*, 27 13 00; *Communications Optical Fiber Backbone Cabling,* and 27 15 00; *Communications Copper Horizontal Cabling* includes the following:
    1. Section 27 01 00; *Operation and Maintenance of Low-Voltage Communications Systems*
    2. Section 27 05 39; *Surface Mounted Raceway*
    3. Section 27 05 40; *Modular Furniture Pathways and Poke-through Devices*
    4. Section 27 05 53; *Identification for Communication Systems*
    5. Section 27 13 23 .01; *Intra-building Optical Fiber Backbone Cabling*
    6. Section 27 13 23. 02; *Inter-building Optical Fiber Backbone Cabling*
    7. Section 27 15 01 .13; *Communications Copper Horizontal Cabling Station Applications and POE*
    8. Section 27 15 01 .19; *Data Communications Copper Horizontal Cabling*
    9. Section 27 15 01 .20; *Wireless Data Communication Copper Horizontal Cabling*
C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
    1. Appendix A; *Codes, Standards, and Regulations*
    2. Appendix B; *Abbreviations and Acronyms*
    3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
    4. Appendix D; *Rack Elevation and Room Sizing Drawings*
D. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification, apply to this Section.
E. Communications copper jack information outlets and connectors, communications fiber connectors and cassettes, work area faceplates/wall plates and surface mount to comply with the requirement of the currents version and practices in:
F. Horizontal cabling, POE, station applications, and Wireless to comply with the requirements of the current versions and practices in:
    1. BICSI *Telecommunications Distribution Methods Manual* (TDMM)
    2. BICSI *Information Technology Systems Installation Manual* (ITSIMM)
    3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
    4. ANSI/BICSI 008-2018; *Wireless Local Area Network (WLAN) System Design and Implementation Best Practices*
    5. ANSI/BICSI N1-17; *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*
    6. ANSI/BICSI N2-17; *Practices for the Installation of Telecommunications and ICT Cabling to Support Remote Power (PoE) Applications*
    7. ANSI/TIA 568.1; *Commercial Building Telecommunications Standard, Part 1: General Requirements*
    8. ANSI/TIA-568.2-D; *Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling*
    9. ANSI/TIA-568.3-E; *Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Component Standard*

10. ANSI/TIA-598.D-1; *Optical Fiber Cable Color Coding in Cable Addendum for Additional Colors*
11. ANSI/TIA-606-C; *Administration Standard for Telecommunications Infrastructure*
12. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facil*ities
13. ANSI/ICEA S-102-732-2009; *Standard for Cat 6 and 6A; 100 ohm Individually Unshielded Twisted-pair Indoor Cables - Incorporated into ANSI/TIA 568.2-D*
14. IEC 61754-20; *Fiber Optic Interconnecting Devices and Passive Components*
15. National Fire Protection Agency (NFPA) – 70 (National Electrical Code)
16. NEC Article 720; *Circuits and Equipment Operating at Less Than 50 Volts*
17. National Electrical Safety Code *(NESC)*
18. UL 969A; *Marking and Labeling Systems*

1.5 Pre-bid Submittals

A. Provide product data sheets and installation instructions for each type of telecommunications outlet, faceplate, surface-mount boxes, and fiber cassette with UPC duplex LC connectors to be installed within the contract Scope of Work (SoW).
B. Contractor/Sub to provide documentation as an authorized cable/connector manufacturer along with the certifications of the assigned on-site technicians installing the copper and/or optical fiber terminated housings. The percentage of certified technicians on-site is dictated by the cable manufacturer for warranty purposes.
C. Architectural drawings to identify each building's floor plan telecommunications outlet (TO) locations for data, WiFi, security and testing cameras, and optical fiber termination points (inside optical fiber enclosures and telecommunications distribution units (TDUs).
D. Labeling schedule.

1.6 Contractor/Sub Qualifications

A. The awarded Contractor/Sub to have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The on-site foreman/supervisor to be competent with authority to act on behalf of the Contractor/Sub. They are to be full-time from the initial walk-through, during the entire project installation, and until work is completed and accepted. The requirement is to have a minimum BICSI Level II Copper (INSTC) and/or Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).
C. Successfully performed at least three projects of low voltage cable installation with similar size and contract Scope of Work (SoW) within two years of the date of the job they are bidding on. If requested, provide proof of performance with a brief job description, start and end dates, and contact information.
D. The Contractor/Sub to provide proof that their on-site personnel have the necessary training and certification(s) to satisfy the testing requirements to cable manufacturer warranty requirements and industry-recognized standards.

E. Contractor/Sub to attend weekly status report meetings:
    1. Provide updates detailing the work that has been completed and inspected
    2. Field quality assurance practices
    3. RFIs/issues encountered
    4. 3-week schedule of work

1.7 Quality Assurance and Warranty

A. Installed cabling work area outlets and optical fiber cassettes housings will be free of defects in material and workmanship.
B. All intra-building premises cabling and termination to be installed in a neat and workmanlike way.
C. Installation will be under the direct supervision of the assigned Contractor/Sub's BICSI-certified supervisor(s)/lead(s) who, in turn, reports to the assigned RCDD project manager.
D. Both to be versed in the preparation of the shop drawings, cabling administration drawings, and field-testing program.
E. Testing the installed systems to be performed by one member of the installation team to be a BICSI and cable manufacturer certified.
F. Install and terminate the horizontal copper UTP cabling into work areas' (WA) telecommunications outlet and field test to the requirements of ANSI/TIA 568-C.0, ANSI/TIA 568.2-D.
G. Install and terminate/splice the communications optical fiber backbone onto the optical fiber pre-terminated duplex LC cassettes with pigtails and field test to the requirements of ANSI/TIA-568.1-E and ANSI/TIA 568.3-D.
H. Provide a copper and optical fiber UTP testing plan and subsequently, the test results and As-Builts to the satisfaction of UNLV/NDE.
I. Subsequently, the Contractor/Sub provides a one (1) year Parts and Labor Warranty along with the connector manufacturer's 25-year warranty for the particular project.
J. Products to be furnished with manufacturer's instructions and mounting hardware.
K. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant..
L. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.
M. Installation work and materials will conform to each detail in the rules and requirements of the National Fire Protection Association, the locally enforced National Electrical Code (NEC) by the authority having jurisdiction (AHJ), current manufacturing standards, and State regulations.

PART 2: PRODUCT

2.1 General

A. The communication optical fiber backbone's termination 'housing' is the point at which the optical fibers are spliced onto pigtail cassettes and 'housed' in the same manufacturer's optical fiber enclosure.
B. Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*

C. A work area's (WA) copper telecommunications outlet (TO) 'housing' is defined as:
   1. A deep 5-square 2 ¾ inch (70 mm) deep electrical box (with single-gang mud ring) or a single-gang surface-mount box.
   2. Covered with a 4-port faceplate; having the top two ports designated for termination of the cable and the lower two ports covered with matching-color snap-in blanks.
   3. Provides for the work area's (WA) cable termination for Cat 6A/Class EA UTP copper, 100-ohm balanced, solid 23-24 AWG 4-pair cable.
   4. Surface-mount boxes, faceplates, and modular RJ-45 jacks to be from the same manufacturer as the modular patch panels.

2.2 Work Area Housing: Modular Connector Characteristics

A. Standard data ports for both the telecommunications outlet's faceplates and the modular patch panels to be:
   1. Able to terminate unshielded and be designated for Cat 6A/Class EA 4-pair UTP cable termination having solid 23-24 AWG conductors.
   2. Female 8-position by 8 conductor (8P8C) un-keyed FCC-compliant RJ-45 jacks wired/terminated to 568B standard.
   3. Use of a standard 110-style Insulation Displacement Contact (IDC) termination 'punch down' tool. Multiwire/crimp specialty tools supplied by the same connector manufacturer are permissible.
   4. Each jack to be single-unit construction with "Keystone" style snap-in mount.
   5. Hinged dust covers are acceptable.
   6. Stuffer caps to have retention snap to ensure conductor strain relief after termination.
   7. Jack housings to be fully encased to protect the PCB or printed circuit board and ultrasonically welded for tamper resistance.
   8. Connector pins to be flat having an industry-standard 50 mil of gold plating that allows for a minimum 500 mating cycles.
   9. IDC contact to have tapered pair-splitting features to aid in wire insertion and minimize pair un-twists.
   10. Black
   11. UL Listed 1863
   12. Cat 6/Class E able to support 1GBase-T application per IEEE 802.3ab.
   13. Cat 6A/Class EA able to support 10GBase-T application per IEEE 802.3an.
   14. Cat 6A/Class EA to support WiFi IEEE 802.3bt for PoE++ Type 3 (60W).
   13. Krone LSA™ and Nortel BIX™ IDCs are not acceptable.
   14. In-line couplers/adapters are not acceptable.

2.3 Work Area Housing: Modular Faceplate Characteristics

A. Flush-mount flat 4-port, vertical, single-gang faceplate designed to mount onto a single-gang mud ring affixed to a 5-square 2 ¾ inch deep electrical box.
B. Made of high-impact PVC plastic or stainless steel depending on the UNLV/P&C project specifications and related environment.
C. To accommodate either Cat 6/Class E or Cat 6A/Class EA snap-in modular Keystone-style jacks.
D. Snap-in upper and lower clear plastic windows to accommodate station port machine-printed paper insert identifiers.

E. Use faceplates and adapters custom designed for the module furniture manufacturers.
F. RJ-45 jacks housed in faceplates not to accept FCC compliant 6-position (RJ-11) plugs nor coax connectors.
G. Custom WiFi access points faceplates a consideration.
H. Angled faceplates/wall plates are acceptable with approval from UNLV/P&C and UNLV/NDE.
I. Color and finish determined by UNLV /P&C project specifications - typically beige/almond/ivory.

2.4 Work Area Housing: Surface-mount boxes and Extenders

A. From the same manufacturer of the raceway system that consists of the raceway base and cover, fittings, mounting brackets, and fasteners.
B. Per UNLV/P&C, only metal surface-mount raceway is to be used. No plastic.
C. Minimum. size is 1 ½ H X 2 ¾ W inches (38 mm X 70 mm) to accommodate proper fill ratio and maintain copper UTP 4X bend radius.
D. Must use deep surface mount boxes minimum 2 ½ to 2 ¾" inches (64 mm- 70 mm) deep. Can be be plastic or metal. This includes a 5-square 2 ¾ inch (70 mm) deep outlet box.
E. Surface-mount options to include surface-mount extenders or stand-off rings to obtain proper depth for mounting the RJ-45 jacks (and using angled faceplates/wall plates.
F. Surface-mount plastic box color and finish determined by UNLV/P&C project specifications - typically beige/almond/ivory.

2.5 Optical Glass

A. OS1A and OS2 8.3/125 µm
B. Glass to be Class IVa dispersion-unshifted single-mode optical fiber complying with ANSI/TIA 492CAAB
C. Compliant with ITU-T G.652D, ITU-T G.671, GR-20-CORE, and GR-356-CORE.
D. Able to support QSFP28-100GBase-LR4 per IEEE 802.3ab @1310 nm (on UPC polish duplex LC) and backwards compatible to 40G, 10G and 1000Base-XX IEEE Ethernet applications
E. Maximum attenuation for both wavelengths @ 1310 nm/ 1550 nm 0.5 dB/Km.
F. Maximum channel budget loss for 40/100GBase-LR4 6.7 dB/6.3 dB @ max. 10 Km (0.15 /Mft)
G. Suitable for -30℃ (-22℉) to +75 ℃ (+167 ℉) environments.

2.6 Communications Backbone Optical Fiber Cassettes and Connector Housings

A. Traditional distribution and ABF optical fiber runs to terminate onto pre-terminated individual UPC duplex UPC LC 12- or 24-fiber cassettes having 250 um pigtails for splicing.
B. Cassettes to 'snap into' the cradle sleeves of the same manufacturer's optical fiber enclosure; horizontally into 1RU and 2RU or vertically in 4RU housings.
C. Plastic HDPE cassette to house and secure the fusion splices while maintaining cable wrap bend radius.
D. Clear plastic lid to allow visual inspection of the fusion splices and service loops.
E. Follows the color code of ANSI/TIA-598.D-1.
F. Usable life expectancy 25 years.
G. See 2.7 Connector, LC for specifications

2.7 Connector, LC

A. Transmission requirements for patch cables connectors, cassettes connectors and mated-pair testing:
    1. Maximum insertion loss (IL) 0.35 dB
    2. Minimum return loss (RL) 0.50 dB
B. Transmission requirements for test reference cables (TRCs):
    1. Maximum insertion loss (IL) 0.25 dB
    2. Minimum return loss (RL) 0.55 dB
C. Pre-polish LC duplex connectors:
    1. Requires no field polishing and no adhesives for termination.
    2. To be factory-polished with a zirconium ceramic ferrule alignment sleeve
    3. Ferrule geometry pre-radiused
    4. Single-mode only for OS1A or OS2 type fiber 8.3/125 µm
    5. Dark blue
    6. UPC polish having a maximum IL < 0.35 dB and minimum RL > 0.50 dB
    7. Able to support 100GBase-LR4 per IEEE 802.3ba @ 1310 nm
    8. Compatible for either 900 µm or 250 µm buffer optical fiber cables
    9. Complies with ANSI/TIA 604-FOCIS-10, ANSI/TIA-455, ITU-T G.652.D standards
    10. Pre-polished connectors individually to be crimped or fusion spliced whereas LC cassettes with pigtails to be fusion spliced. No field polishing.
    11. Minimum 500 mating cycles

PART 3: EXECUTION

3.1 Summary

A. The Contractor/Sub provides all labor, materials, tools and equipment required for the complete installation of the communications (copper) horizontal cabling terminated onto work area (WA) faceplates, information or telecommunications outlets (TOs), surface mount boxes, as well as the communications backbone cabling termination onto optical fiber cassettes without any additional costs to UNLV.
B. Neither the communications copper horizontal nor the optical fiber backbone cables are to be bruised, kinked, scored, deformed, or abraded cable. Splices are not allowed between either terminations points.
C. Contractor/Sub to verify that each communications horizontal copper and optical fiber backbone cable runs are correctly installed, terminated/spliced into the proper termination housings before testing is to begin.

3.2 Communications Horizontal Copper UTP Installation Guidelines to the Work Area's (WAs) Telecommunications Outlets (TOs) Housings

A. The UNLV/NDE standard is to pull two (2) each Cat 6A/Class EA CMP cables to each work area (WA) telecommunications outlet (TO) location (the second is relegated as a spare). The only exception to pulling only one cable has to be approved by UNLV/NDE RCDD or in specifications typically used for badge readers.
B. Communication horizontal UTP cables are to be placed in pathways and spaces dedicated for communications cables.
C. This permanent link is not to exceed 295 ft. (90 meters).
D. Maximum bend radius for UTP is 4X the OD of the cable and no less than one (1) inch (25 mm).
E. The height of a work area (WA) telecommunication wall outlet (TO) to be level with adjoining electrical outlet and the same color. When the telecommunication wall outlet (TO) is in solo locations, cut-out to be 14" (356 mm) AFF (bottom) / 18" (457 mm) AFF (top).
F. Cables routed to the work area (WA) telecommunication outlets (TOs) are to be placed in minimum 1-inch (25 mm) EMT conduit between the walls and having a 45- or 90-degree stub-out on top towards the pathways going to the assigned telecommunications room. For masonry or solid wood walls, vertically route and secure the conduit on the surface along with the surface mounted 5-square electrical boxes.
G. Use only 5-Square 2 ¾ inches (70 mm) deep boxes for work area (WA) outlets. Double-gang for 6-10 cables.
H. Outlet boxes to be fastened securely to a wall stud or structural element in a manner to comply with separation from power and permit flush-mounting of the faceplate/wall plate to the finished wall.
I. Outside plant (OSP) boxes with grommets and faceplates to be outdoor weather-proof rated. For Inside/Outside applications - inclusive of below top floor parking lots and garages - UNLV/NDE and UNLV/P&C will determine if a clear plastic weatherproof outlet cover assembly is required.
J. Allow a minimum 12 inches (305 mm) of UTP cable slack in a single-loop and secured on top near the stub-out abiding the 4X bend radius and without kinking the cable.
K. If cable is in a dedicated conduit run from the telecommunications room to the work area's telecommunications outlet there is to be no more than two (2) each 90 degree bends without a pull box.
L. Inside the 5-square box, allow just enough slack to be able to terminate/re-terminate the modular connectors inside.

3.3 Communications Optical Fiber Backbone Installation Guidelines for the Pre-terminated duplex LC Cassettes

A. Terminations will be completed using no epoxy/no polish connectors. For individual fibers field terminations, use factory-terminated pre-polished LC connectors having pigtail stubs for fusion splicing or crimp-style.
B. Follow the optical fiber enclosure manufacturer's instructions for cable preparation and service loop routing.
C. Single-mode OS1A, OS2 traditional or ABF optical fiber is terminated onto optical cassettes with pigtails by fusion splicing.
D. Cassettes to be slide-n-lock mounted in an optical fiber enclosure from the same manufacturer.
E. The enclosure to be mounted towards the top of an equipment rack or communications cabinet.

F. Fiber strand numbering to be consistent with the Consecutive Fiber Numbering (CFN) sequence as identified in the latest version of ANSI/TIA 568. This fiber stand numbering sequence between each fiber link will be adhered to at each terminated end of the optical fiber cable; straight-thru termination 1-1, 2-2, 3-3 and so forth only. The rolling of fiber optic strands 1-2,2-1, 3-4, 4-3 is not acceptable.

3.4 Cleaning

A. Contractor/Sub to practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the telecommunication rooms and the associated work areas.
B. Extra care given to the proper handling and disposal of fiber shards.
C. Upon completion of a project, all debris, empty boxes, excess material inventory, installation equipment and tools are to be removed leaving the premises clean, neat, and orderly. Floors are to be cleaned and vacuumed.
D. This final cleaning includes using a clean HEPA filter vacuum cleaner to remove dust and debris from all installed conduit and electrical outlets, HVAC units, lighting covers, equipment, racks, cabinets, wall mount TDUs and security cabinets, wire managers and the floor itself.

3.5 Identification Schedule

A. Adhere to the guidelines of Section 27 05 53; *Identification for Communications Systems.* The following is just an overview.
B. Traditional optical fiber cable and ABF cable are terminated and labeled in the same manner in the optical fiber enclosure:
    1. UNLV has standardized on optical fiber cassettes (with pigtails for fusion splicing) and not adapter plates.
    2. The first "A" cassette in an optical fiber enclosure is installed and labeled in the first slot on the left side facing the front of the housing. This first cassette contains fibers strands #1-24 having a row of 12 each duplex (LC) connectors.
    3. Each subsequent cassette will be alpha-sequence left-to-right with the next adapter plate or cassette labeled as "B" (fibers #25-48), the next "C' (Fibers #49-72) and so forth.
C. Machine-label all horizontal cables within four (4) inches (102 mm) of the modular patch panel and the work area (WA) telecommunications outlet box (TO). Use black-on-white flexible vinyl wrap-around labels to match the port identifiers on the modular patch panel per UNLV/NDE guidelines:
"Work Area ID #" - "MDF/IDF ID #" - "Patch Panel (PP) ID #" - "Port ID #"
D. Label the work area (WA) faceplate (clear window inserts) to coincide with the same port-to-port labeling of the modular patch panel ports.

3.6 Close-out Submittals

A. Test documents/results and As-Builts for both intra- and inter-building cable runs separated by the building's telecommunications rooms and then numerical order in PDF and native tester manufacturer software format. The completed installation is to be approved by UNLV/NDE.
B. UNLV/NDE to perform a visual inspection and complete a walkthrough with the Contractor/Sub (and architect if requested). Any discrepancies are to be addressed on a 'punch list' to the

UNLV/P&C assigned project manager (PM). The Contractor/Sub has 48 hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. In turn, the UNLV/P&C PM will notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

C. Within 30 days of the substantial completion of the project or prior to project closeout -- which ever comes first - provide manufacturer(s) system warranty(s) for minimum 25 years covering all components, materials, and equipment plus the Contractor/Sub's one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.

D. Contractor/Sub to provide:
   1. A one-year parts and labor warranty against defective workmanship and cable system component failure.
   2. The associated cable manufacturer's 25-year warranty for the project.

SECTION 27 15 00: COMMUNICATIONS HORIZONTAL CABLING

——— End of Sections 27 15 43 .10, .15, .25 ———

Communications Copper Jack Information Outlets and Connectors,

Communications Fiber Connectors and Cassettes,

Work Area Faceplates/Wall Plates and Surface Mount Boxes

SECTION 27 16 00

COMMUNICATION CONNECTING CORDS

Sections 27 16 19 .02 and .05

Copper Patch Cords and Single-mode Fiber Patch Cords

PART 1: GENERAL - Specific to the Sellers of Patch Cords

1.1 Summary

A. This Section is specific to (male plugs) copper 4-pair UTP Cat 6 Class E/Cat 6A Class EA modular patch cords and OS1A and OS2 duplex UPC LC connector optical fiber patch cords.
B. UNLV/NDE is responsible for the purchase, inventory, and inter-connection of patch cords into switches and active devices at the user end.
C. Accordingly, the Contractor/Sub is not responsible for the purchase nor the installation of modular copper nor optical fiber patch cords. With the exception of the installation of WAP patch cords at the WA side.
D. Neither are to be used as test reference cords (TRCs) for testing purposes.
E. UNLV's communications copper UTP horizontal is considered a 'permanent link' without modular patch cords. Channel configuration having port-dedicated 4-pair patch cords for testing is non-applicable unless specifically required by the cable/connector manufacturer for warranty purposes.
F. Modular patch cords to meet the requirements of IEEE 802.3 af Type I and IEEE 802.3 at Type 2
G. The optical fiber backbone cabling is also considered a single fiber link point-to-point connection without the inter-connectivity of duplex patch cords. The exception would be specified in the project's specification for testing a complete 100GBase-LR4 with 'hops' up to 10 Km.
H. Unless otherwise specified in the project specifications, both modular copper and optical fiber patch cords do not require a fire-rating or have an option to be riser-rated. Per the NEC the accepted designations are:
    1. Modular copper UTP: CM or CMX, (and CMR) U/UTP or U/FTP (foil with a shielded RJ-45 male connector plugs)
    2. Optical fiber: OFN (and OFNR)

1.2 Related Documentation and References

Manufacturers and suppliers of UNLV/NDE modular 4-pair patch cords and duplex LC optical single-mode patch cords are to comply with the requirements of the current versions and practices in:

1. ANSI/TIA-455 Series; *Standard Test Procedures for Testing Optical Fiber*
2. ANSI/TIA-568.2-D; *Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling*
3. ANSI/TIA-568.3-E; *Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Component Standard*

4. ANSI/TIA-598-D; *Optical Fiber Cable Color Coding*
5. ANSI/TIA 604-FOCIS 10; *Fiber Optic Connector Intermateability Standard*
6. ANSI/TIA-1152-A; *Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling*
7. ANSI/ICEA S-102-732-2009; *Standard for Cat 6 and 6A; 100 ohm Individually Unshielded Twisted-pair Indoor Cables*
8. GR-20-CORE; Telcordia/Ericsson *General Requirements for Optical Fiber Cable*
9. GR-326-CORE; Telcordia/Ericsson *Generic Requirements for Single-mode Optical Connectors and Jumper Assemblies*
10. IEC 874-10; *Sectional 10 Specification Fiber Optic Connectors*
11. IEC 60793-2-50; *Sectional Product Specifications for Class B Single-mode Fibers*
12. *IEEE 802.3 af Type I and IEEE 802.3 at Type 2*
13. ISO/IEC 11801-1 4th Edition; EN 50173-2: 2007 + A1: 2012 (CENELEC TC215); *Information Technology - Generic Cabling for Customer Premises (Sept, 2017) - Part 1: General Requirements and, Part 2: Office Premises*
14. ISO/IEC 61300-3-5; *Fibre Optic Interconnecting Devices and Passive Components - Basic Test and Measurement Procedures - Part 3-35: Visual Inspection of Fibre Optic Connectors and Fibre-stub Transceivers*
15. ITU-T G.652D; *Characteristics of Single-Mode Optical Fiber*
16. NFPA-70 *National Electric Cod*e
17. NEC Article 770; *Optical Fiber and Raceways*
18. TIA-492 CAAC; *Detail Specification for Class IVa Dispersion-Unshifted Single-mode Optical Fibers*
19. UL 1666: *Safety Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in (Riser) Shafts*

1.3 Quality Assurance and Warranty

A. Patch cables to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant..
B. Each optical fiber patch cable to be individually tested:
    1. To have an identification test result tag or like with the part number and serial lot number inserted in the packaging.
    2. Included on the tag will be either the LC duplex cable's individual test results or the maximum insertion loss (IL) level and minimum return loss (RL) allowable values for both cables '1' and '2' and from both ends 'A' and 'B'.
    3. Each end of the duplex LC UPC connectors to have dust caps installed.
C. Each of the modular copper and optical fiber patch cords packaging:
    1. To be individually bagged in clear plastic bags hermetically sealed against dust and moisture.
    2. Securely looped with two (2) to three (3) each light-weight twist ties or equal.
    3. Include test results with optical fiber patch cords.
    4. Modular patch cord outer packaging or visible identification tag to identify:
        a. Category level (e.g. Cat 6 Class E or Cat 6A/Class EA)
        b. Designate U/UTP or U/FTP
        c. Length in feet
        d. 568B wiring scheme

5. Optical fiber patch cords outer packaging or visible identification tag
    a. Connect type(s) e.g. LC>LC or LC>SC, and so forth
    b. Length in feet or meters
    c. To confirm A>B polarity

D. Warranty statement from each OEM.

PART 2: PRODUCT

2.1 General

A. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
B. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.
C. Testing organization compliance for performance and fire-rating to be depicted or labeled minimum every 18 inches (458 mm) along the patch cord outer jacket.

2.2 Modular Copper Patch Cords

A. Unshielded U/UTP (and shielded U/FTP upon request) for Cat 6/Class E and Cat 6A/Class EA 4-pair cable termination having 26-28 AWG stranded cable
B. Male 8-position by 8 conductor (8P8C) RJ-45 plug wired/terminated to 568B standard
C. Di-electric pre-alignment element to position the individual conductors in a manner to optimize near-end cross-talk (NEXT) performance.
D. Molded into the plug an integral snagless feature to protect the plug release tab during cable routing
E. Low-profile, tight fit, molded strain relief boot on each connector at both ends
F. Able to be plugged into a “Keystone” style female jack snap-in mount
G. Connector pins to be flat having an industry-standard 50 mil of gold plating that allows for a minimum 500 mating cycles
H. Cable jacket gray PVC
I. Acceptable fire-ratings CM, CMX, and CMR
J. Cat 6/Class E able to support 1GBase-T per IEEE 802.3ab
K. Cat 6A/Class EA able to support 10GBase-T per IEEE 802an
L. Cat 6A/Class EA able to support IEEE 802.3bt PoE++ Type 3 (60W)
M. To be available in 4 ft., 6 ft., and 8 ft. lengths

2.3 Optical Fiber Patch Cords

A. To be constructed with aramid-yarn reinforced PVC loose jacket 900 um duplex cable using heat-cured epoxy to mechanically secure the cordage with required tensile strength at each connector end.
B. A (Tx) > B (Rx) polarity
C. Compliant to ANSI/TIA 604 (FOCIS); *Fiber Optic Connector Intermateability Standard*
D. Typically terminated with duplex LC > LC connectors or hybrid requirements of LC >SC
E. Fiber mode OS1A or OS2 8.3/125 µm glass type

F. Factory polished and tested
G. Single-mode fiber grade to meet ITU G.657.A.1 (Compatible to ITU-T G.652.D) *Bending Loss Insensitive Single-mode Fiber* having a 10 mm (⅜ inch) minimum bend radius
    1. Attenuation @1310 nm = 0.35 dB/Km
    2. Attenuation @ 1550 nm = 0.22 dB/Km
H. "Grade A" precision zirconia ferrule connectors
I. Reversible polarity connector types encouraged if price competitive
J. Insertion loss for each fiber in each duplex connector maximum < or = to 0.30 dB
K. Return loss for each fiber in each duplex connector minimum > or = to 55 dB
L. Cable jackets yellow PVC
M. Acceptable fire-ratings OFN and OFNR
N. Operating temperature -20C t(- 4F) to +70C (158F)
O. Able to support 100GBase-LR4 per IEEE 802.3ba @1310 nm on UPC duplex LC connectors
P. To be available in 1m, 2m, 3m, 5m ,and 7 meter lengths

PART 3: **EXECUTION** (Non-applicable)

SECTION 27 16 00: COMMUNICATION CONNECTING CORDS

– – – End of Sections 27 16 19 .02 and .05 – – –

Copper Patch Cords and Single-mode Fiber Patch Cords

SECTION 27 40 00

INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT

PART 1: GENERAL

1.1 Summary

A. This Section is specific to integrated audio-video (A/V) systems and equipment. It describes the minimum requirements for the PART I General requirements, PART II Product selections, and PART III Execution installation guidelines for integrated audio-video systems and equipment specifications in either new or retrofit construction.

B. The Audio-Visual Contractor (herein referred to as "A/V Contractor" or abbreviated "AVC") is to provide all labor, materials, and equipment required for the complete and proper installation of *Integrated Audio-Visual Systems and Equipment* within the contract Scope of Work (SoW). This includes construction drawings, audiovisual systems drawings, and project specifications that may share or be integrated into the UNLV/NDE Information and Communications Technologies (ICT) structured cabling system (SCS).

C. The AVC acknowledges that they have reviewed the project design specification and the information is sufficient to accurately bid the project and complete the work in the time allotted for the price agreed to with UNLV Classroom Technologies Services (herein referred to as "UNLV/CTS"). This includes all work, whether or not specifically described in the design specification package, that ensures the installation is both fully functional and in compliance with all applicable laws, codes, rules, and regulations.

D. The AVC's scope of work (SoW) is to provide a complete A/V system including delivery, installation, and warranty services as specified.

E. Subcontractors are not authorized for A/V installations.

1.2 Definitions

A. The following abbreviations will apply:

1. UNLV: University of Nevada Las Vegas is also referred to contractually as the 'Owner".
2. A/V: Audio-Visual
3. GC: General Contractor
4. AVC: A/V Contractor (to the General Contractor or UNLV/CTS directly)
5. UNLV/CTS:UNLV Classroom Technology Services (A/V)
6. UNLV/P&C: UNLV Planning and Construction department
7. UNLV/NDE: Network Development and Engineering
8. OFCI: Owner Furnished - Contractor Installed refers to UNLV/CTS furnishing the equipment and supplying it to the AVC. The AVC, in turn, is responsible for its inventory, storage, installation, and integration of this equipment.
9. The basis for terminology used in this document is standard construction and sound

and communications industries practices and that of IEEE/ANSI-100-1996.

1.3 Related Documentations and References

A. The subsections listed in the *Table of Contents* are considered to be "Related Documents".
B. In particular, the subsections that directly or indirectly are related to the A/V cabling infrastructure includes the master Division 27 05 00; *Common Work Results for Communications*, 27 11 00; *Communications Equipment Room Fittings*, and 27 15 00; *Communications Copper Horizontal Cabling* includes the following:
    1. Section 27 01 00; *Operation and Maintenance of Low-Voltage Communications Systems*
    2. Section 27 05 26; *Grounding and Bonding*
    3. Section 27 05 28; *Pathways for Communications Systems*
    4. Section 27 05 29; *Hangers, J-hooks, and Supports*
    5. Section 27 05 33; *Conduits and Back Boxes*
    6. Section 27 05 36; *Cable Trays*
    7. Section 27 05 41; *Firestopping System for Communications*
    8. Section 27 11 10; *Telecommunications Rooms and Backboards*
    9. Section 27 11 16; *Communication Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides*
    10. Section 27 11 19; *Communications Copper Modular Patch Panels*
    11. Section 27 15 01 .13; *Communications Copper Horizontal Cabling Station Applications and POE*
    12. Section 27 15 01 .19; *Data Communications Copper Horizontal Cabling*
    13. Section 27 15 43 .10; *Communications Copper Jack Information Outlets and Connectors*
    14. Section 27 15 43 .25; *Work Area Faceplates/Wall Plates and Surface Mount Boxes*
C. Material and work specified to comply with the applicable requirements of the current revisions of the following:
    1. Appendix A; *Codes, Standards, and Regulations*
    2. Appendix B; *Abbreviations and Acronyms*
    3. Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*
    4. Appendix D; *Rack Elevation and Room Sizing Drawings*
D. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification, apply to this Section.
E. The A/V designs and installation will comply with the particular requirements of the current versions and practices in:
    1. ANSI/INFOCOMM 2M-2010; *Standard Guide for Audiovisual Design and Coordination Processes*
    2. ANSI/INFOCOMM 10-2013; *Audiovisual Systems Performance Verification*
    3. ANSI/BICSI 001-2017-R22; *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*
    4. ANSI/TIA 607-D; *Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises*
    5. AVIXA 102.01-2017; *Audio Coverage Uniformity in Listerner Areas*
    6. AVIXA F502.01-2018; *Rack Building for Audiovisual Systems*

7. INFOCOMM F501.01-2015; *Cable Labeling for Audiovisual Systems*
8. NSI/ICEA S-102-732-2009; *Standard for Cat 6 and 6A; 100 ohm Individually Unshielded Twisted-pair Indoor Cables*
9. ANSI/TIA-4966-A; *Telecommunications Infrastructure Standard for Educational Facilities, Including Addendum 1: Updated References Accommodation of New Media Types*
10. EIA/ECA 310-E; *Cabinets, Racks, Panels, and Associated Equipment*
11. IEC 61935-1;
12. NEC Article 250; *Grounding and Bonding of Electrical Systems*
13. TIA TSB-184-A; *Guidelines for Supporting Power Delivery over Balanced Twisted-Pair Cabling*
14. TIA TSB-190*; Guidelines on Shared Pathways and Shared Sheaths*
15. UL 910; *UL Standard for Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical Fiber Cables Used in Spaces Transporting Environmental Air*

G. This Section has a direct correlation to Division 26 (Electrical)

H. If any change in drawings or specifications be required to comply with governmental regulations, the Contractor/Sub to notify the UNLV/CTS at the time of submitting the construction schedule.

I. See Appendix A; *Codes, Standards, and Regulations.* This includes but not limited to the current published version and/or those enforced by the authority having jurisdiction (AHJ);
    1. ADA Standards for Accessible Design
    2. AIA; American Institute of Architects
    3. ANSI; American National Standards Institute
    4. ASTM; American Society for Testing and Material
    5. BICSI; Building Industry Consulting Service International
        a. BICSI *Telecommunications Distribution Methods Manual (*TDMM)
        b. BICSI *Information Transport Systems Installation Methods Manual (*ITSIMM)
    6. CSI; Construction Specification Institute
    7. ESPEC; Telcordia Technologies GR-CORE Specifications
    8. ETL; Edison Testing Lab > Intertek
    9. FCC; Federal Communications Commission
    10. FOA; Fiber Optic Association
    11. IBC; International Building Code
    12. ICEA; Insulated Cable Engineers Association
    13. IEC; International Electrotechnical Commission
    14. IECC; International Energy Conservation Code
    15. IEEE; Institute of Electrical and Electronics Engineers
    16. IFC; International Fire Code
    17. ISO; International Organization of Standards
    18. ITU; International Telecommunications Union
    19. NEC; National Electrical Code
    20. NEMA; National Electrical Manufacturers Association Standards
    21. NESC; National Electrical Safety Code
    22. NFPA 70; National Fire Protection Agency
    23. OSHA; Occupational Safety and Health Administration

24. SCTE; Society of Cable Telecommunications Engineers
25. SBCCI; Southern Building Code Congress International
26. SNBO; Southern Nevada Building Officials amendments
27. TIA; Telecommunications Industry Association
28. UBC; Uniform Building Code
29. UL; Underwriter Laboratories Incorporated Standards
30. UMC; Uniform Mechanical Code by IAPMO
31. UNLV Planning and Construction (P&C) specifications

1.4 The Roles of UNLV/NDE and UNLV/P&C

A. The UNLV/CTS A/V cabling system will frequently interface with the UNLV/NDE ICT structured cabling system (SCS). The AVC needs to follow the same low-voltage specifications as stated in this *UNLV Division 27 Campus Wiring Design Guide.* The UNLV/NDE will provide network connectivity and the related components listed in the *Table of Contents* as well as in the overview of Section 27 01 00; *Operation and Maintenance of Low-voltage Communications System*s.
B. This telecommunication infrastructure is inclusive of low-voltage; cable pathways, conduits, cabling support systems, surface mounted raceways, pull and junction boxes, telecommunication rooms, and the horizontal copper cabling to a variety of work area (WA) telecommunication outlets permanently installed in floors, walls, and ceilings.
C. UNLV/P&C may also be managing and designing the power connections. They will hire only licensed and UNLV-approved electrical contractors (and AVC contractors). These high-voltage contractors are the ones who will be installing the electrical breaker panels, motorized breaker panels, and power receptacles necessary to bring power to the A/V systems' equipment racks and to other A/V devices.
D. This also includes conduit and boxes inside the walls, room lighting fixtures, dimmers, power receptacle outlets, and interconnecting wiring for these circuits.
E. UNLV/P&C will also oversee and manage any structural work, wall openings, platforms, railings, stairs, fire prevention and safety devices, rough and finished trim, painting and patching, drapes, carpets, floor coverings, computer floors, glazing, acoustical treatments, heating, ventilating, and air conditioning systems unless noted otherwise.

1.5 Scope of Work

A. The A/V project's design specifications have certain requirements for performance, appearance, and costs. It is the responsibility of the AVC to implement the requirements as defined in their scope of work (SoW) into a complete package containing all elements necessary for a complete, operational, and functionally integrated A/V system.
B. Provide materials, labor, and equipment including, but not limited, to:
    1. General
        a. The delivery, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required.
        b. All other work whether or not expressly specified or on the drawings to provide complete operational systems.

c. Record any necessary changes to the system design and request approval from UNLV/CTS.
d. The AVC is to coordinate all aspects of A/V installation with UNLV/CTS.
e. Notify UNLV/CTS Site Manager of unsatisfactory preparation before proceeding.

2. Projection Screens
    a. Installation of motorized projection screens.
        i. Installation of control cabling to screens. Installation of new redundant switch at specified wall location, per UNLV/CTS's specification.
    b. Manually operated projection screens.
    c. Fixed projection screens.
3. A/V Rack and Lectern Racks
    a. Populate with all equipment shown in the A/V drawings and BOM as per the AV drawings.
    b. Provide low voltage cable as per A/V drawings and interconnect system components and equipment.
4. Interconnect Cables
    a. Provide low voltage cable as per A/V drawings.
    b. All interconnection cables, connectors, terminal strips, conduits, cable pathways, flexible conduit, raceways, are to facilitate the A/V systems as detailed in the drawings.
5. Lectern
    a. Installation of lectern equipment, not mounted in rack space, on the lectern in UNLV/CTS specified location.
        i. Cable passthrough
        ii. Touch panel
        iii. Document camera
        iv. Lectern computer monitor, mouse, and keyboard (OFE) and any peripheral devices
6. Projector & Mount
    a. Installation of projector, mount, and scaler.
7. Flat Panel Monitor / Displays
    a. Installation of flat panel, mount, and any peripheral devices required for location.
    b. Installation of control cabling to equipment per UNLV/CTS's specification.
8. Speakers
    a. Installation of new speakers, in specified locations.
9. Floor Boxes
    a. Install new interconnect panels where needed.
10. Large Format Direct View LED Display Systems
    a. Installer Qualifications: Minimum five years documented experience in work of this Section. At least one member of the install team is to have completed the dealer certification program before commencing installation.
    b. Authorized Manufacturer Representative: System to be configured and commissioned by an authorized manufacturer representative.

c. Provide appropriate spare panels of each pixel pitch at time of final installation.
d. Coordinate with others as indicated on the construction drawings for any custom mounting and support of the large format display as specified.
e. Provide shop drawings indicating details of construction, fabrication, and installation of signage systems including but not limited to wiring diagrams, cable routing, interconnections between equipment, anchorage details, and relationship with supporting structure and adjacent construction.

1.6 Responsibilities of UNLV/CTS

A. UNLV/CTS assumes limited responsibilities in the implementation effort, including:
    1. A comprehensive understanding of the RFP project complete with specifications, references, and drawings.
    2. Providing the AVC with access to buildings.
    3. Providing a Project Manager as the main project contact for the AVC provider team.
    4. Facilitating interactions with other trades and/or vendors to promote information exchanges and/or activities required for the installation, implementation, and operation.

1.7 Performance Requirements

A. The AVC to study the drawings and familiarize themselves with the work of the entire project scope. The work of this Section to be carefully organized and programmed so that its progress is concurrent with the work of all other trades to ensure meeting scheduled deadlines.
B. The AVC is responsible for the correct placement of the work of this Section, equipment to fit into the structure As-Built, attachment of equipment to the work of all other trades, and UNLV/CTS furnished equipment and facilities.
C. Install equipment to industry safety and ergonomic standards and provide full engineering and technical support throughout the installation process.
    1. Do not begin installation until substrates and support structure is in place and properly prepared. Use the methods recommended by the manufacturer and any deviations from manufacturer's recommended tolerances are corrected.
    2. Commencement of installation constitutes acceptance of conditions.
D. The functional interconnections of the audio, video, and control systems to comply with the manufacturer’s system installation guidelines first, then industry standard best-practices.
E. It is the responsibility of the AVC to coordinate with those performing related work and to interface other systems. The AVC is to ensure that the work by other trades is properly integrated with the work of this Section and that all work collectively complies with the specified requirements.
    1. Coordination to include providing timely submittal and field coordination of mounting requirements, dimensions, and any other information required by other trades.
    2. Maintain constant communications with all designated personnel of the GC and attend all construction meetings as requested by the GC.
F. The AVC will generate all shop drawings and information for the complete installation and

wiring of the system. The AVC is to provide pre-printed wire labels numerically organized for signal type and cable count in direct reference to the engineering documentation and shop drawings. See 3.5 Identification Schedule for more details.

G. The AVC will be responsible for:
    1. The comprehensive adjustment of the systems as specified and provide all test equipment for the system checkout and acceptance tests.
    2. Adjust and balance all circuits as specified.
    3. Set controls and software parameters to render fully and optimally operating systems and subsystems.
    4. Computer-controlled functions will require complete audio/computer/software setup, balancing, label-entry and documentation to be submitted to CTS.
H. Coordination and review of all conduit, power, pathway, and equipment exact locations and requirements.
I. Verify with all manufacturers and/or suppliers' availability and cost of all material and equipment proposed, including all material and equipment as specified. No cost increases are allowed for manufacturers' cost increases, or for substitutions required because of unavailability of proposed equipment. Bid or quoted pricing is final.
J. The AVC is responsible for ensuring that it is fully aware of the expectation of the project;
    1. The location and condition of the work site
    2. Any specific conditions and limitations of the Site
    3. Any other influences that may affect the work as outlined in the design specification
K. Claims for additional time or additional compensation as a result of The AVC's failure to familiarize itself with all local conditions and the contract documents will not be accepted nor approved.
L. The AVC is to provide all labor, materials, transportation and equipment to complete the installation, furnishing, assembly, set up, and testing of the audio, video, and integrated control systems work indicated on the associated A/V drawings and specifications.
M. Notwithstanding any detailed information in this Section, provide complete, working equipment. The AVC will provide all materials and assemblies and other work that is required, whether or not specifically mentioned in these specifications. All equipment to be completely installed with all the necessary interconnection and wiring to provide a fully functioning system(s).
N. The AVC is to coordinate with GC/EC for all conduits inclusive of junction boxes and pull-wires. Where not included under the EC scope of supply, AVC to supply and install required conduit and/or cable routing.
O. The AVC to coordinate with the UNLV/CTS's lectern supplier to provide the proper cutout for the connectivity solution cutout for the presentation lecterns.
P. Provide work progress schedules keyed to personnel, vendors, and tasks as specified and provide updates as requested by the owner.

1.8 Discrepancies

A. Where there is a discrepancy between drawings and documents, this document will supersede the drawings. However, the AVC is to first seek clarification and approval from UNLV/CTS. The AVC is to consider all the information in combination and not consider one element alone to meet a minimum requirement.
B. The specifications and the drawings do not necessarily indicate the single component part of each system. It is the responsibility of the AVC to engineer each system and its interconnection in order to provide, furnish, and install completely operational systems.
C. If discrepancies occur between contract document scope of work (SoW) , local codes, national codes, utility requirements, most stringent requirements will apply.
D. Upon written request, the AVC is to deliver proof that materials and/or workmanship meet or exceed requirements of the referenced standard(s).
E. No error or omission or on any related construction documents to relieve the AVC from this responsibility to do so.

1.9 Contractor Qualifications

A. Contractor Qualifications
    1. A copy of the contractor's valid State of Nevada Contractor License.
    2. Statement showing experience installing systems of similar size and scope to the work specified in this section is to include:
        a. Primary business of the contractor is audio-visual system installation.
        b. Minimum of ten (10) years' experience with the specified audiovisual systems.
        c. Experience with at least five (5) projects of this type (Higher Education facility) and comparable scale within the last three years.
        d. Be a distributor or certified dealer in good standing of all major specified system components.
        e. All work to meet or exceed all applicable standards/references listed and all government or local authority codes and regulations having jurisdiction and the contract documents.
    3. Evidence of an in-house audio-visual service department
        a. List names and certifications of full-time service technicians upon request.
        b. List in-house electronic service and test equipment upon request.
    4. Evidence of full-time personnel with experience on projects of similar size, scope and construction schedule of the work in the section. One member needs to have AVIXA/ANSI Certified Technical Specialist or "CTS" assigned to this project who has had experience on projects of similar size, scope and construction schedule as this project.
    5. Provide the name, date of employment, qualifications and experience of the installation supervisor for this project.
    6. Any contractor personnel associated or presented as part of this team is expected to perform the work associated with this project. Any and all employee add or removal from the submitted project team to be approved in writing by the UNLV/CTS, and if

applicable the consultant/architect.

7. Submit personnel résumés or curriculum vitae indicating in detail that the contractor has competent engineering, installation, service and maintenance personnel and facilities with reasonable stock of service parts. Contractor to submit a warranty statement certifying that they are capable of conforming to specified warranty requirements.
8. Proof of documentation to be presented

B. Contractor to follow the project schedule as provided by the General Contractor (GC). Required adjustments to the schedule to be promptly coordinated with the GC.

1.10 Pre-bid Submittals

A. Any associated 1.8 “Contractor Qualification” documentation.
B. References:
    1. Furnish no less than three (3) references for installations of similar size and scope, performed throughout the United States within the past eighteen months.
    2. At a minimum, reference information will include the reference company or institute name, contact person’s name and title with telephone and fax numbers, address and detailed project description, and contact information of the organization that is responsible for the day-to-day operation of the audiovisual installation.
C. The AVC to provide formal written evidence of:
    1. Current original equipment manufacturer’s certification(s) for the on-site technicians
    2. Current industry certifications for the installer(s) dedicated to this project
D. Data Submittal and Bar Chart Milestone (also called a Gantt chart).
E. Provide within 15 business days after Award Letter and Notice to Proceed:
    1. All manufacturer data sheets (commonly referred to as “cut sheets”) to be originals not copies.
    2. On manufacturer data sheets where multiple part numbers exist, clearly identify the part number of products submitted for the project.
    3. Detailed bill of materials (BoM) or equipment list including quantities for all parts and pieces of the project.
    4. Manufacturer data sheets to be from the manufacturer.
F. The Bar Chart Milestone, to include but not be limited to, time frames for the following:
    1. When work will be ready to begin (mobilization period)
    2. Length of time for various phases of work, including but not limited to:
        a. Wire pulling
        b. Speaker mounting
        c. Projection screen mounting
        d. Projector mounting
        e. Flat panel display mounting
        f. Direct View LED Video Display System mounting
        g. Lectern Buildout
        h. A/V Rack Buildout
        i. Testing and troubleshooting

j. Training
k. Turning over of system to UNLV/CTS
l. Drawing milestone issues
m. Submittals
n. Start and end dates

G. Shop drawings and be made available prior to any fabrication within the time schedule approved by the Architect and General Contractor. This is to be noted on the electronics systems Bar Chart milestones submitted and approved during the Phase I Submittal Program.
H. Products to be furnished with manufacturer's instructions, mounting hardware, and warranty coverage.

1.11 Quality Assurance and Warranty

A. In the event of conflicts between cited standards and/or the project specifications, inform UNLV/CTS as the more stringent will govern. However, the manufacturer instructions take precedence.
B. At least one (1) AVIXA, Certified Technology Specialist (CTS) to be assigned to be on-site and oversee the complete installation of the system.
C. At least one manufacturer certified programmer on staff.
D. The AVC's A/V technicians assigned to the systems are to be trained, qualified, and carry valid and current industry certifications regarding the engineering, installation, operation and testing of A/V technologies within scope.
E. The AVC to maintain permanent fabrication, service and support facilities within Clark County, Nevada.
F. Installed cabling will be free of defects in material and workmanship.
G. Products to be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
H. Products to be furnished with manufacturer's instructions and mounting hardware.
I. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.
J. Shop Drawings to be engineered and drawn on a vector/raster- based CAD system. Approved software is AutoCAD in a .dwg format. Each submission to include one (1) full size print copies (blueprints are not acceptable) and one (1) electronic format copy of the following.
    a. Complete floor drawings, as scale of contract documents, showing the locations throughout the project of all receptacles, pathways, wire ways, pull boxes, junction boxes, equipment racks, microphone stations, speakers, visual displays and other devices associated with the systems specified.
    b. Complete system riser diagrams, showing all elevations, room numbers, pathway sizes, types and fills, box sizes and types, devices, equipment and rack designations.
    c. Full fabrication details of custom enclosure and millwork indicating size, material finish and openings for equipment.
    d. Loudspeaker mounting details including hardware type, material and load capacity. Structural information to include design calculations and copy of

engineer's seal.

e. Fabricated plates and panels: Provide complete drawings on custom fabricated plates or panels. Drawings to include dimensioned locations of components, engraving information, plate material and color, font size, including descriptive bill of materials.
f. Complete scaled (1/4" = 1") equipment rack elevation drawings, including equipment designations, manufacturer's name and model number, power distribution, and requirements within the racks and connection to power panels by the electrical contractor outside the racks.
g. Complete heat generation details by device totaled per room to be compiled in spreadsheet form.
h. Run sheets or field wiring drawings: clearly show at each terminal point, the type of connector to be used and include point to point wiring details of each connector. Take note of the connected shields and where they will float to ensure the integrity of the grounding system. Call out wire types and color-codes where appropriate.

K. Provide the manufacturer warranty for the particular project.
L. Products to be UL Listed and be manufactured by an ISO 9000/9001 approved manufacturer and be RoHS 2011/65/EU compliant.
M. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.

PART 2: PRODUCT

2.1 Summary

A. All materials and equipment supplied by the AVC to meet or exceed the latest published specification of the manufacturer in all respects.
B. The AVC to supply, at a minimum, the latest model, available at the time of bidding, of each piece of equipment.
C. If the Bill of Materials (BoM) calls for more than one unit of a specific product, all units purchased will be from the same manufacturer.
D. Equipment and material to be the current model and new, and less than one (1) year from the manufacturer manufactured date), unused, and without blemish or defect.
E. Delivered materials and equipment to the project are to be in the manufacturer's original, unopened, and labeled packaging. Packaging is to provide protection against moisture, tampering, or damage from improper handling or storage. AVC will protect and be responsible for any damage to work or materials until final acceptance by the UNLV/NDE.
F. All applicable low-voltage systems components, equipment and material will be NEC fire-rated and bear labels attesting to Underwriters Laboratory (UL) or other Nationally Recognized Testing Laboratories (NRTL) for performance including but not limited to ETL/Intertek for cabling certification.

G. Products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*.

2.2 Delivery, Storage, and Handling

A. Deliver equipment in manufacturer's original undamaged packages or in bulk packing, which provides equivalent protection.
B. Store packaged equipment off ground or on slab in manner to protect them from elements, especially moisture damage.
C. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by the manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
D. If no storage is available per the UNLV/CTS in advance of the pre-bid submittals, AVC to be flexible with multiple equipment delivery locations and times.
E. Timely delivery and installation of material required for the work of this Section is the responsibility of the AVC. The AVC is to determine equipment lead times prior to developing a construction schedule.
F. The AVC is responsible for all delays associated with both the specified and alternate materials, and for the timely submission of proposals, submittal items, drawings, and other information in order to expedite the work and to avoid delays.
G. Costs of all shipping to the site and of all storage requirements to be borne by the AVC. It is the responsibility of the AVC to make appropriate arrangements, and to coordinate with authorized personnel at the site, for the proper acceptance.
H. During the installation, and up to the date of final acceptance, the AVC is under obligation to protect their finished and unfinished work against damage and loss. In the event of damage or loss, AVC is to replace or repair the work at no extra cost to the UNLV/CTS.

2.3 Substitutions

A. Model numbers and manufacturers included in the drawing package are listed as a standard of quality, complexity, and capabilities due to the current enterprise system in place at UNLV.
B. Proposals for equipment from other manufacturers to be considered but subject to approval by the UNLV/CTS. Unless approved by the UNLV/CTS, the AVC will not supply or install any equipment not specified.
C. Requests for substitutions to be submitted in writing to the UNLV/CTS and Consultant at the time of bidding. Suggested substitutions to be clearly identified, and product data sheets listing all relevant technical specifications to be provided. Submit substitution requests during the bid period as Requests for Information (RFI).
D. AVC to submit full technical data sheets, and any necessary system drawings to demonstrate how the proposed equipment would be used in the system to meet the specification.
E. Substitution requests to be received no later than one (1) week prior to the bid date. Any requests received after that date will not be accepted.
F. Bidding AVC will be responsible for all costs associated with submission, review, and approval process for substitutions. This includes any item of equipment or hardware not specifically shown on the drawings or specified that is required for proper system operation or installation.

G. In the case of a conflict between specified equipment, the AVC to notify the UNLV/CTS of the specifics and include proposed modifications to resolve the conflict. UNLV/CTS will, in turn, review the proposal and determine what course of action will be necessary to achieve a resolution.
    1. When a specific piece of equipment specified has been discontinued and/or replaced by a new model, substitution will be acceptable only when the UNLV/CTS has approved submission of complete data on the new model or substitute.
    2. Subject to the functional and minimum performance requirements for each item, the UNLV/CTS may require independent laboratory tests proving equivalence of certain alternative equipment not fully or adequately described by the technical specification of the manufacturer. Any and all costs arising from equivalency testing to be the sole responsibility of the AVC.

2.4 Major Equipment

1. If any specified product has reached end-of-life or is otherwise unavailable, AVC will provide an acceptable replacement that meets the requirements of the specified equipment. Any suggested replacements to specified equipment to be brought to the attention of UNLV/CTS and the consultant/architect as soon as the issue is identified and at no extra cost to UNLV.
2. Material and equipment specified are the basis of acceptable quality and performance and have been coordinated to function as components of the specified systems. Where a particular material, device, piece of equipment or system is specified, the current manufacturer's specification for the same to be considered a part of these specifications. Each material, device or piece of equipment provided will comply with all of the manufacturer's published specifications for that item.
3. The A/V equipment specified consists of all major equipment for the project . The AVC to integrate all components and provide any additional components, wiring, or accessories required to complete a functional system.
4. The manufacturer specifications are to be considered as ‘minimum performance’ levels of acceptance. These characteristics are part of a design as a whole and particularly the UNLV/CTS’s designs are in full coordination with these characteristics.
5. Systems are described in terms of major products. Even if not specifically mentioned, provide and install small parts such as patch cables, connectors, hardware, converters, power supplies, labels, terminals, mounting and hardware accessories as necessary for a complete and working system meeting the design intent of specifications.
6. AVC to be responsible for verifying that all equipment is in complete functional, working order prior to delivery on site. Test all major components in-shop before attempting integration into systems. UNLV/CTS and consultant/architect are not responsible for any additional costs related to restocking or delivery of non-functional equipment due to failure.
7. Any and all potential product delivery delays that may cause equipment to be obtained less than four (4) weeks prior to its installation on-site to be brought to the attention of the UNLV/CTS and consultant/architect within two (2) days of notification of delay by the supplier. AVC will make reasonable effort to order and secure delivery

of specified products, including alternates and substitutions, to meet the installation schedule.

8. UNLV/CTS and consultant/architect will not be responsible for increased costs or delays caused by the negligence of the AVC to secure orders on equipment, cabling, or miscellaneous parts, which includes any necessary down payments required by vendors, manufacturers, or suppliers.
9. Refer to A/V wiring diagrams drawings for makes and models of all major pieces of equipment.

2.5 Additional Components

1. AVC is responsible for providing all necessary components and accessories to form complete working systems.
2. Provide required power supplies and power strips or power distribution needed for A/V components including 120V AC connections, AC/DC power supplies, and power over Ethernet injectors.
3. Provide required mounts and mounting hardware as referenced on A/V wiring diagrams and associated drawings including any necessary mounting hardware required.
4. Provide all miscellaneous hardware, fasteners, mounts, cable dressing, tie-downs, and safety cables to complete a permanent installation.

2.6 Cabling and Patch Cables

10. Any horizontal cabling infrastructure design, installation, and testing is subject to UNLV/NDEs subsections of the master Division 27 00 00; *Communications Design Guidelines,* 27 05 00; *Common Work Results for Communications*, 27 10 00; Structured Cabling Hardware (Testing), 27 11 00; *Communications Equipment Room FIttings, 27 15 00; Communications Copper Horizontal Cablin*g, and 27 16 00; *Communication Connecting Cords* (Patch Cables), and 27 40 00; *Integrated Audio-Video Systems and Equipment,* plus products are to be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*
11. Transmission performance parameters to be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.
12. The standard fire-rating for communications horizontal copper UTP cable at all times is plenum or CMP-rated and in compliance with UL 910.
13. Cat 6A/Class EA UTP copper, 100-ohm balanced, solid 23-24 AWG 4-pair cable to be available from the same manufacturer for the following two (2) applications;
    a. The inside plant (ISP) premises “permanent link” cabling and always to have a plenum (CMP) fire-rating jacketing. Maximum OD 0.29 inch (7.3 mm)
    b. The outside plant (OSP) “permanent link” which always needs to have an outdoor rated jacketing. Indoor/Outdoor rating preferred.
14. All patch cables will be factory terminated and tested. See Section 27 16 00; *Communication Connecting Cords* for details.

2.7 UNLV/CTS Furnished Equipment

A. UNLV/CTS reserves the right to furnish any materials necessary for the project.
B. OFCI or Owner Furnished - Contractor Installed are for those items of equipment which are to be installed, but not purchased by the AVC. The Work is to include:
    1. Coordination of delivery
    2. Safe handling and field storage up to the time of permanent placement in the project
    3. Correction of any damage to the item(s) by the AVC
    4. Mounting in place and connection(s) as specified

2.8 Audio-Visual Systems and Systems Equipment By System Type

A. Most not all of the systems' components are referenced by manufacturer name and model number on the wiring diagrams. Listed products are provided as a courtesy only to assist with bidding and where these items may require additional detail.
B. AVC is responsible for verifying all quantities and options required to form complete and functional systems as described in Part 1. GENERAL: AVC to include a list of all significant pieces of equipment with quantities in the documentation;
    a. Line item pricing is required. Include summary pricing for each subsystem that follows in Bid Response, with a roll-up total for turnkey installation.

PART 3: EXECUTION

3.1 General

A. Any item of equipment or hardware not specifically shown on the drawings or specified but required for the proper system operation or installation, is to be furnished and installed and to the highest quality of workmanship.
B. The performance of all equipment is to meet or exceed the most recently published manufacturer's data sheet specifications and installation instructions.

3.2 Coordination

A. Job Site Supervision;
    1. The AVC will provide a working project superintendent to be a AVIXA, Certified Technology Specialist (CTS) to oversee the work of their employees and subcontractors.
B. Specific Site Conditions. The AVC is responsible for;
    1. Surveying the project areas to locate poke-throughs, furniture openings, sleeves, conduits, cable trays, conduit stub-ups, back boxes and pull boxes provided by others for the A/V cabling.

2. Verifying on-site conditions during the mandatory site walk. This includes equipment and conditions that directly or indirectly affect the AVC's contract scope of work (SoW) to include, but is not limited to:
    a. Painted walls
    b. Carpet or other floor covering
    c. Power and conduit installed as per project drawings and schedules
    d. A/V devices installed by the electrical contractor or the general contractor (GC) including projection screens, screen low voltage control interfaces, A/V back boxes, A/V floor boxes, room lighting A/V interfaces
    e. A/V related furniture installed including lecterns, credenzas, board/conference tables, closets and other millwork designed to house A/V equipment
    f. Any obstructions hidden above in the ceiling
3. AVC is responsible for protecting and inventorying their work and material from environmental conditions. Any delivery schedules affected by environmental conditions are to be noted to the general contractor (GC) not less than 72 hours prior to the day of scheduled delivery stating the just cause in writing.
4. Will be in compliance with all local, state, and federal building and fire codes.
5. Coordinating the exterior finish required for all fixtures, plates, panels, grilles, and enclosures supplied as part of this specification section with the UNLV/CTS. If requested, the AVC is to supply finish samples of each.
6. Coordinating with the millworker for any A/V items to be built or mounted into millwork.
7. Cooperating at all times with the assigned contractors and subcontractors doing work on the same project. The purpose is to keep the project productive to the end that lost time, work stoppages, interference, and inefficiencies do not occur.
8. The AVC project supervisor is responsible for attending all project meetings, coordinating work schedules with all related trades, and supplying any requested information to ensure the successful completion of the project.

3.3 Equipment Layout

A. The AVC equipment layout and locations are to be detailed enough to reflect the same as shown in the UNLV/CTS A/V drawings and architectural layouts.

3.4 Fabrication and Installation

A. General
    1. Installation practices to be in accordance with, but not limited to, the project's specifications and drawings. Installation to be performed in accordance with the applicable standards, requirements, and recommendations of authorities having jurisdiction. (AHJ).
    2. Installation of the system to be in a manner of compliance with the standards as specified in this Division 27 document. This includes providing all audio, video and control cabling elements of the final design in a subtle, unobtrusive manner to maintain the architectural and visual integrity of the building.

3. If, in the opinion of the AVC, an installation practice is desired or required, which is contrary to these specifications or drawings, a written request for modification is to be made to UNLV/CTS. Modifications will not commence without written approval from UNLV/CTS.
4. The AVC to take precautions as necessary to guard against electromagnetic and electrostatic hum, to supply adequate ventilation, and to install the equipment to provide maximum safety to the operator.
5. Care to be taken during installation to prevent chips, scratches, dents, and other cosmetic damage. The AVC is responsible to protect all material from damage and/or loss once installed prior to UNLV/CTS's acceptance and handover. Any affected damaged products to be repaired or replaced prior to installation at no additional cost to UNLV/CTS.
6. To ensure a proper finished appearance, the AVC is to furnish and install trim/escutcheon components at all conditions where A/V components pass through the finished ceilings. This would include - but not be limited to - video projector supports, flat-panel display supports and any other components, which are not specifically supplied with integral flanges/trim components including speaker mounts, assistance listening devices, and other related accessories.
7. Trim components at the ceiling plane to be finished to match the approved acoustic ceiling tile (ACT) ceiling grid system components. The AVC is to obtain a sample from the UNLV/CTS, including any custom color information, or standard color numbers.
8. Dimension Verification - Verify dimensions and space requirements to assure that proper mounting, clearance, and maintenance access space is available for system components.

B. Mounting
   1. Mounting and attachment methods to follow industry best-practices and be designed for both applicable static and dynamic loads. Double-sided adhesive tape is not considered to be a permanent mounting solution.
   2. Equipment and enclosures to be plumb, level, and square. Ensure that permanently installed equipment is firmly and safely held in place. Equipment supports loads to have project safety factors of five (5) or greater.
   3. Separate safety cable to be provided for all overhead items including but not limited to; lights, loudspeakers, video projectors mount, and other related devices. Safety cables to attach directly to the suspended device and a structural member capable of supporting the load. Safety cables and their fittings to withstand impact loads in any direction and permit replacement of the device without damaging the safety cable or attachment fittings.
   4. Threaded Connections:
      a. Nuts and bolts used together to be matched in grade and be in conformance to U.S. Standard inclusive of ANSI, ASTM, and SAE. This includes but not limited to #10/32, M6, and M8.
      b. Only use load-bearing fasteners that employ a nylon or 'ny-lock' locking component that can be verified by visual inspection. Split washers, star washers and any thread- damaging nuts, as well as double nuts are not acceptable.

C. Equipment Racks
    1. Specified equipment listed to be rack-mounted into UNLV/CTS A/V specified equipment racks as shown in AV drawings.
    2. Provide unused rack space with blank or ventilating panels.
    3. Power supplies, rack mounts, interconnects, brackets and mounting hardware to be included.
    4. Any equipment with front-panel controls that are not required for daily use to be furnished with protective covers or programmatically locked out to prevent unwanted or inadvertent tampering. Supply and install security covers on any electronics with front panel controls that do not need to be adjusted after initial set-up, per UNLV/CTS specifications.
    5. If decorative equipment fascia interferes with flush mounting of security covers:
        a. Fascia to be removed, if possible
        b. If removal is not possible, a custom method to affix security cover to be approved by UNLV/CTS
    6. Ventilation and Cooling:
        a. A/V equipment racks are to be fitted within air-conditioned spaces in order that component's operating temperatures do not exceed manufacturers' recommendations
        b. If the equipment rack is not located within technical space, proper furniture with adequate ventilation will be supplied to architectural design
    7. Rack Hardware:
        a. Standard Mid-Atlantic rack is drilled to accommodate #10-32 rack screws for mounting devices, blank panels and vents
        b. Rack screws to be tightened to a maximum torque of 24 in/lbs (2.7 n-m)
        c. Equipment mounted on shelves to have "L" brackets to secure equipment from side or rear-ward motion.
        d. Equipment mounted on shelves to also have a security bar to prevent motion.
    8. Use only ½ inch (13 mm) wide black Velcro™ with minimal one (1) ich (102 mm) overlap around cables and cordage:
        a. Nylon cable zip ties are not permitted.
        b. Use plenum-rated (typically maroon in color) in plenum environments
    9. Excess signal cabling to be looped at source device and secure with Velcro™ fasteners.

D. Wiring Cable Harnesses
    1. Shielded cables to be insulated. Shields not to have contact with conduit, raceways, boxes, panels, or equipment enclosures.
    2. Service loops to be maintained in or adjacent to all enclosures, termination cabinets, racks, and junction boxes. Service loops are not to be excessive in length causing undue crowding in cable raceways. Cables to be neatly harnessed and dressed with Velcro™ fasteners having the appropriate amount to allow for future expansion.
    3. Cables to be harnessed according to professional best-practices and to prevent mechanical stress on electrical connections. No cable to be supported by a connection point.
        a. Lacing bars must be mounted horizontally
        b. Lacing bars must be separated by 1.5 rack units (RUs)

   c. Cables must be perpendicular to the lacing bars
4. Wire and cable to be continuous and splice free for the entire length of run between designated connections or terminations.
5. Care to be exercised in wiring so as to avoid damage to the cables and to the equipment. Do not exceed cable manufacturer's pull-force or bend radius recommendations.
6. Individual cables to exit the harness at the same elevation as the equipment to which the cables terminate.
7. Cables running in plenum spaces without conduit to be plenum-rated cable.
8. Cables running in areas exposed to environmental factors, but not limited to, UV, chemicals, direct burial, and other concerning environments to be rated for the exposure and to match the performance characteristics of its equivalent cable as specified.
9. Wire bundles to be neat and combed free of cable crossovers.
10. As a general practice, power cables, control cables, and high-voltage level cables to be run on one side of an equipment rack. All other cables, especially those susceptible to interference are to be run on the opposite side of an equipment rack.
11. Vertical cable bundles to be neatly dressed and attached to the rack frame.
12. Provide extra cable length to allow for complete range of motion for equipment affected by movable work surfaces.
13. Touch panels not secured to the work surface must have ample cable length to reach the edge of the work surface.
14. Cables should not be secured to rack shelves or removable equipment.

E. Termination Enclosures (Floor Boxes)
1. Cables intended for connection to wall, floor, or ceiling mounted panels to be terminated in the appropriately rated termination enclosure (floor box). Termination of wires and cable, without an appropriately rated enclosure, will be considered to be defective, and will require replacement at no additional charge to UNLV/CTS.
2. Wiring connections to be secured so they cannot work loose under normal vibration conditions. Enclosures containing harnessed conductors to be sized so that the wiring harness may be neatly bundled together and distributed in an orderly fashion.
3. Bundled cable harnesses not to interfere with the enclosure door(s) or latch(s) or intrude into the clearance space allocated for dressed conductor termination.
4. The AVC to field verify all back-box installation conditions on site.
5. Clean floor boxes of all dust and debris prior to installation of any active or connector plate.

F. Terminations
1. Proper termination tools and practices to be used during the termination process. Crimping to be performed per the connector manufacturer’s instructions.
2. No terminations to have stress from cable weight or cable bending. No cable to be supported by a connection point.
3. Serial data interfaces to be wired using appropriate cable with an overall shield. These cables to be terminated with an appropriate connector that plugs directly into the serial-controlled device.
4. Except where noted otherwise in the specifications, no bare wire terminations will be

accepted. Heat-shrink tubing to be used to insulate the ground or drain wire.

5. Unused wires at the end of a cable to remain unstripped and to be laid back and held in place with Velcro™ fasteners.
6. When connecting stranded wire to captive screw terminals, use a crimp-on wiring ferrule. Reference UL 508A 29.3.4 refers to 29.3.6 for the specifications of how ferrules are to be used in an industrial control panel;
    a. Used with stranded copper wire(s) only.
    b. Terminated in a connector rated for copper wire and rated for the number and size of wire(s) crimped to the ferrule.
    c. Crimped with an appropriate tool as recommended by the ferrule manufacturer before terminating in a terminal of a component.
    d. Sized in diameter appropriate for the number of wires and wire size(s) as recommended by the ferrule manufacturer.
    e. Crimped to the wires so that the length of the uninsulated portion of the wires do not result in the reduction of electrical spacings.
7. Polarity (Audio) to comply as follows:
    a. The "high" side will be connected to “Pin 2” on XLR connectors.
    b. The "low" side will be connected to “Pin 3” on XLR connectors.
    c. Microphones will be wired so that an acoustic compression at the diaphragm produces a positive going signal on “Pin 2” with respect to “Pin 3”.
    d. Speakers will be wired so that when a positive going signal is applied to the “+” or red terminal an acoustic compression is produced.
    e. The system will be wired to maintain absolute polarity through all system components to ensure that a positive signal on “Pin 2” or tip produces a positive signal at the + or red speaker terminal.
8. Shield grounding for audio to comply with the following to eliminate any possibility of ground loops:
    a. Do not tie pin 1 to the case of XLR connectors anywhere.
    b. Audio low-level signal lines to be balanced and floating.
    c. Any other situations that arise which would form a ground loop, immediately inform the UNLV/CTS for direction.

G. Electrical

1. A/V equipment racks to have pre-wired AC power distribution that conforms to an approved testing laboratory specification.
2. Power supplies to be located, oriented, and connected electrically so as to minimize hum and RFI interference. Further, plug-in type power supplies are to be firmly attached using mechanical fasteners, such as lever-actuated splicing connectors unless impractical, to its associated power receptacle. This is to ensure against accidental removal and/or connection loss.
    a. Joints and connections to be made with rosin-core electrical solder or with mechanical connectors and insulated with heat-shrink on each conductor as approved by the UNLV/CTS.
    b. Excess power cabling for devices to be looped at power source, with the exception of service loop at device.

3.5 Identification Schedule

A. Cable labeling to abide by INFOCOMM/AVIXA International Standard (F501.01:2015).
B. Cable labeling to follow cable schedules in A/V drawings.
C. Cable scheme is dictated by the UNLV/CTS and has the option to make changes at any time.

3.6 Cleaning

A. AVC to practice good “sweep clean” housekeeping and remove and empty trash on a daily basis from both the telecommunication or A/V rooms and the associated work areas. This includes keeping inventoried material staging areas in the telecommunications and A/V rooms clean and organized.
B. Debris includes but is not limited to solder splatter, cable ends, stripped insulation, spent crimp connectors, gypsum board and ceiling tile dust, product wrappings and cartons.
C. If the A/V installation is using modular patch panel(s) in the telecommunication and/or A/V room yet still be exposed to sanding, dust and debris, the AVC is to use painter's blue tape or equivalent to cover the patch panel ports at no additional cost to UNLV/CTS. Only UNLV/CTS will remove the tape when cutover begins.
D. Upon completion of a project, all debris, empty boxes, excess material inventory, installation equipment and tools are to be removed leaving the premises clean, neat, and orderly. Floors are to be cleaned and vacuumed.
E. This final cleaning includes using a clean HEPA filter vacuum cleaner to remove dust and debris from the equipment racks, equipment and floor area. This includes the non-visible areas including equipment rack interiors, rack top panels, and inside lockable floor and wall boxes.
F. Remove all packing stickers and protective film from all equipment and AV furniture.

3.7 Test Equipment

A. The AVC to furnish the appropriate test equipment for testing and adjustments. Multiple functions listed below may be combined into a single instrument and be available on-site for use by the UNLV/CTS during any final inspection:
    1. Digital Multimeter (VOM)
    2. Impedance Bridge
    3. Sound Level Meter - ANSI Type 2
    4. Real-time One-Third Octave Audio Spectrum Analyzer
    5. Polarity Tester
    6. Programmable Video and Audio Test Generator (or separate Video and Audio Test Generator devices) providing High-Definition Multimedia Interface (HDMI) output, including switchable on/off High-bandwidth Digital Content Protection (HDCP) and audio over HDMI, and Extended Display Identification Data (EDID) test of sink: Test generator to generate, at a minimum, the following:
        a. Video:
            1. Computer and Full High-Definition/Ultra-High Definition (HD/UHD) resolutions up from 1920 x 1080P) to 3840 x 2160 @ 60Hz
            2. Audio over HDMI

3. Minimum pattern generation available on all outputs: Society of Motion Pictures and Television Engineers (SMPTE) Colorbars, Grid/crosshatch, Circle, Grayscale (100 IRE visible range above zero value), and White field (100 IRE output above zero value)

b. Audio:
   1. Sine wave, adjustable between 20Hz and 20kHz
   2. Pink Noise
   3. Sweep function
   4. Polarity

c. HDCP:
   1. HDCP authentication status for each source and sink
   2. Includes each version of HDCP

d. EDID:
   1. EDID preferred video timing for each sink

7. Laptop Computer – containing all DSP and control system software

3.8 Performance Requirements

A. Digital Video Systems:
   1. Any digital video distribution and cabling to conform to the applicable standards contained within the latest CEA-861 versions.

B. Audio Systems:
   1. Depending upon the system design, the amplifier and loudspeakers referred to in this section may be discrete devices or they may be integrated into a display device.
   2. Analog line level signal processing and extending equipment in front of the loudspeaker amplifier audio input to pass the signal at unity level.
   3. With the gain structure set to unity with a -10dBU pink noise source connected at the source input, loudspeakers to collectively generate 78dB (+/- 2dB) C-weighted throughout the entire direct coverage area.
   4. Speaker channel equalization for full-range systems (speech and program reinforcement systems) to be flat between from 90Hz and 16kHz (+/- 3dB per 1/3rd octave band) C-weighted throughout the entire direct coverage area.
   5. Speaker channel equalization for extended-range systems (surround sound and performance systems) to be flat between from 50Hz and 16kHz (+/- 3dB per 1/3rd octave band) C-weighted throughout the entire direct coverage area.

3.9 Tests and Measurements

A. Loudspeakers:
   1. Perform sweep frequency testing of loudspeakers channel to check for rattles, buzzing, and/or functional problems. Sweeps not exceed the manufacturer's rated bandwidth or one-quarter rated power for the device under test.
   2. Verification testing to ensure that systems are free from spurious oscillation, RFI or EMI.
   3. Test for audible clicks or pops caused by normal operation of the controls.
   4. Test for phasing or “beating” between speakers on the same channel and between the

same noise content on different speaker channels.

5. 1/3rd octave measurements taken at four (4) inches (102 mmm) above the finished floor and from at least four (4) each different locations within the speaker channel coverage area to determine correct equalization and gain before feedback.

B. Video display devices:
   1. Projected images are aligned with the image area of the screen when the screen is in the "show" position with bleed into borders not exceeding 0.25 inches (7 mm) in any direction.
   2. Test generator - Grid: Grid is in focus across entire image area
   3. Test generator - White field: No dead pixels found
C. Source inputs to display devices:
   1. Test generator - Grid: Grid geometry is correct (no warping or distortion) across entire image area
   2. Test generator - Grid: With source matched to projector native resolution or system scaler output resolution, there is no image overscan (i.e. the entire image shows)
   3. Test generator - Color bars: Color registration correct on all segments
   4. Test generator - 32 segment grayscale: All segments differentiate
   5. Test generator - 255 segment grayscale: Smooth transition with no coloration
   6. Testgenerator - Alternating pixel grid: With source matched to display native resolution, all "on" pixels show clearly
   7. Images display in aspect ratio specified in the contract documents or in source native aspect ratio if not specified
   8. Images display in resolution specified in the contract documents or in source native resolution up to the projector/display native resolution if not specified
   9. Manually route source inputs to display devices.
D. HDMI source inputs to display devices:
   1. Test generator - red field with audio: No other color other than red is visible, and no distortion seen in the field
   2. Test generator - HDCP on: Signals pass normally
   3. Video signal chain (transmitter/receivers, switchers, DA's, display devices, and other related devices Test generator - EDID test: With the test generator inserted in front of the device at the output of the previous device in the chain, the device correctly communicates all EDID information back to the test generator.
E. Projection Screens
   1. Motorized projection screen raises and lowers to appropriate limits
F. Redundant screen controls operate as expected

3.10 Close-out submittals

A. UNLV/CTS will not sign-off on any system for final payment to the AVC if the following items have not been delivered:
B. As-Built Drawings
   1. After substantial completion of the project, the AVC to submit marked-up As-Designed drawings as the As-Built drawings.

2. All changes to the As-Designed system to be indicated on these drawings.
3. Drawings to be provided in .pdf for editing and auto then final submittal in AutoCad .dwg format.

C. Equipment Manuals
   1. No less than thirty (30) days prior to job site acceptance testing, submit one (1) preliminary copy of each of the following manuals prior to, and as a requirement of, UNLV/CTS acceptance of the work of this section.
      a. Equipment operating instructions; complete comprehensive instructions for the operations of the fabricated devices and equipment items provided as part of the work of this section
      b. Systems operating instructions; complete instructions for the operations of the systems provided as part of the work of this section
      c. Manufacturer's original operation instruction and service manuals; brochures, manuals and service sheets published by the manufacturer(s) of the equipment for systems checkout and acceptance tests
      d. A list of model/current software revisions (as applicable) and serial numbers for the equipment installed in the project. Provide this in a copy of the operations manual and in electronic spreadsheet form

D. Training
   a. Provide on-the-job (OJT) training in the operation of the electronics systems for personnel designated by the UNLV/CTS during the first thirty (30) calendar days of operation at no extra cost to UNLV/CTS personnel.
   b. Training to be able to start a minimum of five (5) working days prior to a system's completion date. Project training periods to be coordinated with UNLV/CTS and scheduled during regular business hours.

E. Inventory List and Documentation
   a. The AVC to submit a spreadsheet listing the location, brand and model, description, serial number, firmware version, MAC address, and Ethernet ports to be connected to all network equipment by the UNLV/CTS.
   b. Provide custom DSP and Control System programming source code (un-compiled) and compiled versions by UNLV/CTS.

F. Custom Software and Programming
   a. It is required that the AVC be experienced in the project's programming systems. Due to the nature of a project, the UNLV/CTS may be providing the necessary compiled Crestron program for selected classroom designs.
   b. The AVC to be experienced in the necessary manufacturers' tools to configure, deploy, and troubleshoot the specified equipment and code. In the pre-bid submittals, the AVC agrees that they understand systems of this type and that all programming services are included to the satisfaction of the UNLV/CTS.
   c. The AVC agrees that they will not make any claim for additional monies because of misinterpretation of programming requirements.
   d. The AVC to provide and install the seamless integration of the management software via the University's computer network to all of the classrooms, meeting rooms and auditoriums specified within this RFP. The AVC to work directly with the UNLV/CTS department to implement this function.

3.11 Commissioning

A. The primary purpose of the official Commission process is to provide the AVC and UNLV/CTS the opportunity to fully test and inspect the installation practices and functionality of all systems. The AVC is to demonstrate to UNLV/CTS that each room is functionality operational.
B. Please refer to UNLV/CTS primary engineer for commissioning instructions.

3.12 Acceptance and Warranty

A. The system installation warranty to be for twelve (12) months from the date of final acceptance and be inclusive of all necessary parts and labor. AVC to provide all equipment, material, and labor required to uphold a full system warranty at no charge to the UNLV/CTS. Manufacturers' equipment warranties to be activated in the UNLV/CTS's name and to commence on the date of final acceptance.
B. Conditions where the manufacturer's warranty has been voided, AVC to provide the UNLV/CTS with a warranty equivalent to that of the original manufacturer.
C. AVC to respond with an on-site technician within 24-hours of a service call (including Saturday and Sunday) for all equipment and system failures that occur during the warranty period. AVC to provide name(s) and telephone number(s) of service personnel to be contacted regarding repair and maintenance.
D. There will be no cost to the UNLV/CTS for maintenance performed during the warranty period beyond the fixed cost of the contracts. AVC to replace or repair any failed equipment hardware or software installations required to provide full system operations.
E. To maintain certain manufacturer's warranties, the installed and aligned equipment to be serviced by only those installers authorized by the manufacturer. If the AVC is not authorized by the manufacturer, it is the AVC sole responsibility to make the appropriate arrangements at no extra cost to UNLV/CTS.

———————— End of SECTION 27 40 00 ————————

INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT SPECIFICATIONS

APPENDIX A

Codes, Standards, and Regulations

Link to Appendix A will be here when published.

https://www.it.unlv.edu/sites/default/files/assets/network/Division27-AppendixA.pdf

– – – End of APPENDIX A – – –

Codes, Standards, and Regulations

APPENDIX B

Abbreviations and Acronyms

Abbreviation / Acronym	Description / Second Description
A	Ampere or current expressed as "I" (Ohm's Law V=I*R)
AASHTO	American Association of State HIghway and Transportation Officials
ABC	Always Be Cleaning
ABF	Air Blown Fiber
AC	Alternating Current
ACP	Access Control Panel
ACR	Attenuation-to-Crosstalk Ratio
ACS	Access Control System
ACRF	Attenuation-to-Crosstalk Ratio Far-end
ADA	Americans with Disability Act
ADSS	All-Dielectric Self Supporting
AFEXT	Alien Far-End Crosstalk
AFF	Above Finished Floor
AFG	Above Finished Grade
AHJ	Authority Having Jurisdiction (Inspector)
AHU	Air Handling Unit
AIA	American Institute of Architects
AM	Amplitude Modulation
AMES	Architectural, Mechanical, Electrical, Structural (drawings)
AMP	Amplifier
ANEXT	Alien Near-End Crosstalk
ANSI	American National Standards Institute
AP	Access Point (WAP)
AP	Access Provider
APC	Angled Physical Contact ferrule (LC connector green)
APWA	American Public Works Association
ASTM	American Society for Testing and Materials
ATM	Asynchronous Transfer Mode (protocol)
ATR	All-Threaded-Rod
As-Built	Graphical documentation of the installed SCS
A/V	Audio-Visual
AVC	UNLV/CTS Audio-Video Contractor
AWG	American Wire Gauge (OD)
AXT	Alien Crosstalk
b	One Bit

B	One Byte (8 bits)
BAS	Building Automation System
BASE	Baseband (IEEE square wave signal)
BBC	Backbone Bonding Conductor
BC	Bonding Conductor
BCT	Bonding Conductor for Telecommunications (TMGB>AC grnd)
BD	Building Distributor (IC)
BER	Bit Error Rate
BET	Building Entrance Terminal
BICSI	Building Industry Consulting Services International
BIM	Building Information Modeling (3D CAD)
BLDG	Building
BNC	Bayonet Neil Councilmen coaxial connector
BPS	Bits Per Second
BOM	Bill of Material
BTWN	Between
C	Ceiling/Conduit
CAB	Cabinet
CAD	Computer-Aided Design
CAN	Campus Area Network
CSMA/CA-CD	Carrier Sense Multiple Access with Collision Avoidance-Collision Detection
CAT	Category; 4-pair balanced 100-ohm UTP/FTP/ScTP - Cat 6/Cat6A (250/500 MHz rating)
CATV	Community Antenna TV
CBC	Coupled Bonding Conductor
CCTV	Closed-Circuit Television
CD	Construction Document
CDF	Campus Distribution Facility
CDWM	Coarse Wavelength Divisional Multiplexing
CEA	Consumer Electronic Association
CEP	Cable Entry Point
CFM	Cubic Feet per Minute
CFN	Consecutive Fiber Numbering
C.I.	Circuit Integrity (firestop) rating
C.L.	Centerline
CUL	Canadian Underwriters Laboratory
CM	Communications Cable (UTP)/Common Mode / Control Module
CMP	Communications Cable (UTP) Plenum-rated
CMR	Communications Cable (UTP) Riser-rated

CMU	Central Management Unit
CO	Change Order (RFI) / Central Office
COL	Column
CORE	Bellcore Specification suffix
CP	Consolidation Point
CPE	Customer Premises Equipment
Cp/s	Cycle per second (=1Hz)
CPR	(EU) Construction Products Regulation / Cardiopulmonary resuscitation
CPT	Carpet
CR	Card Reader
CSI	Construction Specification Institute
CT	Ceramic Tile
CTS	UNLV Classroom Technology Services / Certified Technology Specialist
CUL	Canadian Underwriters Laboratory
D	Depth
DAC	Digital Attach Cable
dB	Decibels (10 log)
DBL	Double
dBm	Decibels per milliwatt (mW)
DAS	Distributed Antenna System
DC	Direct Current / Door Contact
DEMO	Demolition (To be removed)
DEMARC	Demarcation Point
DIA	Diameter
DIM	Dimension
DIV	Division (27)
DMCE	Digital Media Certified Engineer
DR	Door
DSL	Digital Subscriber Line
DTE	Data terminal Equipment
DWDM	Dense Wave Divisional Multiplexing
DVI	Digital Video Interface
DWG	Electronic Drawing File
(E)	Existing work
E	East
EA	Each
E&O	Error and Omissions
ECA	Electronic Components, Assemblies and Materials Association (w/ EIA-310)

EDA	Equipment Distribution Area
EDP	Electrical Distribution Panel
EF	Entrance Facility
EGC	Equipment Grounding Conductor
EIA	Electronic Industry Association / Environmental Impact Assessment
ELECT	Electrical
ELEV	Elevator
ELFEXT	Equal Level Far-end Crosstalk
EMB	Effective Modal Bandwidth
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference (supersedes RFI)
EMP	Electromagnetic Pulse
EMR	Electromagnetic Radiation
EMS	Energy Management System
EMT	Electrical Mechanical Tubing
EOL	End-of-Life
EP	Entrance Point
EPC	Electrical Plastic Conduit
EPON	Ethernet Passive Optical Network
EQ	Equal and Equal To
ER	Equipment Room (MDF/MDA)
ESD	Electrostatic Discharge
ESS	Electronic Safety and Security System (BICSI)
ETL	Edison Testing Lab (Intertek)
EMS	Electronic Marker System (ball markers)
EMT	Electrical Mechanical Tubing
ES	Electronic Switch
EU	European Union council
EXIST	Existing
EXT	Exterior
(F)	Future Work
FA	Fire Alarm
FACP	Fire Alarm Control Panel
FAX	Facsimile (Tele Copying Machine)
FC	Fiber Connector / Fixed Connector
FCC	Federal Communications Commission
FD	Floor Distributor
FEP	Fluorinated Ethylene Propylene (Teflon)

FEXT	Far-end Crosstalk
FLR	Floor
FM	UNLV Facilities Management department
FMC	Flexible Metal Conduit
FND	Foundation
FO	Fiber Optic
FOA	Fiber Optic Association
FOCIS	Fiber Optic Connector Intermateability Standard
FR	Frame
FT	Flame-Temperature rating (CUL) / Feet
FTP	Foil Twisted Pair
F/FTP	Overall Foil cable with Foil Twisted Pairs
F/UTP	Overall Foil cable with Unshielded Twisted Pairs
FTTB	Fiber-To-The-Building
FTTC	Fiber-To-The-Curb
FTTH	Fiber-To-The-Home
FTTN	Fiber-To-The-Neighborhood
FTTO	Fiber-To-The-Office
FTTx	Fiber-To-The-"X" destination
Ft.	Foot (12")
FOTP	Fiber Optic Test Procedures
FTP	Foil 100-ohm Twisted-pair or F/UTP)
FURN	Furniture / Furnishing
GALV	Galvanized
GBE	Gigabit Ethernet
Gb/s	Gigabit per second
GC	General Contractor
GE	Grounding Equalizer
GEC	Grounding Electrode Conductor
GFCI	Ground Fault Circuit Interrupter
GHz	Gigahertz
GIGA (G)	One Billion (1,000,000,000)
GL	Glass
GND	Ground (GRND)
GPON	Gigabit-capable Passive Optical Network (G.984)
GR	Telcordia/Ericsson Specification prefix
GRC	Galvanized Rigid Conduit
GRS	Galvanized Rigid Steel

GRND	Ground (GND)
GYP	Gypsum Board
H	Height
HASB	HIgh-Speed Air Blown Procedure
HC	Horizontal Cross-connect (point)/Handicap
HDA	Horizontal Distribution Area
HDCP	High-Density Digital Content Protection (4K Ultra)
HDMI	High-Definition Multimedia Interface
HDPE	High-Density Polyethylene (ducts/conduit)
HDWE	Hardware
HF	HIgh Frequency
HIPAA	Health Insurance Portability and Accountability Act of 1996
HH	Handhold
HORZ	Horizontal
HVAC	Heating, Ventilation, & Air Conditioning
Hz	Hertz (1 CPS)
IAPMO	International Association of Plumbing and Mechanical Officials (UMC)
ID	Inside Diameter / Identifier
I/O	Input/Output
IBC	International Building Code
IBN	Isolated Bonding Network
IC	Intermediate Cross-connect
ICEA	Insulated Cable Engineers Association
ICIA	International Communications Industries Associations
ICP	Intrusion Control Panel
ICT	Information and Communications Technology
ID	Identifier
IDA	Intermediate Distribution Area (IDF/TR)
IDC	Insulation Displacement Connection (110, BIX, & Krone)
IDF	Intermediate Distribution Frame (IDA/TR)
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IFC	International Fire Code
IL	Insertion loss (dB)
IMC	Intermediate Metallic Conduit
In.	Inch (25 mm)
INSUL	Insulation
INT	Interior

IoR	Index of Refraction
IoT	Internet of Things
IP	Internet Protocol / Ingress Protection rating
IR	Infrared
IS	Intrusion Master Station
ISO	International Organization for Standardization
ISP	Inside Plant (premises) / Internet Service Provider
ITU	International Telecommunications Union
J-Box	Junction Box
kb/s	Kilobits per second
KB	1,024 Bytes
kHz	kiloHertz
KILO (K)	One Thousand (1,000)
Km	1,000 meters ("Click")
KP	Key Pad
kW	Kilowatts
LAD	Link Access Device
LAN	Local Area Network
LAV	Lavatory
LBF	Pounds-force
LC	Lucent Connector/Little Connector SFF 1.25mm ferrule
LEC	Local Exchange Carrier
LED	Light-Emitting Diode
LDP	Local Distribution Point
LFMC	Liquid-tight Flexible Metal Conduit
LS	Light Source (OLTS)
LSZH	Low Smoke Zero Halogen or LS0H
LV	Low Voltage
m	Meter (3.281 ft. or 39.4 in.)
M	Motion Detector
MAC	Media Access Control address
MAN	Metropolitan Area Network
Max.	Maximum
Mbps	Megabits per second
MC	Main Cross-connect
MD	Motion Detector
MDA	Main Distribution Area (MDF/ER)
MDF	Main Distribution Frame (MDA/ER)

MDM	Subsequent unit of electrical conductor OD sizes after 0/00/000/0000. The number designates fuse voltage.
MDP	Main Distribution Panel
MDU	Multi-Dwelling Unit
MECH	Mechanical
MEGA (M)	One Million (1,000,000)
MFG.	Manufacturing
MFR.	Manufacturer
MH	Manhole
MHz	Megahertz
MHz*km	Megahertz*kilometer (bandwidth)
Micron	One Millionth of a meter (1/1,000,000 m = 0.00004 in.)
Min.	Minimum
MFD	Mode Field Diameter
MFR	Manufacturer
MMF	Multimode Fiber
MPO	Multifiber Push-On connector (MTP)
MPOE	Minimum Point of Entry (demarc) / (MPOP/NID/SNI)
MPOP	Minimum Point of Presence (demarc) / (MPOE/NID/SNI)
MSDS	Material Safety Data Sheets (now SDS)
MTP	Multi--fiber Termination Push-on (US Conec is MPO) / Media Transport Protocol
MUTOA	Multi-User Telecommunications Outlet Assembly
MVFACP	Main Voice Fire Alarm Control Panel
mW	Milli-watt (0dBm = 1 mW)
(N)	New work
N	North / Newtons
NA	Numerical Aperture
N/A	Non-Applicable
NANO	One Billionth (1/1,000,000,000 = 0.00000001))
NDE	UNLV Network Development & Engineering department of OIT
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NEXT	Near-End Crosstalk
NFPA	National Fire Protection Agency (NEC)
NIC	Network Interface Card
NID	Network Interface Device (demarc)/(SNI/MPOE/MPOP)
nm	Nanometer

No.	Number (#)
NOC	Network Operating Center
NRTL	Nationally Recognized Testing Laboratory
NVP	Nominal Velocity of Propagation (%)
NOS	Network Operating System
NRZ	Non-Return-to Zero
ns	Nanosecond
NSHE	National System of Higher Education
NVP	Nominal Velocity of Propagation
OD	Outside Diameter
OFC	Optical Fiber Conductive (Armored)
OFCR	Optical Fiber Conductive Riser-rated
OFCP	Optical Fiber Conductive Plenum-rated
OFCI	Owner Furnished - Contractor Installed
OFN	Optical Fiber Nonconductive
OFNP	Optical Fiber Nonconductive Plenum-rated
OFNR	Optical Fiber Nonconductive Riser-rated
OIT	UNLV Office of Information Technologies department (NDE)
OLT	Optical LIne Terminal (PONs)
OLTS	Optical Loss Test Set (Power Meter and Light Source in both units)
ONT	Optical Network Terminal (PONs)
ONU	Optical Network Unit (PONs)
OPM	Optical Power Meter
OS	Optical Fiber Single-mode (OS1, OS1A and OS2) / Operating System
OSHA	Occupational Safety and Health Administration
OSI	Open Systems Interconnection (ISO 7-layer reference model)
OSP	Outside Plant
OTDR	Optical Time Domain Reflectometer
P	Projector
P&C	UNLV Planning and Construction department
PA	Public Address
PBX	Private Branch Exchange
PB	Pull Box / Push Bar
PBB	Primary Busbar (TMGB)
PCB	Printed Circuit Board / Polychlorinated Biphenyls
PDF	Printed Document Format by Adobe
PDU	Power Distribution Unit
PE	Polyethylene / Professional Engineer

PERT	Program Evaluation Review Technique
PETA (P)	One Quad Trillion (1,000,000,000,000,000)
PFAS	Personal Fall Arrest System
PHY	Physical Layer Interface
PIC	Plastic Insulated Conductor
PIN	Personal Identification Number
PLYWD	Plywood
PM	Project Manager
PoE	Power Over Ethernet
POF	Plastic Optical Fiber
PON	Passive Optical Network
POP	Point-of-Presence (demarc)
POS	Point-of-Sale / Personal Operating System / Passive Optical Splitter (PONs)
POTS	Plain Old Telephone Service (Analog)
PP	Patch Panel
PPE	Personal Protection Equipment
PRR	Pulse Repetition Rate
PSAFEXT	Power Sum Alien Far-End Crosstalk
PSANEXT	Power Sum Alien Near-End Crosstalk
PSACR	Power Sum Attenuation-to-Crosstalk Ratio
PSACRF	Power Sum Attenuation to Crosstalk Ratio, Far-End
PSAACRF	Power Sum Attenuation to Alien Crosstalk Ratio, Far-End
PSAACRN	Power Sum Attenuation to Alien Crosstalk Ratio, Near-End
PSELFEXT	Power Sum Equal Level Far-End Crosstalk
PTD	Painted
PSNEXT	Power Sum Near End Crosstalk
RTPM	Registered Telecommunications Project Manager (BICSI)
PTZ	Pan Tilt Zoom (CCTV)
PUC	Public Utilities Commission
PVC	Polyvinyl Chloride
PWD	Pulse Width Modulation
QA	Quality Assurance
QC	Quality Control
QoS	Quality of Service
QSFP	Quad Small Form Factor (40/100 Gigabit Optics)
QTY	Quantity
RCDD	BICSI Registered Communications Distribution Designer
R	Resistance (Ohm's Law V=I*R) / Radius

RBB	Rack Bonding Busbar
RBC	Rack Bonding Conductor
REQ'D	Required
RFI	Request for Information or Interpretation (CO)
RFQ	Request for Quotation or Qualifications
RFP	Request for Proposal
RGB	Rack Grounding Busbar
RJ	Registered Jack (RJ-45)
RL	Return Loss (dB)
RMC	Rigid Metallic Conduit
RMS	UNLV Risk Management & Safety department
RNC	Rigid Nonmetallic Conduit
RoHS	Restrictions of Hazardous Substances
RPP	Remote Power Panel
PROJ	Projector
PS	Power Sum
PSACR	Power Sum Attenuation-to-Crosstalk Ratio
PSFEXT	Power Sum Far End Crosstalk (far end)
PSNEXT	Power Sum Next End Crosstalk (local end)
RU	Rack Unit (1 3/4")
QA	Quality Assurance
QC	Quality Control
RACE	Race, Alarm, Confine, Extinguish
RF	Radio Frequency
RFID	Radio Frequency Identification Device
RFI	Radio Frequency Interference = EMI
RoHS	Restrictions of Hazardous Substances
ROI	Return on Investment
Rx	Receive
S	South
SAC	Security and Access Control
SAE	Society of Automotive Engineers
SAN	Storage Area Network
SBB	Secondary Bonding Busbar (TGB)
SBCCI	Standard Building Code Congress International
SBC	Secondary Bonding Conductor
SC	Subscriber Connector (2.5 mm ferrule)
SCS	Structured Cabling Systems

SCTE	Society of Cable Telecommunications Engineers
SCSI	Small Computer System Interface
ScTP	Screened 100-ohm balanced Twisted-pair
S/FTP	Screened/Foil Twisted Pair
SDS	Safety Data Sheets (Formerly MSDS)
SFF	Small Form Factor
SFP	Small Form Factor Pluggable
SHF	Super HIgh Frequency
SIM	Similar
SMF	Single-mode Fiber
SNBO	Southern Nevada Building Officials
SNI	System Network Interface (Demarc) / (MPOE/MPOP/NID)
SNR	Signal-to-Noise Ratio
SoW	Scope of Work
SP	Service Provider
SPKR	Speaker
SRL	Structural Return Loss
SSID	Service Set Identifier
ST	Straight Terminus connector (2.5 mm ferrule) "Stab and Twist"
STP	Shielded Twisted-pair
S/FTP	Overall Shielded cable over Foil Twisted Pairs
S/UTP	Overall Shielded cable over Unshielded Twisted Pairs
STRUCT	Structure / Structural
STS	Shared Tenant Services
SUB	Sub-contractor
SVC	Switched Virtual Circuit
TB	Terminal Block
TBB	Telecommunications Bonding Backbone (Min. 6 AWG)
TBBIBC	Telecommunications Bonding Backbone Interconnecting Bonding Conductor
TBC	Telecommunications Bonding Conductor
TBD	To Be Determined
Tb/s	Terabits per second
TC	Telecommunications Closet / Terms & Conditions
TCP/IP	Transmission Control Protocol/Internet Protocol
TDM	Time Divisional Multiplexing
TDR	Time Domain Reflectometer
TE	Telecommunications Enclosure / Terminator Entrances
TEBC	Telecommunications Equipment Bonding Conductor

TEL	Telephone
TERA (T)	One Trillion (1,000,000,000,000)
TGB	Telecommunications Grounding Busbar (SBB)
TDU	Telecommunications Distribution Unit (blown fiber)
THNN	Thermoplastic High-heat resistant electrical Nylon building wire
TIA	Telecommunications Industry Association
TMGB	Telecommunications Main Grounding Busbar (PBB)
TO	Telecommunications Outlet
TP	Transition Point
TR	Telecommunications Room (IDF/IDA)
TRC	Test Reference Cord (Max. loss 0.25 dB)
TS	Touch Screen
TSB	Technical Service Bulletin or Telecommunications Systems Bulletin
TV	Television
Tx	Transmit
TYP	Typical
UBC	Uniform Building Code / Unit Bonding Connector
UHF	Ultrahigh Frequency
UL	Underwriters Laboratory
um	Micron
UMC	Uniform Mechanical Code (IAPMO)
UNLV	University of Nevada, Las Vegas
UPC	Ultra Physical Contact ferrule (LC connector dark blue - "ultra polish connector")
UPS	Uninterruptible Power Supply
UTP	Unshielded (100-ohm) Twisted Pair-Cat 6/Cat6A (Class E/Ea)
UV	Ultraviolet
V	Volt (Ohm's Law V=I*R)
V/D	Voice/Data Outlet
VERT	Vertical
VFL	Visual Fault Locator (Optical fiber continuity checker)
VHF	Very High Frequency
VLF	Very Low Frequency
VoIP	Voice over Internet Protocol
VOL	Volume
VOM	Volt-Ohm Milliammeter
VPN	Virtual Private Network
W	Width / Watt / West
W/	Width

WA	Work Area
WAN	Wide Area Network
WAP	Wireless Access Point (AP)
WA	Work Area
WD	Wood
WDM	Wave Divisional Multiplexing
WiFi	Wireless Fidelity (WAP & AP)
WLAN	Wireless LAN
W/O	Without
WP	Weather Proof
WSP	Wireless Service Provider
(X)	Scheduled for demolition/demo work
X	Times (e.g. 8X radius = 8 times the radius)
ZDA	Zone Distribution Area
1M	1000 ft.(Manufactured) length of spooled cable 15%
4-11	4 11/16" square electrical box 2 1/2" deep
5-square	5' square electrical box 2 1/2" deep
8P8C	8 position x 8 conductor modular jack ("RJ-45")

– – – End of APPENDIX B – – –

Abbreviations and Acronyms

APPENDIX C

Approved Telecommunications Manufacturers and Part Numbers

Master Division 27 Folders		
A	27 05 26	Grounding and Bonding
B	27 05 29	Pathways, Hangers, J-Hooks, and Supports for Communication Systems
C	27 05 33 & 36	Conduit, Back Box and Cable Trays for Communications Systems
D	27 05 38	Fiber Cable Troughs / “Fiber Runners” Cable Ducting
E	27 05 39 & 40	Surface-Mounted Raceways And Modular Furniture Raceways, and Poke-Through Devices
F	27 05 43	Underground Ducts and Raceways for Communication Systems
G	27 05 41 & 44	Firestopping Systems for Communication Systems and Sleeve Seals for Communication Pathways and Cabling
H	27 05 53	Identification for Communication Systems
I	27 10 20 .10, .20, .30	Copper System and Optical Fiber Testing and Documentation
J	27 11 10	Telecommunication Rooms and Backboards
K	27 11 16	Communications Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides
L	27 11 19	Communications Modular Patch Panels
M	27 11 20	Communications Optical Fiber Enclosures

N	**27 13 23 .01**	**Intra-building Optical Fiber Backbone Cabling**
O	**27 13 23 .02**	**Intra-building Optical Fiber Backbone Cabling**
P	**27 15 01 .13**	**Communications Copper Horizontal Cabling Station Applications and PoE**
Q	**27 15 01 .19**	**Data Communications Copper Horizontal Cabling**
R	**27 15 01 .20**	**Wireless Data Communication Copper Horizontal Cabling**
S	**27 15 43 .10**	**Communication Copper Jack Information Outlets & Connectors**
T	**27 15 43 .15**	**Communication Fiber Connectors**
U	**27 15 43 .25**	**Work Area Faceplates/Wall Plates & Surface Mount Boxes**
V	**27 40 00**	**Integrated Audio-Video Systems and Equipment**
W	**Extra**	**Extra**

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Approved Telecommunications Manufacturers and Part Numbers

APPENDIX D

Rack Elevation and Room Sizing Drawings

Item	Page	Figure Section ID	Description
1	11	**27 01 00** Fig 1:	*As-Built Data Symbol Schedule*
2	25	**27 05 26** Fig 1:	*Rack Bonding Busbar Layout Options*
3	45	**27 05 28-40** Fig 1:	*Conduit Sizing Fill Ratio Table*
4	74	**27 05 43** Fig 1:	*TDU & Vault Preferred Cable Entry*
5	95	**27 05 53** Fig 1:	*UNLV Faceplate Labeling Scheme*
6	96	**27 05 53** Fig 2:	*UNLV Patch Panel Labeling Scheme*
7	97	**27 05 53** Fig 3:	*UNLV ABF Outer Sheath Labeling Scheme*
8	98	**27 05 53** Fig 4:	*UNLV ABF Microduct Labeling Scheme*
9	99	**27 05 53** Fig 5:	*UNLV Fiber Enclosures Vertical Labeling Scheme*
10	100	**27 05 53** Fig 6:	*UNLV Fiber Enclosures Horizontal Labeling Scheme*
11	117	**27 10 20 .20 & .30** Fig 1:	*Maximum Loss for OS1A and OS2 SMF Fiber Cable*
12	139	**27 11 16** Fig 1:	*TR-IDF Room Layout*
13	140	**27 11 16** Fig 2:	*ER-MDF Room Layout*
14	159	**27 13 23 .01 & .02** Fig 1:	*TDU & Vault Preferred Cable Entry*

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Rack Elevation and Room Sizing Drawings197 pages