Division 27 - COMMUNICATIONS
UNLV Campus Wiring Design Guide

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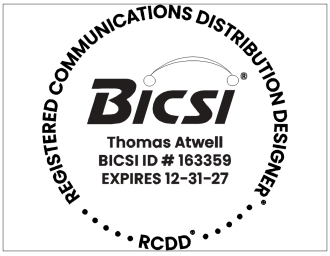

Version	Revision Date	Description
1.0	1/12/2021	Initial Version
1.1	1/25/2021	Miscellaneous Changes
1.2	2/9/2021	Formatting
1.2.5	9/23/2021	Updates for Fiber Optic Testing and Wireless Access Points
1.3	6/01/2023	Complete Update
1.4	9/1/2026	Complete Update

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SECTION 27 00 00

COMMUNICATIONS DESIGN GUIDELINE

Introductory Note:

This UNLV Division 27 *Campus Wiring Design Guide* V.1.4 July, 2026 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 eight digits; the last two represent the Subsection, XX): **27 XX XX XX**.

Part 1 - General
Part 2 - Products
Part 3 - Execution

Each Part (1, 2, and 3) are then itemized in alphanumeric 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 "Layer 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, engineers, developers, contractors, subcontractors, etc. involved in low-voltage telecommunication construction on the UNLV campus(es).

B. UNLV Planning and Construction (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 as 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 in 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 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 General Contractor and their Subcontractors to ensure that a fully compliant and efficient Structured Cabling System (SCS) infrastructure is properly provided inclusive of furnishing and installing.

E. The requirements of this document must be met by the Low-Voltage Telecommunications General Contractor and their Subcontractors, whether the General Contractor and their Subcontractors are hired directly by UNLV/P&C as the 'Prime Contractor' or hired by the General Contractor as a Subcontractor. This includes providing the cabling infrastructure for both interbuilding outside plant (OSP) optical fiber backbone and intrabuilding premises optical fiber backbone and horizontal copper distribution applications.

F. The 'Owner' referred to as UNLV/NDE and and the Low-Voltage Telecommunications General Contractor and their Subcontractors 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 General Contractor and their Subcontractors must 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 General Contractor and their Subcontractors must be issued the *UNLV/NDE RCDD Jr Check List.*
3. Note: These documents must be completed and signed by both parties before the installation can 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 must 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 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) whether partially or wholly enforced by the local Authority Having Jurisdiction (AHJ).
J. The General Contractor and their Subcontractors must include in their bid price the removal of all communications cabling that is or will become abandoned as part of this renovation, previous renovations, or temporary construction setups.

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 must 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 is 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 Materials
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 for Standardization
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 Association
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; Underwriters Laboratories (UL) Standards
30. UMC; Uniform Mechanical Code by IAPMO
31. UNLV Planning and Construction (P&C) Technical Design Guidelines

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 General Contractor and their Subcontractors must abide by all manufacturer warranty provisions, protocol, and maintain the percentage of approved technicians and/or management on site as specified by the manufacturer.

C. A manufacturer system warranty for a minimum twenty-five (25) years covering all components, materials, and equipment plus the General Contractor and their Subcontractors one (1) year workmanship must be submitted with system pre-bid submittal documentation and as a requirement for the signed Close-out Submittal process.
D. The manufacturer must work in coordination with their approved certified General Contractor and their Subcontractors 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 documentation for the same genuine product. Faulty or replaced materials must be promptly corrected by the same manufacturer at no cost or time to UNLV/NDE.
F. Warranty begins on the assigned date on the manufacturer warranty documentation must 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 General Contractor and their Subcontractor's working with the assigned P&C Project Manager (PM). The General Contractor and their Subcontractors must be responsible for correcting any work that does not meet the requirements detailed in this document for each project.
H. Products must be furnished with manufacturer's instructions and mounting hardware.
I. Products must be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
J. Transmission performance parameters must be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.

1.4 General Contractor and their Subcontractors Qualifications

A. The low-voltage General Contractor and their Subcontractors company must be a BICSI member in good standing.
B. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff. This RCDD certification must be valid for the duration of the project. Other BICSI ICT certifications including; outside plant (OSP), Registered Telecommunication Project Manager (RTPM) and Data Center Design Consultant (DCDC) are encouraged and preferred.
C. Upon request, UNLV must require the manufacturer to formally verify that the personnel identified by UNLV are certified to work with, install, or support the manufacturer's product. The contractor must provide any necessary documentation or access needed for this verification process, and confirmation from the manufacturer must serve as the authoritative determination of personnel certification status.
D. All testing and installation work must comply with current TIA standards. In the event of any discrepancy between the installer's interpretation and the University's requirements, the manufacturer's written installation guidance must determine the correct installation method. UNLV reserves the right to request site visits to evaluate installation quality. When requested,

such visits must occur within ten (10) working days to ensure timely evaluation and resolution of identified issues.

E. For projects containing more than twenty-four (24) communications cables, the General Contractor and their Subcontractor's RCDD must conduct weekly onsite, in-person site walks. Virtual site walks are not permitted. All site walks must be conducted jointly with UNLV IT/NDE RCDD representative(s).
F. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must 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).
G. The company and their onsite management and technicians must be an approved manufacturer authorized contractor of the product(s) being installed. The General Contractor and their Subcontractors must have no less than 30 percent of onsite technicians necessary to have their current certifications in compliance with the provisions of the approved contractor manufacturer warranty provisions.
H. The General Contractor and their Subcontractors must be an approved UNLV State of Nevada-authorized contractor.
I. The General Contractor and their Subcontractors must have successfully performed at least five (5) 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.
J. All General Contractor and their Subcontractor's personnel performing work on this project must be properly trained. This includes being trained on the General Contractor and their Subcontractor'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.
K. Note: In highly sensitive areas like the data centers, check with UNLV/NDE who must 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 General Contractor and their Subcontractors Responsibilities; Accountability, Obligations, and Services

A. The General Contractor and their Subcontractors must 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 General Contractor and their Subcontractors must visit the site prior to bid and verify that conditions and infrastructure descriptions are as indicated on the project drawings and specifications. The General Contractor and their Subcontractors must 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. The General Contractor and their Subcontractors agree 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 General Contractor and their Subcontractors must be in full compliance to codes, regulations, and restrictions as dictated by the local Authority Having Jurisdiction (AHJ).
E. The General Contractor and their Subcontractors must not disrupt any network services during construction. Any required disruption of existing services must be coordinated with UNLV/NDE in advance.
F. The General Contractor and their Subcontractors must never unplug or plug any patch cords from active devices or patch panels for any reason. This must be performed only by UNLV/NDE technicians.
G. In retrofit projects, UNLV/NDE must remove the patch cords associated with the cable runs that must be demolished/removed (herein referred to as “demo'd”).
H. The assigned BICSI and manufacturer-certified foreman/supervisor must be onsite at all times during the installation, testing, and closeout submittal process.
I. The General Contractor and their Subcontractors must attend weekly project review meetings and provide a status report along with a three-week forecast of the work-in-progress describing any Request for Information (RFI) or any issues encountered as part of the installation.
J. Any cabled port run that extends from the patch panel but is not terminated or coiled at the Work Area (WA) must be noted on the test results, or in an email referencing the specific date and version of those results. The patch panel must be labeled properly and legibly. (Use of painter’s tape and an indelible marker is permissible and must be 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:

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 must not block room identification (ID). Each location must be boxed with an arrow pointing to the appropriate outlet. All formatting must 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 thirty (30) days of UNLV/NDE approval of the Test Results and As-Built PDF format, the General Contractor and their Subcontractors must provide final As-Built drawings in AutoCAD .dwg format to comply with Close-out Submittals.

M. Note: Architectural drawings must 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). The drawings must also include the locations of the telecommunications outlets for voice/data/Wi-Fi/security and the pathways from the Telecommunications Rooms(s).
N. If applicable, maintain old-to-new retro port documentation as 'cut sheets' in a spreadsheet and not handwritten format. This record must 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 must be properly coordinated. Conduit, fixtures, and other equipment locations must 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 telecommunications, the General Contractor and their Subcontractors must provide weekly progress/status reports with percentage (%) complete before scheduled meetings, including a 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 General Contractor and their Subcontractors workmanship, the General Contractor and their Subcontractors must promptly make all required corrections without cost to UNLV/NDE in an expedited time frame.

1.6 UNLV/NDE Responsibility to the General Contractor and their Subcontractors

A. 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 General Contractor and their Subcontractors 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		DATA LOCATION	CAT-5E	E-COPPER-DATA-OUTLET
0		WAP LOCATION	WIRELESS ACCESS POINTS	E-WAP
0		CAMERA LOCATION	SECURITY CAMERAS	E-CAMERA
		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	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 (CAT-6A)	LINE	E-COPPER-DATA
		COPPER DATA (CAT-6)	LINE	E-COPPER-DATA
		COPPER LINE (CAT-5E)	LINE	E-COPPER-DATA
		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 compilation of multiple projects with multiple vendors. Content accuracy can not always be guaranteed.

These drawings are not to be reproduced, borrowed, transferred or edited, physically or electronically, without the written permission of both UNLV's Planning and Construction Department and the Office of Information Technology.

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

B. 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 General Contractor and their Subcontractors must incur the charges with no additional cost or time to UNLV/NDE.
C. Removal of all abandoned or demolished cabling costs must be included in the General Contractor and their Subcontractors scope of work (SoW) bid submittal.
D. 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 must be resolved by the General Contractor and their Subcontractors at no cost or time to UNLV/NDE.
E. 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. Provided Structured Cabling Systems (SCS) must be 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 must be submitted to the Planning and Construction (P&C) assigned Project Manager (PM) who must communicate the request to UNLV/NDE.
C. It must 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 must be included on each architectural "T" drawing. These construction drawings must 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 for general information only and to the best knowledge of the design team.
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 General Contractor and their Subcontractors must 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 must 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 General Contractor and their Subcontractors must be aware of all Federal, State and local codes that 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 number(s), product data sheet(s) of the materials being used for the project, and installation instructions.
C. All submittals must be complete. Partial submittals must not be considered.
D. Provide manufacturer system warranty documentation for a minimum of twenty-five (25) years warranty covering all components, materials, and equipment plus the General Contractor and their Subcontractors one-year workmanship must be submitted with system documentation as a requirement of the closeout submittal process.
E. Provide proof of BICSI and manufacturer(s) certifications for all onsite technicians and management before installation work begins.
F. Provide UNLV and State of Nevada-authorized General Contractor and their Subcontractor documentation and current licensing, permitting, and bonding requirements to the UNLV/P&C department.
G. The General Contractor and their Subcontractors are 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 installers" certification.
H. Firestopping considerations include providing a copy of the manufacturer's firestop assembly specification and application documentation, which must be used for all types of membrane and through-penetrations both inside and outside of the pathways. The same manufacturer must be used throughout the installation.
I. Proposed labeling schemes, methods, and samples if requested.
J. Submit a test plan that abides by these Division 27 guidelines to ensure that the installed and tested system meets technical requirements, operational and performance specifications.
K. Submitted drawings must be signed and sealed by a qualified Professional Engineer.
L. Coordinate with P&C and RMS for safety compliance.

1.10 Moves, Adds, and Changes

A. Moves, adds, changes or MACs initiated by UNLV to the General Contractor and their Subcontractors must be initiated using a Request for Information (RFI) and possibly a Change Order Request (COR) to UNLV/P&C.

B. RFI and COR response(s) must be issued as a written response by P&C that may require revised project drawings and specifications. Changes must be clearly denoted in the As-Builts (PDF and AutoCAD .dwg).
C. Moves, adds, changes or MACs that affect installations covered in a manufacturer warranty must be performed by the original General Contractor and their Subcontractors under 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 General Contractor and their Subcontractors must furnish a quote for the time, materials and equipment required to perform low-voltage telecommunication repairs. UNLV has the right of first refusal of selecting a suitable General Contractor and their Subcontractors. The decision may be based on the original General Contractor and their Subcontractor's cable/connector manufacturer's warranty considerations.
C. Additions or retrofitting of either the communication optical fiber backbone or the horizontal copper distribution cabling must be completed in a professional manner and must be labeled, tested, and documented with test results and as-built drawings.
D. New cabling installations, additions, or retrofitting to an already installed and existing warrantied installation must 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 must be from the same manufacturer.
B. All low-voltage manufacturers are required to have a minimum twenty-five (25) year warranty.
C. Products must be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*.

2.2 Substitutions

A. No substituted items can be installed without prior written consent by UNLV/NDE.
B. Approval of a substitution must not relieve the General Contractor and their Subcontractors from their responsibility for compliance with all requirements of the Contract Documents. Where "an approved equal" is stated in Appendix C; *Approved Telecommunications Manufacturers and Part Numbers*, materials and equipment must be equivalent in every way or more to that what was specified and still subject to approval by UNLV/NDE

C. The General Contractor and their Subcontractors must bear the expense for any changes in other parts of this work or other work caused by the proposed substitution.
D. Product data sheet documentation is required with all submittals as well as Request(s) for Information (RFIs) or Change Orders Requests (CORs) for approval.

2.3 Materials

A. Equipment and material must 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 must be in the manufacturer's original, unopened, and labeled packaging. Packaging must provide protection against moisture, tampering, or damage from improper handling or storage. The General Contractor and their Subcontractors must protect and be responsible for any damage to work or materials until final acceptance by UNLV/NDE, State Fire Marshal, and State Public Works Board.
C. All applicable low-voltage systems components, equipment and material must 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 must 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 General Contractor and their Subcontractors 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) must be certified as an end-to-end solution.
G. All cabling installations must 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. The General Contractor and their Subcontractors must coordinate delivery, storage and handling of equipment, tools, and materials to the job site. They must 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 with 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 and must adhere to the manufacturer's warranty requirements.

B. Any discrepancies or contradictions between the drawings and specifications must be considered an error or omission. This must be addressed to UNLV/NDE for clarification before proceeding with the design or installation.
C. The General Contractor and their Subcontractors must keep a reviewed print copy of the drawings and specifications at all times to document changes from the original Contract Documents.
D. The General Contractor and their Subcontractors must be in compliance with the drawings and specifications. Any violations, infringements or infractions of the specifications and/or drawings to require correction by the General Contractor and their Subcontractors without additional cost or time 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 must not be used for installation guidelines.

3.2 Examination and Preparation

A. Ensure all stakeholders are referencing the same updated specifications and drawing versions and dates.
B. Full examinations of the campus, or building(s), surrounding area, and jobsite(s) is the responsibility of the General Contractor and their Subcontractors.
C. All distances and site surroundings must be field verified by the General Contractor and their Subcontractors before ordering any material.
D. For intrabuilding projects; room numbers, equipment room-main distribution frame (ER-MDF), Telecommunications Rooms-intermediate distribution frames (TR-IDF) - hereto referred to as "Telecommunications Rooms" - security cameras, wireless access point (WAP) locations are labeled and identified plus type and size pathways are clarified on the drawings.
E. For interbuilding 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 TR-IDF locations on the drawings.
G. UNLV/NDE to provide the patch panel/switch interconnections between the Telecommunications Rooms network.
H. The General Contractor and their Subcontractors must 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 must be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.
J. All conduit and cabling must be concealed in walls, above ceilings, within soffits, under access flooring, etc.
K. Surface mounted conduit, wire mold raceways, and exposed wiring are prohibited in all areas visible to the public, students, and staff.

3.3 Installation Practices

A. All workmanship must be in full conformance with applicable building, electrical, and other codes as determined by the Authority Having Jurisdiction (AHJ).
B. The General Contractor and their Subcontractors acknowledge they are obligated to exercise the highest standard of care in performing their responsibilities as defined in the Contract Scope of Work (SoW).
C. Products must be installed in accordance with manufacturer installation instructions.
D. Any damage to the building or job site caused by the General Contractor and their Subcontractors must be repaired and restored at General Contractor and their Subcontractors's expense and no additional time to the contract 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 General Contractor and their Subcontractors's expense.
E. The General Contractor and their Subcontractors must keep all foods and liquids away from the installation area (s) and use only designated break areas. No smoking of any kind on campus.
F. No smoking or drug use of any kind on campus.

3.4 Testing

A. Before testing begins, check with UNLV/NDE to verify the copper and/or optical fiber cabling system installations, terminations, and labeling are in compliance with all applicable codes and standards as set forth in this documentation. See Appendix A; *Codes, Regulations and Standards.*
B. Copper testers having optical fiber OLTS adapters must 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 General Contractor and their Subcontractors 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 must be set to permanent link, and optical fiber testing must be set to fiber link through the use of compliant components inclusive of test cordage. No patch cords, no channel testing.
G. PDF and native tester manufacturer software test results are to follow the same pattern in sequential order by building:

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

H. Separate each PDF and native tester manufacturer software files by the Telecommunications Rooms with current date/version of test in email file ID #.
I. Both copper and optical fiber test results have connectivity/cable manufacturer's name and part numbers.
J. Use ANSI/TIA 568 as a default standard.

K. Minimum network applications for copper are 10GBase-T per IEEE 802an and optical fiber 100GBase-LR4 per IEEE 802.3ba as well as backwards compatibility to lower speed standards.
L. All tester results summaries (in sequential order) to include the graphical documentation for each test.
M. End-to-end cabling must be considered defective if it does not pass tests and must be replaced or repaired at no cost or time to UNLV. **Marginal PASS results (*PASS) are considered a failure and must not be accepted by UNLV/NDE**.
N. Electronic format copies only required. No hard copies.

3.5 Cleaning

A. The General Contractor and their Subcontractors must practice "good sweep" clean housekeeping and remove and empty trash on a daily basis from both the Telecommunications Rooms and the associated work areas. This includes keeping inventoried material staging areas in the Telecommunications Rooms organized.
B. Once the Telecommunications Rooms are complete with terminated modular patch panels, yet still exposed to sanding, dust and debris, the General Contractor and their Subcontractors must use painters' blue tape or equivalent to cover the patch panel ports at no additional cost or time to UNLV/NDE. Only UNLV/NDE is authorized to remove the tape at the start of the cutover.
C. Upon completion of a project, all debris, empty boxes, excess material inventory, installation equipment and tools must be removed leaving the premises clean, neat, and orderly. Floors must 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 entire floor.

3.6 Examination and Acceptance

A. Results Expected
    1. If applicable, cut sheets for cut-over.
    2. The ICT Structured Cabling System (SCS) and related infrastructure must 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 must first be 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 (herein referred as Velcro™)
    6. Remove any pencil/pen markings or graffiti on walls, including fire-rated plywood.
    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; AutoCAD documents in .dwg format and manufacturer warranties to follow within thirty (30) days .
11. Complete cleanup, tool and equipment removal, detailed HEPA vacuuming of the Telecommunications Rooms.
12. UNLV/NDE to perform a visual inspection and complete a walk-through with the General Contractor and their Subcontractors (and architect if requested). Any discrepancies must be addressed on a 'punch list' to the P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have 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 must 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, flat, and damaged tiles or T-bars replaced at no additional cost or time 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 General Contractor and their Subcontractors'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 thirty (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) twenty-five (25) year warranty certifications plus General Contractor and their Subcontractors 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 walk-through with the General Contractor and their Subcontractors and the design team. Any discrepancies must be addressed on a 'punch list' to the P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (48) hours to establish a time schedule in a mutually agreed timeframe to make the corrections and notify the P&C PM. The P&C PM must 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 Part 1 (General), Part 2 (Products), and Part 3 (Execution) for low-voltage telecommunications grounding and bonding components in either new or retrofit construction.
B. The General Contractor and their Subcontractors must 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 Contract Documents must 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* include the following:
    1. Section 27 05 28; *Pathways for Communications Systems*
    2. Section 27 05 33; *Conduits and Backboxes*
    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; *Communications 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; *Intrabuilding Optical Fiber Backbone Cabling*
    11. Section 27 13 23.02; *Interbuilding 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 must 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 Electrical 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 must be installed in a neat and professional workmanlike manner.
B. All methods of construction not specifically described or indicated in the Contract Documents must be subject to the control and approval of the UNLV/NDE.
C. Equipment and materials installed must be of the high-quality as presented with pre-bid submittals.
D. Where “an approved equal” is stated for substitution, equipment and materials must be equivalent to that of the equipment specified and subject to UNLV/NDE approval.
E. The General Contractor and their Subcontractors must strictly adhere to all Building Industry Consulting Service International (BICSI),
Telecommunications Industry Association (TIA), and National Fire Protection Association (NFPA-70) National Electrical Code (NEC) recommended installation practices.
F. Products must be furnished with manufacturer’s instructions and mounting hardware.
G. Products must be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.

1.5 General Contractor and their Subcontractors Responsibilities

A. The licensed Electrical General Contractor and their Subcontractors must 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 must 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 (with cut sheets) and installation instructions.

PART 2: PRODUCT

2.1 General

A. The General Contractor and their Subcontractors are 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 telecommunications 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 must be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*
D. All materials must be new and all from the same manufacturer.

2.2 Wall and Rack-mount Busbars

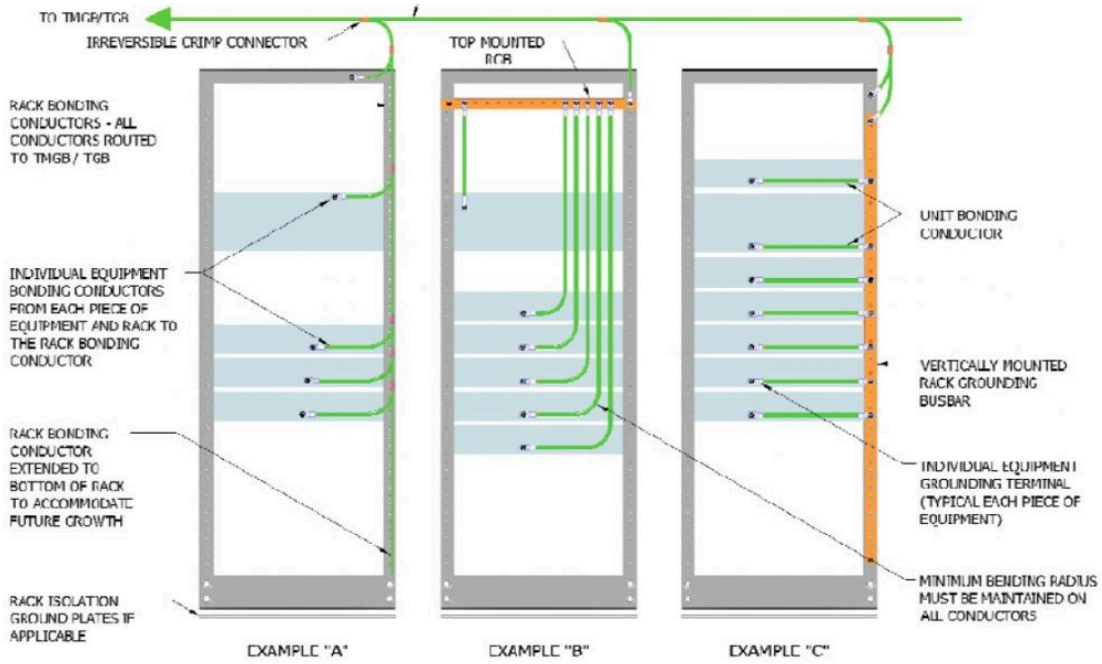
A. Telecommunications Primary Bonding Busbar (PBB):
    1. Located in the building's Equipment Room (ER)-Main Distribution Frame (MDF)
    2. Dimensions must be one-quarter inch (1/4") (6.4 mm) thick), four-inch (4") (102 mm) height, and be minimum twenty inches (20") (510 mm) in length.
    3. The busbar must be listed with UL and per the current version of UL 467 approved, being constructed with a solid, hard-drawn copper or copper-alloy bar having thirty (30) each pre-drilled attachment points (two (2) rows of fifteen (15) each) for two-hole compression grounding lugs. Check specifications and drawings for five-eighths inch (5/8") and one-inch (1") 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 twenty-seven (27) each two (2)-hole double-compression lugs with five-eighths inch (5/8") hole centers and three (3) lugs with one inch (1") (25.4 mm) hole centers.
    5. The busbar to include wall-mount stand-off brackets with two (2) insulators and assembly screws to allow four-inch (4") (100 mm) clearance from the fire-rated plywood wall. Wall location height and orientation (horizontally or vertically) determined in elevation drawings .
B. Telecommunications Secondary Bonding Busbar (SBB):
    1. Located in the building's Telecommunications Rooms (TRs)-Intermediate Distribution Frames (IDFs).
    2. Dimensions must be one-quarter inch (1/4") (6.4 mm) thick, two-inch (2") (100 mm) height, and be minimum twelve (12) inches (300 mm) in length.
    3. The busbar must be listed with UL 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 (2)-hole grounding lugs. Check specifications and drawings for five-eighths inch (5/8") (15.8 mm) and one-inch (1") (25.4 mm) hole spacing.
    4. The hole pattern for attaching grounding lugs must meet the requirements of the current version of ANSI/TIA-607-D (ANSI-J-STD-607) and must accommodate six (6) lugs

with five-eighths inch (5/8”) (15.8 mm) hole centers and three (3) lugs with one-inch (1”) (25.4 mm) hole centers.

5. The busbar to include wall-mount stand-off brackets, assembly screws and insulators creating a four-inch (4”) (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. Nineteen-inches (19”) (483 mm) wide, one-inch (1”) (25 mm) high busbar must be UL listed, being constructed with a minimum 0.188-inch solid tinned copper bar
3. Busbar to have minimum forty-nine (49) each angled pre-drilled #12-24 tapped holes at five-eighths inch (5/8”) spacing to ground bond up to twenty-four (24) each two (2)-hole TBC grounding lugs.
4. Mounted on top back two (2) post channels of the four (4)-post equipment rack and communications cabinet.
5. Another option is a vertical equipment rack/communications cabinet Bonding Busbar seventy-two inches (72”) or thirty-six inches (36”) (1,827 mm or 914 mm) in length to mount vertically.
6. Communications racks and communications cabinets must be bonded to the RBB. In turn, the RBB must be bonded directly to the PBB or 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 number six (#6) AWG stranded 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 six-hundred volts (600V) and one-hundred ninety degrees Fahrenheit (190°F) (90℃).
   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) must 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 must 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 five eight-inch (5/8”) or one-inch (1”) 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 twelve inches (12”) (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 (2) 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 is permissible.

5. Typically used on raised floor environments.

F. Conduit/Pipe Clamps or “Collars”:
   1. UL-listed and manufactured from electroplated tinned bronze. Installation hardware must be stainless steel.
   2. Sized to fit up to two (2) each same-sized conductors ranging from number six (#6) AWG to size two hundred fifty (250) MCM (250 fuse voltage protection).
   3. Pipe clamp “collars” sized to matching pipe size from trade size one to six inches (1”-6”) (25mm-152 mm) inside diameter (ID).
   4. On sleeves between walls or floors, only one side must be grounded back to the telecommunications busbar.
   5. Use of single-hole, single-crimp compression lug is permissible.
   6. On interbuilding (between buildings) conduit runs, both ends must 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 must 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 General Contractor and their Subcontractors must provide and install a low-voltage telecommunications grounding and bonding system, independent of the building’s electrical and building ground. It must be Designed to comply with the recommendations in the current version of ANSI/TIA 607-D (ANSI-J-STD-607).

C. The main telecommunications entrance facility (EF) in each building must be equipped with a 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 TR-IDF must be provided with an SBB. The intent is to provide a low-voltage telecommunications grounding system that is equal in potential to the building electrical grounding system. This must minimize ground loop current potential between telecommunications equipment and the electrical system that supplies power to the equipment.

E. The PBB must be connected to each TR’s/IDF’s 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. The General Contractor and their Subcontractors must 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, must 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 and the design team 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 must be accomplished using exothermic welding.
   2. Must be inspected by the Authority Having Jurisdiction (AHJ) before burial.

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

F. Wall-Mount Busbars:
   1. Attach busbars to the fire-rated 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 four-inch (4”) (102 mm) insulated clearance between the wall and the busbar.
   3. Conductor connections to the PBB and SBBs must be made with two (2)-hole bolt-on double-compression lugs sized to fit the busbar. Single (1)-hole mounts are not permitted on any telecommunications busbars.
   4. Wall-mount telecommunications busbars must be bonded to the building’s ground system.
   5. The PBB must be bonded to the SBBs via TBBs or, if applicable, the TBBIBCs.
   6. When there are multiple TBBs, the BBC is employed to interconnect them through the
      i. 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 PBB and SBBs.
   8. The PBB must 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 must be grounded to the PBB and those in TR-IDF must be grounded to the SBB. The SBC must be a minimum number six (#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 Primary Bonding Busbar (PBB) to the Telecommunications Rooms-Intermediate Distribution Frames (TR-IDF) Telecommunications Grounding Busbar-Secondary Bonding Busbar (SBBs)
12. Note: NEC requires the first (ER-MDF) PBB and top floor (TR-IDF) SBB must 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. Middle floors are not required to be bonded but must be bonded for three (3) and four (4) story buildings.
13. Ground wires used for telecommunications grounding purposes must 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 PBB and 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 PBB and the ac service equipment ground and/or to the building grounding system must not be smaller than No. 1/0 AWG.
    2. Check electrical standards for proper sizing.

I. Rack-mounted Bonding Busbars (RBB):
    1. Provide nineteen-inch (19”) (483 mm) equipment rack/communications cabinet-mounted horizontal or vertical Rack Bonding Busbar (RBB) per manufacturer installation instructions.
    2. Alternatively, per specifications, provide seventy-two inches (72”) or thirty-six inches (36”) (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 (2)-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 (6th) raised floor pedestal with a minimum number six (# 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 number six (#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 nonconductive materials, bonding jumpers from the cable tray to building steel are required every fifty to sixty-five feet (50’-65’) (15.2 m - 19.8 m) or a continuous ground wire attached every fifty to sixty-five feet (50’-65’) (15.2 m - 19.8 m) 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 do not require a 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 ninety degrees (90°).
   4. Install without splices.
   5. Support at not more than thirty-six inches (36”) (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 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 must comply with the latest edition of NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment must be considered as a supplement to bonding requirements in this Section .

3.3 Cleaning

A. The General Contractor and their Subcontractors must practice “good sweep” clean housekeeping and remove and empty trash on a daily basis from both the Telecommunications Rooms and the associated work areas. This includes keeping inventoried material staging areas in the Telecommunications Rooms organized.

3.4 Identification

A. Use one-half inch (½")(12-14mm) size black on white labels, which must 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 fire-rated 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 drawings of the projects for their walk-through inspection for Quality Assurance (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 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 telecommunications busbars, equipment rack/communications cabinet RBBs and their bonding to the busbars, and pathways jumpers and TBC to the busbars.
E. Products must be installed in accordance with manufacturer's instructions.
F. All materials must be installed in a neat and professional manner.
G. UNLV/NDE to perform a visual inspection and complete a walk-through with the General Contractor and their Subcontractors and the design team. Any discrepancies must be addressed on a 'punch list' to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (48) hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. The UNLV/P&C PM must 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 Primary Bonding Busbar (PBB) to the Telecommunications Rooms-Intermediate Distribution Frames (TR-IDF) Telecommunications Secondary Bonding Busbar (SBBs).
B. Within thirty (30) days of the Substantial Completion of the project or prior to project closeout, - which
ever comes first, provide manufacturer system warranties for a minimum of twenty-five (25) years covering all components, materials, and equipment plus the General Contractor and their

Subcontractors's one (1) year workmanship documentation. Warranty documentation to specify project number and building IDF(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, 27 05 29, 27 05 33, 27 05 36, 27 05 38, 27 05 39, and 27 05 40
Pathways: Hangers, J-Hooks, Supports, Conduits, Backboxes, 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, backboxes, cable trays, Surface-Mounted Raceway, modular furniture pathways and poke-through devices. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) for hangers, J-hooks, supports, conduits, Backboxes, cable trays, Surface-Mounted Raceway, modular furniture pathways and poke-through device components in either new or retrofit construction.

B. The General Contractor and their Subcontractors must 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 Backboxes, 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: *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 must 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* include 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; *Communications 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; *Intrabuilding Optical Fiber Backbone Cabling*
7. Section 27 13 23.02; *Interbuilding 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 must 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 Backboxes, Cable Tray, and Raceways for Communication Systems must 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 Electrical 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 Backboxes, Cable Tray, and Raceways for Communication Systems* starting from Entrance Facility (EF) demarc, and Telecommunications Rooms as pathways through the corridors and hallways and into the Work Areas (WAs) to the Telecommunications Outlets (TOs).

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

1.4 Quality Assurance and Warranty

A. The General Contractor and their Subcontractors must coordinate with the Owner's Contractor and their Subcontractors prior to final placement of telecommunications pathways. Pathways must be readily accessible for placement of low-voltage telecommunications cable (copper UTP and optical fiber).
B. All pathways must be installed in a neat and workmanlike manner to support possible future expansion of the system.
C. Any poke-through devices requiring core drilling must be designed, authorized, located, X-rayed, and managed by UNLV/P&C. Ensure the Telecommunications Outlet (TO) is a minimum 4-port outlet to accommodate at least two (2) RJ-45 jacks, plus other media as required (e.g., A/V).
D. All methods of construction that are not specifically described or indicated in the Contract Documents must 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 PDF and as-built drawings in AutoCAD (.dwg) format.
F. Where "approved equal" or "equal to" is stated for substitution, equipment and materials must be equivalent to that of the equipment specified and is subject to UNLV/NDE approval.
G. The General Contractor and their Subcontractors must strictly adhere to all current versions of Building Industry Consulting Service International (BICSI),
Telecommunications Industry Association (TIA), and National Fire Protection Association (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 must be inspected and approved by UNLV/NDE RCDD prior to any cables being installed.
I. Products must be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.

J. Products must be furnished with manufacturer's instructions and mounting hardware.

1.5 General Contractor and their Subcontractors Responsibilities

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. The foreman/supervisor must 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 General Contractor and their Subcontractors are 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 required due to the General Contractor and their Subcontractors's lack of awareness of project/site conditions must not 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, the General Contractor and their Subcontractors must X-ray floors prior to core drilling to avoid damaging structural components, including rebar and tension bars.

1.6 Pre-bid Submittals

A. Provide a manufacturer's product technical data sheet summarizing product information and characteristics, 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 the manufacturer's certification indicating the manufacturer is ISO 9000/9001 quality certified and 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 must be new, unused, free of defects, and high quality; materials must be from a single manufacturer and delivered in manufacturer-labeled packaging.
B. Products must 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 must field-fabricated cable support products be acceptable.
E. Comply with current version of IEC 61537.
F. All metallic cable trays must be grounded and clearly marked in accordance with ANSI/TIA-606-D and ANSI J-STD-607.
G. The General Contractor and their Subcontractors must be solely responsible 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. Damaged materials must not be installed.
I. Any materials showing signs of mishandling, improper storage, reduced value, or missing inventory must be replaced at no additional cost or time to UNLV.
J. All emptied packaging materials must 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 General Contractor and their Subcontractors.
L. Products must be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*
M. Fire-rated wall membrane penetrations and through penetrations must be installed in accordance with Division 27 05 41, Firestopping for Telecommunications Systems.

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

A. Cable supports must comprise manufacturer-recommended hardware for a complete system supporting standard and blown ABF optical fiber and copper UTP Category 6 and 6A.
B. Hangers and supports must be suspended from or attached to structural ceilings or walls using hardware designed to support the tray's maximum load.
C. Standard support systems 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 must 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 stubbed-out work area (TO) conduit, provide metal-only saddle-type J-hooks with locking clips 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. Nine-inch (9”) yellow drop-wire stand-offs secured with a clip to 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 Backboxes for Communication System

A. Minimum EMT metal pathway size (e.g., stub-outs): one-inch (1”) trade size and comply with the current version of UL 797.
B. All boxes and conduits must be grounded and installed per the current version of NFPA 70 (NEC).
C. Electrical Metallic Conduit (EMT) splice fitting must use a 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 must be designed for the environment in which it must be installed.
D. Outside and garage applications must use rated boxes, minimum NEMA 250 Type 4X / IEC 60529 IP65. Interior applications may use inside plant (ISP) or premises-rated flush and surface-mount boxes.
E. EMT conduits must be rigid and the minimum size is one-inch (1”).
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 installations can use one-half inch (1/2") FMC having just one patch cord.
G. Premises Telecommunications Outlet (TO) boxes must be 5-square, two and three-quarter inches (2-3/4”) (70 mm) deep electrical boxes with integral wire management. This must require properly sized mud rings or screw-on covers if used as a pull box.
    1. Furnish and install minimum one-inch (1”) conduit stubs-outs inside the walls from the 5-square two and three-quarter inches (2-3/4”) deep Telecommunications Outlet (TO), through the top wall plate and attaching a forty-five (45) degree or ninety (90) degree elbow sweep directed to the J-hook or cable tray that leads back to the Telecommunications Rooms.
    2. Note: The TO must accommodate IP data and/or voice on top left (RJ-45) port.
H. Indoor application for boxes and enclosures must 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 must meet NEC Article 392 and all federal, State, and local codes enforced by the Authority Having Jurisdiction (AHJ).
    2. Cable trays must be dedicated to low-voltage telecommunications use and must not be shared with electrical systems. 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. The General Contractor and their Subcontractors must 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, must 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. The basket ‘ventilated’ tray must 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 inches (4”) (102 mm) deep, eighteen inches (18”) (457 mm) wide, and ten feet (10’-0”) (3 meters) long specifications (or subsequent UNLV/NDE approval) may vary tray height and width based on ceiling clearances, anticipated cable fill, and other installed materials.
3. The cable tray must 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. Must 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. The overhead system must be wall, cable tray, ceiling-mounted threaded rod, or ladder rack mountable.
C. The systems' components of channels, transitional fittings, drops and support structures must 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. Must be modular and can fit into restricted low space applications.
G. If requested, be available with covers.
H. The color of choice is yellow.
I. Support brackets must be self-supporting
J. Be available in (inches); 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 must 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. The alternative is the installation of one-inch (1") EMT conduit and one (1) 5-square electrical box. 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. The minimum surface-mount raceway size must be one and one-half inches (1-1/2") deep and two and three-quarter inches (2-3/4") wide (38 mm x 70 mm) to accommodate proper fill ratios and maintain bend radius. Provide deep surface-mount boxes, minimum two and three-quarter

inches (2-3/4") (70 mm) deep, to accommodate RJ-45 terminations, considering angled faceplates/wall plates.

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 must be selected by UNLV/P&C.
E. Modular raceway boxes must 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 General Contractor and their Subcontractors are responsible for providing all appropriate and qualified labor, tools, equipment and materials to complete the installation.
B. Comply strictly with the manufacturer's installation instructions and industry best practices.
C. Receiving the materials onsite must be examined for damage and straightness. Any materials found to be in unsatisfactory condition must be rejected and cannot be installed. Replacement must be at the expense of the General Contractor and their Subcontractors.

D. Examine all intrabuilding premises, hallways, corridors, rooms, offices, labs, and Telecommunications 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 one-inch (1”) (25 mm) conduit radiating from the Telecommunications Rooms to each work area (WA) telecommunications outlet (TO) in a star configuration. 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 forty percent (40%).
F. Empty conduits to have a pull string secured at both ends.
G. General Contractor and their Subcontractors must provide horizontal and vertical transitions to suit field conditions in order to meet routing requirements.
H. Pathways and cable tray must be installed level and plumb, and secured per manufacturer’s instructions.
I. Maximum fill ratios: J-hooks seventy percent (70%) (or fifty (50) cables) for two-inch (2”) J-hooks; conduit forty percent (40%); and basket tray fifty percent (50%) .
J. Keep pathways at least twelve-inches (12”) away from parallel runs of flues and steam or hot-water pipes. If possible, install all horizontal pathway runs above water and steam piping.
K. Complete pathway installation before starting conductor installation.
L. Metal horizontal pathways must 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) must 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 four-inch (4”) 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 not applicable.

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

A. All communications pathways must be independently supported. Suspending pathways from piping, HVAC ductwork, and ceiling grids are not acceptable.
B. Mounting Brackets: Surface-Mounted Raceway must 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 (2) minimum size three-eighths inch (3/8”) ceiling-mounted threaded rods with sections directly supported by and securely

clamped to the Unistrut. The exposed rod stud, in turn, must be flush-cut to the bottom of the lowest locking nut or cut to one-half inch (1/2") (12 mm) to allow the installation of black plastic cap.

D. Individual J-hooks may support no more than fifty (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 when approved by UNLV/NDE prior to the start of construction.
F. J-hooks must not 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 must not be shared with any high-voltage systems nor can be mounted to any electrical conduit.
H. J-hooks must be spaced at a minimum four feet (4'-0") (1.2 meters) or less and a maximum five feet (5'-0") (1.5 meters) along a pathway. Spacing can be staggered in between.
I. Low-voltage telecommunications J-hooks must 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' must 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. Clarify prior to construction with the Authority Having Jurisdiction (AHJ) if the telecommunications stringers must be left hanging freely or if they are required to be attached to the T-bar supports.

3.3 27 05 33: Conduits and Backboxes for Communication Systems

A. NECA 101-2013; *Standard for Installing Steel Conduit*; Electrical 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 intrabuilding premises applications. Only in use in outside plant (OSP) interbuilding applications.
C. Electro Metallic Tubing (EMT) "conduit" routes must 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 must be reamed at both ends and fitted with a plastic bushing on each end to prevent damage to the cable during pulling. This includes conduit routed into a pull box or telecommunications outlet.
E. Downspouts or sweep extended conduit must be installed on all horizontal four-inch (4") conduit that drops into the tray or ladder rack below.
F. Horizontal wall-mounted riser conduits and/or sleeves entering Telecommunications 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 chafing of the installed cable bundle.

G. Various bend angle configurations can be combined to accomplish specific requirements but not a single bend to exceed ninety-degrees (90°) and total not to exceed one-hundred eighty degrees (180°).
H. Conduit required through areas in which flammable materials may be stored or over and adjacent within three feet (3') (1 meter) to boilers, incinerators, hot water lines or steam lines.
I. LB conduit box is permissible as in-line pull box for straight one-inch (1") EMT runs having less than four (4) cables.
J. Empty metal conduit less than two-inches (2") (51 mm) to have a pull cord or pull tape installed and secured at both ends that has a minimum test rating of two-hundred pounds (200 lbs.) (90 kg). Leave and secure at least twelve-inches (12") (305 mm) of slack at each end of the conduit or innerduct.
K. Empty metal conduit greater than two-inches (2") to have a pull tape installed and secured at both ends having a minimum test rating of one-thousand two-hundred pounds (1,200 lbs.) (544 kg). Leave and secure at least twenty-four inches (24") of slack at each end of the conduit or innerduct.
L. Three- and four-inch (3" and 4") conduit whether empty or partially filled with cable or innerduct, each occupied with empty plastic or mesh innerduct, must have a pull tape installed and secured at both ends having a minimum test rating of one-thousand two-hundred pounds (1,200 lbs.) (544 kg)
M. Three- and four-inch (3" and 4") conduit wall or ceiling 'through' sleeves require bonding and grounding collars one-side only to the building steel supports.
N. All communications cabling passing through non-rated walls must be installed within an EMT conduit sleeve. Where existing communications cabling passes through newly constructed non-rated walls, a listed split-sleeve assembly must be installed to protect the cabling at the wall penetration. Where existing communications cabling passes through newly constructed rated walls, all penetrations must be protected in accordance with NEC requirements and applicable firestopping standards to maintain the fire-resistance rating and integrity of the wall assembly.
O. One-inch (1") through four-inch (4") conduit floor and ceiling sleeves to protrude a minimum three-inches (3"), preferred four-inches (4") (102 mm) above finish floor and have plastic grommets installed on both ends. All new and unused four-inch (4") conduits must be capped.
P. Support conduit within twelve-inches (12") (305 mm) of enclosures to which they are attached.
Q. When making a ninety-degree (90°) penetration through a wall using only one (1) ninety-degree (90°) sweep, or two (2) "Smart" LBs with built in bend radius guide. No exceptions.
R. One-inch (1") through four-inch (4") conduit wall and ceiling protrusions;
    1. Entering the Telecommunications Rooms to have a minimum seven-inch (7") (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-inch (3") (76 mm) clearance extending from the wall (with plastic grommet on both sides).
S. Rigid Metallic Conduit (RMC) and Intermediate Metallic Conduit (IMC) must use threaded rigid steel conduit fittings in compliance with NEMA FB 2.10. Both are permitted to extend

non–fire-rated Outside Plant (OSP) cable beyond the fifty feet (50'-0") (15 m) demarcation point inside or through a building in accordance with NFPA 70 (NEC).

T. LB conduit box is not permissible as an in-line pull box. Use a five (5)-square two and three-quarter inch (2 3/4") deep electrical box only.

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

V. 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.

W. All conduits must 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).

X. Telecommunications conduits to maintain large bends and sweeps. Provided are the ratios for minimum conduit bend radius to conduit size diameter.
    1. Two-inch (2") (50mm) and smaller: 6:1
    2. Larger than two-inch (2") (50 mm): 10:1

Y. 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 one-inch (1") conduit to exceed six (6) each one-quarter inch (1/4") (7 mm) Cat 6 or 6A OD cables and no more than ninety-five (95) cables through a four-inch (4") floor or ceiling sleeve into a Telecommunications Rooms.

Z. Telecommunications outlets (TOs) must be stubbed out vertically into accessible wall space with a minimum one-inch (1") EMT having a forty-five or ninety-degree (45° or 90°) elbow on top protruding above drop ceiling level and pointing to the pathways (J-hooks and/or tray) leading back toward the assigned Telecommunications Rooms.

AA. Appropriately sized pull boxes approved by UNLV/NDE are required when there are more than two (2) ninety-degree (90°) bends or a combination of bends exceeding one hundred-eighty degrees (180°) in a section not exceeding one-hundred feet (100'-0") in length between pulling points. At a minimum use a five (5)-square two and three-quarter inch (2-3/4") deep electrical box.

BB. 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 must be made outside the pull box with forty-five-or ninety-degree (45°or 90°) elbow sweeps.

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

DD. Those in recessed ceilings must be unblocked and readily accessible from other trades 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 as part of the project, 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. The General Contractor and their Subcontractors must use the installation tools and practices recommended by the manufacturer to field fabricate cable tray intersections and changes in elevation.
C. The General Contractor and their Subcontractors must 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 must hold the General Contractor and their Subcontractors accountable to make any corrections to condition which interferes with telecommunications low-voltage pathways:
    1. Provide a minimum of twelve-inches (12”) (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 must be installed with a minimum clearance of twelve-inches (12”) (300 mm);
        a. From the top of the 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 bottom of the cable tray above.
    3. 3. The General Contractor and their Subcontractors must contact UNLV/NDE immediately if any other trades install any device, material, or equipment across and below the six-inches (6”) 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. 4. Provide a preferred six-inches plus (6" +) (152 mm) but a minimum three-inches (3") (76 mm) clearance above acoustical drop-ceiling T-bar supports.
5. 5. When installed under a raised floor, the cable tray must be installed with a minimum six-inches (6") (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. 6. Maintain a three-inch (3") (76 mm) clearance between trays wherever trays cross over at ninety-degrees (90°) measured from the top of the sides of the lower tray to the bottom of the tray above.
7. 7. Given ceiling congestion, attempt to allow a minimum thirty-inches (30") (762 mm) of clear working space adjacent to the cable tray on at least one (1) 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 must be continuous without gaps, misalignments, having no openings or breaches.
G. At no time must tray sides or bottoms be cut away for cable entry or 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 must be bonded to the Telecommunications Primary Bonding Busbar (PBB) in the Equipment Room - Main Distribution Frame (ER-MDF) or the Telecommunications Grounding Busbar - Secondary Busbar (SBB) in the Telecommunications Rooms - 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 must be electrically continuous through bonding and attached to the telecommunications secondary bonding busbar (SBB).
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 must 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' must be made with side-action bolt cutters or hand-held hydraulic "Gator Byte". Both must 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 must be supported per manufacturer instructions but not to exceed every five feet (5'-0") (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 feet (4'-0") (1.2 meter).
5. Support cable tray within two feet (2'-0") (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 time 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. 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 manufacturers rounded outside/inside corner spoke assembly or plastic radius guide inserts when cable is transitioning around "T" or ninety-degree (90°) basket tray intersections.
    c. Route cables away from vertically-supported threaded or use appropriate plastic radius guides.
8. All surfaces must be left completely smooth and finished. Cut edges must not be exposed. Remove burrs and sharp edges from cable trays. Exposed edges must be covered with appropriate fittings like plastic caps or studs and to ensure cables being installed must not be damaged or chafed being routed through the tray.
9. Install no more than the equivalent of three (3) each horizontal ninety-degree (90°) bends in any pathway run. Provide support within twelve inches (12") (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 must 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 must be installed (usually in office corridors with 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 must be installed a preferred twelve inches (12”) (305 mm) and minimum six inches (6”) (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 must 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 feet (5’-0”) (1.5 meters).
F. Installation must 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 ninety-degree (90°) elbow or T-fitting bends to allow for a minimum two-inch (2”) 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 forty-eight inches (48”) (1.2 meters) and with no less than two (2) 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 must 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 must be designed, authorized, located, x-rayed, and managed by the UNLV/P&C department.
B. Ensure the Telecommunications Outlet (TO) is a minimum four (4) port to accommodate minimum two (2) 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. The General Contractor and their Subcontractors must practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the Telecommunications 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" must 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. Four-inch (4") outside plant (OSP) stub-up conduits must 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 must 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 walk-through with the General Contractor and their Subcontractors (and the design team if requested). Any discrepancies must be addressed on a 'punch list' to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (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 must 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 thirty (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 twenty-five (25) years covering all components, materials, and equipment plus the General Contractor and their Subcontractors' 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, Backboxes, 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 Part 1 (General), Part 2 (Products), and Part 3 (Execution) for underground ducts, raceways, or a combination of communication system components in new and 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 interbuilding outside plant diameter HDPE piping/conduit is trade size four-inch (4”) (102 mm).
F. Approved outside plant (OSP) rated conduits for special projects are HDPE trade sizes one or two inch (1” or 2”) (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 must be made with UNLV/NDE to discuss Internet Service Providers (ISP) and distributed antenna system (DAS) pathway access requirements.
H. Components covered in this section:
    1. Conduit types
    2. Duct accessories, including rigid innerduct and fabric innerduct.
    3. Precast concrete handholes.
    4. Polymer concrete handholes and boxes with polymer concrete cover.
    5. Fiberglass handholes and pull boxes with polymer concrete cover.
    6. Fiberglass handholes and pull boxes.
    7. High density plastic boxes.
    8. Precast maintenance holes.
    9. Cast-in-place maintenance holes.
    10. Utility structure accessories.
    11. Vaults
    12. Maintenance Holes / Manholes (MH)
    13. Pull boxes PB) / Junction boxes (JB)

14. Innerduct
15. Air-blown / Jetting Microduct system

a. 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) must conduct a visual walk-through inspection of the identified pathways of the project inclusive of the maintenance holes (MHs) and vaults (Vs).

B. Open inspection without entry to an OSHA-defined 'confined space' is permissible for top-view inspection only. A 'pre-entry checklist' must be distributed to each bidder to complete during the walk-through and to keep for their records.

C. Should any venomous 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 General Contractor and their Subcontractors provide in their submissions is their in-house confined space protocol (as required).
   2. They are to include the assigned onsite technicians' confined space certifications.
   3. General Contractor and their Subcontractors must 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 must be manned and equipped with rail guards, personnel, blowers, tripod crank retrieval, and more.
   4. This documentation must be reviewed and must be approved by UNLV/FMS before the General Contractor and their Subcontractors can conduct business in any maintenance hole (MH) or vault (V).

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

F. The General Contractor and their Subcontractors must review the UNLV Confined Spaces Map and other resources, to familiarize themselves with the conditions in the vaults they are to enter.

G. Once the project is awarded the General Contractor and their Subcontractors need 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 twenty-four (24) hour advance notice.
   3. Have their schedule and checklists onsite and readily available for inspection by UNLV/FMS.

H. All OSHA established confined space entry requirements must be met and air monitoring must occur prior to entry and during the duration of the entry.

I. Advise that all emergency rescue services must be arranged by the contractor, through either in-house or outside agency resources. There are no rescue services by UNLV staff.

1.3 General Contractor and their Subcontractors Responsibilities

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must 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 General Contractor and their Subcontractors must 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 interbuilding pathways of conduits connecting between buildings through either or a combination of maintenance holes/manholes (MH), vaults (V), handholds (HH)/ pull boxes (PB)/ and pedestals (PEDs).
E. Directional Boring
    1. High-density polyethylene (HDPE) piping/conduits must be used for directional boring.
    2. A swivel must 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* include 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 Backboxes*
    4. Section 27 05 41; *Firestopping Systems 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; *Interbuilding Optical Fiber Backbone Cabling*
C. Material and work must 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 A48; *Standard Specification for Gray Iron Casting*
13. ASTM C270; *Standard Specification for Mortar for Unit Masonry*
14. ASTM C387; *Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete (Aug, 2017)*
15. ASTM C858; *Standard Specification for Underground Precast Utility Structures (Feb, 2010)*
16. ASTM C891; *Standard Practice for Installation of Underground Precast Concrete Utility Structures (Dec, 2020)*
17. ASTM C990; *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants*
18. ASTM C1037; *Standard Practice for Inspection of Underground Precast Concrete Utility Structures*
19. ASTM C1107/C1107M; *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 is 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 fifty (50’) feet (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 conduits that are 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 one-inch (1”) 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 four (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. General Contractor and their Subcontractors must ensure they have the most current version of the project's campus layout drawing issued by UNLV or by the design team.

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 (2) days in advance of the proposed interruption of communications service.
    2. Do not proceed with interruption of communications service without 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 buildings may occur.
E. Any branch conduits entering/exiting a maintenance hole (MH)/vault (V)/handhold (HH) must 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 must 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) four-inch (4") HDPE piping/conduits are not to exceed six hundred feet (600'-0") (183 meters).
    2. At the intersection of main and branch conduit runs.
    3. And maximum pulling cable tension is six hundred pounds (600 lbs.) (272 kg).
    4. Adjacent and in-line to pedestals or Wi-Fi bollards.
    5. More than two (2) each ninety-degree (90°) bends in four-inch (4") 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 must be a minimum of seven-eighths inch (7/8") 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 twenty-four inches (24") to require:
    1. The installation of permanent cement steps around the neck of the maintenance holes (MH) per manufacturer instructions.
    2. These steps must be installed at the same time as the maintenance hole's (MH) neck ring is being installed. Steps must not 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) must 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) must only be placed at strategic locations in the four-inch (4") 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 must be installed within Handhold (HH)/Pull boxes (PB) that, in turn, are installed deeper than the standard two feet (2') (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 must enter at the lowest level first and progress upwards. The upper space must be reserved for future additions.

1.8 Quality Assurance (QA) and Warranty

A. Qualified according to the current version of ASTM E329 for outside plant construction inspection.
B. Products must be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
C. Manufacturer twenty-five (25) year warranty documentation.

1.9 General Contractor and their Subcontractors Responsibilities

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must 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. Directional Boring

1. Only high-density polyethylene (HDPE) conduit can be used for directional boring.
2. A swivel must 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 C858.
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), complying with the current versions 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. Twenty-two (22) degree and forty-five (45) degree, four-inch (4”) HDPE piping/conduit angles are preferred. Regardless of depth, there must not be more than the equivalent of combined one-hundred eighty (180) degrees between pull points, including offsets and kicks. Back-to-back ninety (90) degree bends must be avoided.
E. All manufactured three (3) and four (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 one-inch (1”) and two-inch (2”) to have a radius not less than six (6) times the internal diameter of the conduit.
F. Four-inch (4”) HDPE piping/conduits must be provided with mule tape with a minimum of one-thousand-two hundred pound (1,200 lbs.) (544 kg) pulling tension and secured at both ends with or without an innerduct installed.
G. Four-inch (4”) “Smart LBs” for entering/exiting a building above surface grade.
H. Where possible, entrance and distribution four-inch (4”) conduit floor penetrations to enter and exit on the same outside wall(s). Design and use ladder racking inside the Telecommunications Rooms to provide distribution wall-to-wall.
I. JackMoon or Shaw Plugs to plug four-inch (4”) stub-ups inside the entrance facility (EF).

2.3 Innerduct

A. Optical fiber cable must be installed with corrugated or mesh fabric innerduct for protection of optical fibers in a shared pathway. Both must 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 four-inch (4”) HDPE piping/conduit pathway. Ensure sizing to accommodate blown fiber microduct housing:

1. A four-inch (4”) conduit can typically house four (4) each one-inch (1”) innerduct (25 mm) or three (3) each one and one-quarter inch (1-1/4”) innerduct (38 mm).
2. Or, a combination with mesh fabric innerduct.

C. Check specifications for using mesh fabric innerduct: Maximum one (1) each four-inch (4”) x three (3) cell in four-inch (4”) HDPE piping/conduit and must 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 must 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-H-20-44 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) must be galvanized or stainless steel.
C. Handhold (HH)/Pull boxes (PB) minimum dimensions: eighteen inches (18”) (457 mm) wide by thirty-six inches (36”) (914 mm) in length by twenty-four inches (24”) (610 mm) in depth (height):
    1. Any larger units must have inserts for cable racks and pulling-in irons installed before concrete is poured.
D. Comply with ASTM C858 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 a hold-open ratchet assembly.

F. Cover features:
   1. Non-skid finish: Must be marked for easy identification ("Communications") and have a permanently attached metal label indicating the assigned number from UNLV/NDE.

G. Units must 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 1. twelve inches (12") (305 mm) minimum.
   3. Slab to have the same dimensions as bottom of enclosure and arranged to provide closure.

I. 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.

J. Knockout Panels to have precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional six inches (6") (152 mm) to twelve inches (12") (304 mm) vertically and horizontally to accommodate alignment variations:
   1. Must be located no less than six inches (6") (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 must be framed with at least two (2) additional Number three (3) steel reinforcing bars in concrete around each opening.
   4. Must be one and one-half to two inches (1-1/2" to 2") (38 to 50 mm) thick.

K. Duct Entrances in Handhole Walls:
   1. Cast end-bell or duct-terminating fitting in wall for each entering duct.
   2. Type and size must match fittings to duct or conduit being 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)/pull boxes (PB) with Polymer Concrete Frame and Cover

A. Vault (V) minimum dimensions: Two feet (2'-0") (610 mm) wide by six feet (6'-0") (1.8 meter) in length by three feet (3'-0") (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 (2).

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 must be made of polymer concrete, hot-dip galvanized-steel diamond plate, or plastic.

E. All three (3) to comply with SCTE 77.
F. Color: Gray or green
G. Units must 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. Must 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 twelve inches (12”) (305 mm) wide by twenty-four inches (24”) 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 feet (4’-0”) (1.2 meter) wide by six feet (6’-0”) (1.8 meter) in length by four feet (4’-0”) (1.2 meter) in depth (height).
B. Comply with ASTM C858 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 inches (6”) (150 mm) or twelve inches (12”) (300 mm) vertically and horizontally to accommodate alignment variations.
    2. Splay or center window location and be located no less than six inches (6”) (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. Must be framed with at least two (2) additional Number three (3) steel reinforcing bars in concrete around each opening.
    5. Minimum Sizes must be one and one-half to two inches (1-1/2”- 2”) (38.1 to 50.8 mm) thick.
E. Duct Entrances in maintenance hole (MH) walls must be end-bell or duct-terminating fitting in wall for each entering duct:
    1. Type and size must match fittings to duct or conduit being 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 three-inch (3”) (76.2 mm) PVC sleeve in maintenance hole floors two-inches (2”) (50 mm) from the wall adjacent to, but not underneath, the duct routed from the facility.
G. Ground joint sealant must 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 C858 for design and manufacturing processes.

2.10 Utility Structure Accessories

A. Utility equipment and accessory items used for utility structure access and utility support must 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 holes.
C. Frame and cover must be weatherproof, gray cast iron complying with ASTM A-48, Class 30B or cast aluminum, with milled cover-to-frame bearing surfaces; A. twenty-six-inch (26”) (660-mm) or twenty-nine-inch (29”) (725-mm) diameter.
D. The cover finish(es) to have a non-skid finish with a minimum coefficient friction of 0.50:
    1. If requested in project specifications, special covers must be recessed and designed to accept finish material in paved areas.
E. Maintenance hole chimney components must 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 C270, Type M, except for quantities of less than two cubic feet (2.0 cu. ft.) (60 L), where packaged mix complying with ASTM C387, Type M, may be used.
    2. Seal joints are watertight using preformed plastic or rubber conforming to ASTM C990. 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 must have a minimum two- inches (2”) (50 mm) diameter eye and be one by four inch (1”x4”) (25-by-100-mm) in length. Working load embedded in six-inch (6”) (150 mm) four-thousand psi (4000-psi) (27.6-MPa) concrete to have thirteen-thousand pound (13,000 lb.) (58-kN) minimum tension.

2. In non-concrete walls, the eyebolt with reinforced fastening must have a minimum one and one quarter inch (1-1/4”) (31 mm) diameter eye, rated to twenty-five thousand pounds (2500 lbs.) (11 kN) minimum tension.

G. Pulling-in and lifting irons in concrete floors must be a minimum seven-eighths inch (7/8”) (22 mm) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening-yield strength must be minimum forty-thousand pounds (40,000 lbs.) (180 kN) shear and sixty-thousand pounds (60,000 lbs.) (270kN) tension.

H. Bolting inserts for concrete utility structure cable racks and other attachments must be flared, threaded inserts of noncorrosive, chemical-resistant, non-conductive, thermoplastic material sized to a minimum one-half inch (1/2”) (13 mm) interior dimension (ID) by two and three-quarter inches (2-3/4”) (70 mm) deep, flared to a minimum of one and one-half inches (1-1/4”) (31 mm) at the base. Ultimate pullout strength must be a minimum twelve-thousand pounds (12,000 lbs.) (53 kN).

I. Ground rod PVC sleeves must be three-inch (3”) (76 mm) located in maintenance hole floors two- inches (2”) (50 mm) from the wall adjacent to, but not underneath, the duct entering the structure.

J. Expansion anchors for installation after concrete is cast must be zinc-plated, carbon-steel wedge type with stainless-steel expander clip, a one-half inch (1/2”) (13 mm) bolt, five-thousand-three hundred pound (5,300 lb.) (24 kN) rated pullout strength, and minimum six-thousand-eight hundred pound (6,800 lb.) (30-kN) rated shear strength.

K. Cable rack assembly must be nonmetallic having components fabricated from nonconductive, fiberglass-reinforced polymers:
    1. Stanchions must be nominally thirty-six inches (36”) (900 mm) high by four-inches (4”) (102 mm) wide, with a minimum of nine (9) holes for arm attachment.
    2. The arms must be arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. The arms must be available in lengths ranging from three-inches (3”) (76 mm) with four-hundred-fifty pound (450 lb.) (204-kg) minimum capacity to twenty-inches (20”) (508 mm) with two-hundred-fifty pound (250 lb.) (114 kg) minimum capacity. Top of the arms must be nominally four inches (4”) (102 mm) wide, and the arm to have slots along the full length for cable ties.

L. Duct-sealing compound must be non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as thirty-five degrees Fahrenheit (35°F) (2°C). Capable of withstanding temperature of three-hundred degrees Fahrenheit (300°F) (150° 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 must be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin or hot-dip galvanized steel.
    2. Portable maintenance hole ladders must 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 thirty-six inches (36”) (900 mm). One required.

N. Cover Hooks per Project Specifications:
    1. Heavy duty is designed for lifts greater than sixty pounds (60 lbs.) (270 N).
    2. Light duty is designed for lifts less than sixty pounds (60 lbs.) (270 N).

2.11 Vault Lids/Covers

A. The two (2) most frequent UNLV hinged vault lids/covers requirements per ANSI/TIA 758-D and AASHTO-M-306 are:
    1. Single lid/cover having a pedestal load rating for both off-street locations including walkways and campus open ‘sheath’ spaces.
    2. Double-lid/cover for vehicle traffic areas having a H-20 rating (two (2)-axle 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 thirty-two thousand pounds (32,000 lbs.) (14,515 kg) or sixteen-thousand pounds (16,000 lbs.) (7,257 kg) per wheel load plus a thirty-three percent (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 ninety-degree (90°) arm, and compression springs must be made of stainless steel.
F. All hardware must be able to be removed and replaced in the field.
G. The vault/lid assembly must 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 must 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 must be secured onto the TDU with Kellum Grips™ mounted on the outside. This must 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 A. Must Include:
    1. Microduct type (quantity): One, two, three, four, seven, twelve, nineteen, and twenty-four way (1, 2, 3, 4, 7, 12, 19 and 24-way) (5 mm-27mm outside diameter)
       Note: Nineteen (19)-way most frequently used on UNLV campus.
    2. Configurations limited to 8.5/6 mm.
    3. Capable of handling a minimum four hundred thirty-two (432) fibers.
    4. Coextruded sheath with smooth or ribbed inner lining to reduce friction on cable installs.
    5. Outer sheath must 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: zero (0) degrees C to plus forty (+40) degrees C.
    8. Maximum pulling tension: Per manufacturer's recommendations.
    9. Bending radius: twenty (20)x outside diameter (OD) during installation, ten (10)x outside diameter (OD) after installation.
    10. Footage/meter markings.
F. Indoor applications are suitable for installation in any type of cable tray and metallic conduit housing, including conventional, split corrugated, and mesh fabric innerducts. These applications must not be supported by J-hooks**.**
G. Outdoor Applications:
    1. must 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/NDE; direct burial/directional boring applications for specialty projects (e.g., Wi-Fi, security, and emergency telephone).
H. Offer a complete line of accessories including couplers, plow chutes, end caps, and pull tape.
I. Specialty 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 handholds, vaults, and maintenance environments; inclusive of tripods, sniffers, blowers, and cattle guards where applicable;
B. The General Contractor and their Subcontractors must fill out a "Confined Space" entry notification form when any technician enters into a handhold, vault or maintenance hole that is

three feet (3') or deeper. The form must be acquired from the UNLV/RMS department. The link is: Risk Management & Safety UNLV page

C. General Contractor and their Subcontractors must 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 forty-eight (48) hours or in accordance with statutes regulating utilities prior to any excavation on campus. An USA call number receipt (ticket) must be present and onsite 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 design team, 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 design team, and UNLV/NDE.
F. Grub vegetation must 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 must require 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 the 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 topsoiling, 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). All must comply with current version of NEMA RN 1 standard.
B. Must 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 fifty feet (50) (15.2 meters) demarcation 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 ten feet (10) (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 be also used to extend the outside plant non-fire rated optical fiber cabling/microduct system beyond the fifty feet (50) (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 must be threaded. If applicable, both ends must have a plastic threaded protective collar installed on both ends to prevent chafing of the cable during the installation process.
G. Emergency splices must be sealed.
H. RMC conduit must be secured to the building infrastructure using properly sized clamps specifically designed for RMC, or by utilizing Unistrut and mounting brackets. Both methods must involve the use of appropriately sized and designed inserts that are compatible with the building's exterior 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/conduit 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 must be maintained at all times.

D. Any size HDPE underground piping/conduit must be kept at a minimum ten feet (10’-0”) (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 must not be subject to environmental temperatures above one-hundred-four degrees Fahrenheit (104°F) (40°C).
    1. 1. Where environmental temperatures are calculated to rise above one-hundred-four degrees Fahrenheit (104°F) (40°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. 2. When crossing is necessary within the ten feet (10’-0”) (3 meter) distance limitation, transition to galvanized rigid conduit (GRC) for at least ten feet (10’-0”) (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. The General Contractor and their Subcontractors must 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 in the Contract Documents. Designed for four-inch (4”) HDPE piping/conduit and must be used in the trenches for support and separation of the conduits.
G. Ground Water:
    1. Assume ground-water level or ‘freeze line’ is thirty-six inches (36”) (914 mm) below ground surface unless a higher water table is noted in the Contract Documents.
    2. The minimum depth of a trench must be thirty-six inches (36”) (914.4 mm) continuously from the top of the conduit system to final grade.
H. Four-inch (4”) (102 mm) HDPE piping/conduit continuous pathways, bends and sweeps must be encased in concrete when the following conditions exist. This must prevent movement and thus the possibility of “burn-through” by the pull rope during cable installations. Conduits must 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 five-degree (5°) angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of four-feet (4’-0”) (1.2 meters) both horizontally and vertically, at other locations unless otherwise indicated.
J. Not to exceed two (2) ninety-degree (90°) bends (one-hundred-eighty degrees (180°) total) between pull points, including offsets and kicks. Back-to-back ninety-degree (90°) bends must be avoided. Bends must be manufactured having a radius not less than six (6) times the internal

diameter of conduits two-inches (2”) or smaller or ten (10) times the internal diameter of conduits larger than two-inches (2”) (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 ten feet (10’-0”) (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 must extend four-inches (4”) (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 four-inch (4”) “Smart LBs” entering/exiting a building above surface grade.
   2. Extend a minimum four-inches (4”) (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-inches (4”) (102 mm) below the finished ceiling and seven inches (7”) (178 mm) above ladder racking.

P. Provide temporary closure at terminations of conduit/duct entering the entrance facility (EF).
   1. Unused entrance conduits must be capped/plugged with expandable type duct plugs,
   2. JackMoon or Shaw Plugs or equal inside the building. This must prevent rodents, water or gases from entering the building.
   3. 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. Four-inch (4”) HDPE conduits must 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 one-eighth inch (1/8”) (3.2 mm) 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, prior to installing cable, must be free of debris, clean, dry, unobstructed, labeled with destination (both ends) and if applicable, firestopped. For four-inch (4”) (102 mm) HDPE piping/conduit, this must require a flexible mandrel and a stiff brush or equivalent. Mandrels must be minimum nine-inches (9”) (229 mm) in length and sized to within one-quarter inch (1⁄4”) of the inside diameter of the conduit.

S. Empty conduits, or having innerduct or cable installed, must be provided with mule tape having a minimum of one-thousand-two hundred pound (1200#) (544 kg) pulling tension.

T. There are two (2) options for the purpose of locating and tracing underground pathways to minimize any chance of an accidental dig-up:
    1. Warning tape containing metallic tracings must be placed a minimum of eighteen inches (18") directly above the underground conduit structure cable. Both ends of the metallic warning tape must be accessible after installation.
    2. Use of electronic marker system (EMS) programmable ball markers is permitted. Balls must 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 to four inches (3"-4") (76 to 102 mm) from the conduit centerline and spaced at a maximum six feet (6'-0") (1.8 meters) for clear identification. Ensure they are buried within the threshold of the generated signal. Check with UNLV/NDE project specifications to verify color choice and facility information that must be programmed.

U. Use minimum one-to-two-inch outside diameter (1"-2" OD) HDPE piping/conduit permissible for special projects authorized by UNLV/NDE (e.g., Wi-Fi APs between bollards):
    1. Still subject to a minimum thirty-six inches (36") (914.4 mm) 'Freeze Line' burial depth.
    2. Outdoor rated copper UTP subject to the same indoor limitations having a maximum one-hundred feet (100'-0") (33 meters) between pull points and no more than two (2) each ninety-degree (90°) bends or a combination of bends not to exceed one-hundred-eighty degrees (180°).
    3. Applications for one-to-two-inch (1"-2") 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-inches (6") (152 mm) in nominal diameter.
B. Width: Excavate trench twelve-inches (12") (305 mm) wider than duct or duct bank on each side.
C. Width: Excavate trench three-inches (3") (76 mm) wider than duct or duct bank on each side.
D. Depth: Install top of duct and duct bank at least twenty-four inches (24") (610 mm) below finished grade in areas not subject to deliberate traffic, and at least thirty inches (30") (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 proper duct size, duct spacing, and outdoor temperature.

F. Minimum space between conduit/duct: Three-inches (3”) (72 mm) between the edge of duct and exterior envelope wall, two-inches (2”) (51 mm) between ducts for services, and four-inches (4”) (102 mm) between power and communications ducts.

G. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four (4) spacers each per twenty-feet (20’-0”) (6 meters) of duct. Place spacers within twenty-four inches (24”) (610 mm) of duct ends. Stagger spacers are approximately six-inches (6”) (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.

H. Use manufactured duct elbows for stub-ups at 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-inches (3”) (76 mm) of concrete.
2. Stub-Ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of five-feet (5’-0”) (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-feet (5’-0”) (1.5 meter) from the edge of the wall. Install insulated grounding bushings on terminations at equipment.
4. Stub-ups must be a minimum three-inches (3”) (76 mm) above finished floor (AFF) and a minimum three-inches (3”) (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 the 1. mandrels and 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. Lubricate if necessary.
5. Properly prepare the pulling end per industry best practices. Ensure at least two-feet (2’-0”) 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 innerduct 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 four-inch (4") HDPE piping/conduit use four-inch (4") (102 mm) three (3)-cell. Maximum of two (2).
    2. Install per manufacturer instructions which includes a bullet swivel/pulling eye.
    3. Use silicone-based or hydra-based lubricate if necessary. The use of Yellow 77 lubricant is strictly prohibited, as it voids the manufacturer warranty/installation standards.

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 1. 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/manholes (MH), concrete and polymer concrete handholes (HH), and pull boxes (PB): Provide end bells spaced approximately six-inches (6”) (152 mm) on center for four-inch (4”) (102 mm) duct and proportionally for other duct sizes.
      a. Begin change from regular spacing to end-bell spacing ten-feet (10’-0”) (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 three-quarter inch (3/4”) (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-inches (6”) (152 mm) on center. For four-inch (4”) (102 mm) duct and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to terminator spacing ten-feet (10’-0”) (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 three-quarter inch (3/4”) (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-inches (3”) (76 mm) of concrete cover between edge of duct to exterior envelope wall, two-inches (2”) (51 mm) between ducts, and four-inches (4”) (102 mm) between power and communications duct. The bed must be sand a minimum depth of three- inches (3”) depth compacted to ninety-percent (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 three-quarter-inch (3/4”) (19-mm) reinforcing-rod dowels extending a minimum of eighteen inches (18”) (457 mm) into concrete on both sides of the joint near the corners of the envelope.
4. Comply with requirements 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 eighteen-inches (18”) (300 mm) above all concrete-encased duct and duct bank and approximately twelve-inches (12”) (300 mm) below grade. Align tape parallel/offset to and within three to four inches (3”-4”) (76-102 mm) of the centerline of the duct bank. Provide an additional warning tape for each twelve-inch (12”) (300-mm) increment of duct bank width over a nominal eighteen-inches (18”) (450 mm). Space additional tapes twelve-inches (12”) (300 mm) apart, horizontally.

H. Use of electronic marker system (EMS) programmable ball markers is permitted. Balls must 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 to four inches (3”-4”) (76 to 102 mm) from the conduit centerline and spaced at a maximum six-feet (6’-0”). (1.8 meters) for clear identification. Ensure they are buried within the threshold of the generated signal. Check with UNLV/NDE project specifications to verify color choice and facility information that must 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 one and a half to two inches (1-1/2”-2”) (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 C891 unless otherwise indicated.
    2. Install units' level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
    3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from one-inch (1") (25-mm) sieve to a No. four (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 fifteen-inches (15") (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-inch (1") (25 mm) above finished grade.
    3. Install handholes with bottom below three-feet (3'-0") (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-inch (1") (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. Install drains in the 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 openings in the maintenance hole (MH) roof must 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. Damp proofing:

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 (3) days.
2. Damp-proofing materials and installation are specified in Section 07 11 13 "Bituminous Damp-proofing."
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 (3) 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 three and seven-eighths inches (3-7/8”) (97 mm) into the walls for maintenance holes/manholes (MH). Use a minimum of two (2) anchors for each cable stanchion.

L. Vault (V) access:
   1. Vault opening must be two(2)-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 one-half inch (1/2”) (12 mm) sieve to No. four (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-inch (1”) (25 mm) above finished grade.

D. Install handholes (HH)/pull boxes (PB) with bottom below three feet (3’) (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 must 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 being cut. Size holes for terminating fittings must 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: Three-thousand (3000) psi (20 kPa), twenty-eight (28) day strength, complying with Section 03 30 00 "Cast-in-Place Concrete," with a troweled finish.
3. Dimensions: Ten inches (10”) wide by twelve inches (12”) 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) must have two (2) A. one-eighth inch (1/8”) (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 all capital letters.
    2. 2 x 6-inch (52 X 152 mm) label marked with the vault number assigned by UNLV/P&C in all capital letters. “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 General Contractor and their Subcontractors have accepted the existing conditions. This includes access to and inspection of the maintenance holes/manholes (MH), vaults (V) and handholes (HH)/pull boxes (PB).
B. General Contractor and their Subcontractors must furnish all required tools to facilitate Blown/Jetted Fiber “Microduct” installation without damage to the existing or newly installed microduct.
C. The ABF equipment must include, but not be limited to, sheaves, winches, cable reels, cable reel jackets, duct entrance funnels, compressed air, pulling tension gauges, and similar devices.
D. All equipment must be of high-quality construction to allow a steady progress once pulling has begun.
E. Prior to blowing/jetting the microduct, the awarded General Contractor and their Subcontractors are responsible for ensuring the conduits/ducts are clean, free of dirt and debris, foreign materials and animals of any kind. This must require the use of properly sized mandrels and a vacuum cleaner or a similar product 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 must be secured onto the TDU with Kellum Grips™ mounted on the outside. This prevents any shrinkage of the sheath from pulling out of the TDU and exposing the microducts.
G. For existing and newly installed microduct, the assigned General Contractor and their Subcontractors must verify that the tubes are sealed prior to pulling microduct fibers by performing a pressure check first.
H. Makeshift devices that pose a hazard to the Microduct or personnel must not be used.
I. Pulling microduct with a motorized vehicle is not acceptable.
J. Microduct blowing/jetting or removal must be done in accordance with the manufacturer’s installation guidelines. Manufacturer’s instructions and data sheets must be part of the General Contractor and their Subcontractors’s submittals.

K. Recommended pulling tensions and minimum bending radii must not be exceeded. Any microduct bent or kinked to a radius less than recommended must not be installed, and must be replaced at no extra cost to UNLV.

L. During the blowing/jetting operation, an adequate number of workers must be made available to provide observation points of each pathway conduit/duct entry and exit. If daisy chaining a pull between pull points, make a figure eight (8) of the excess microduct tubes and fiber before feeding back into the next succession of microduct tubes.

M. Cable pulling lubricants must be used when needed so as not to exceed recommended pulling tensions as set by the manufacturer. Lubricants must be of silicon-based or hydra-based type that is non-injurious to the microduct. The use of Yellow 77 lubricant is strictly prohibited, as it hardens with age and voids the manufacturers' warranty/installation standards.

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 twenty-four (24) hours between the installation of the microduct and the installation of fiber units per manufacturer's guidelines.

Q. During installation, microduct tube ends must 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 and proof tests per the manufacturer's recommended procedures. Indoor microduct specifications are as follows:
        a. Fifteen (15) bars (217 PSI) at thirty-five (35) CFM are the ideal and maximum pressure that can be used, while ten (10) bars (145 PSI) at one-hundred-eighty (180) CFM of pressure is the minimum.

R. The following test sequences must be followed per manufacturer's specifications after installation of ABF Microduct:

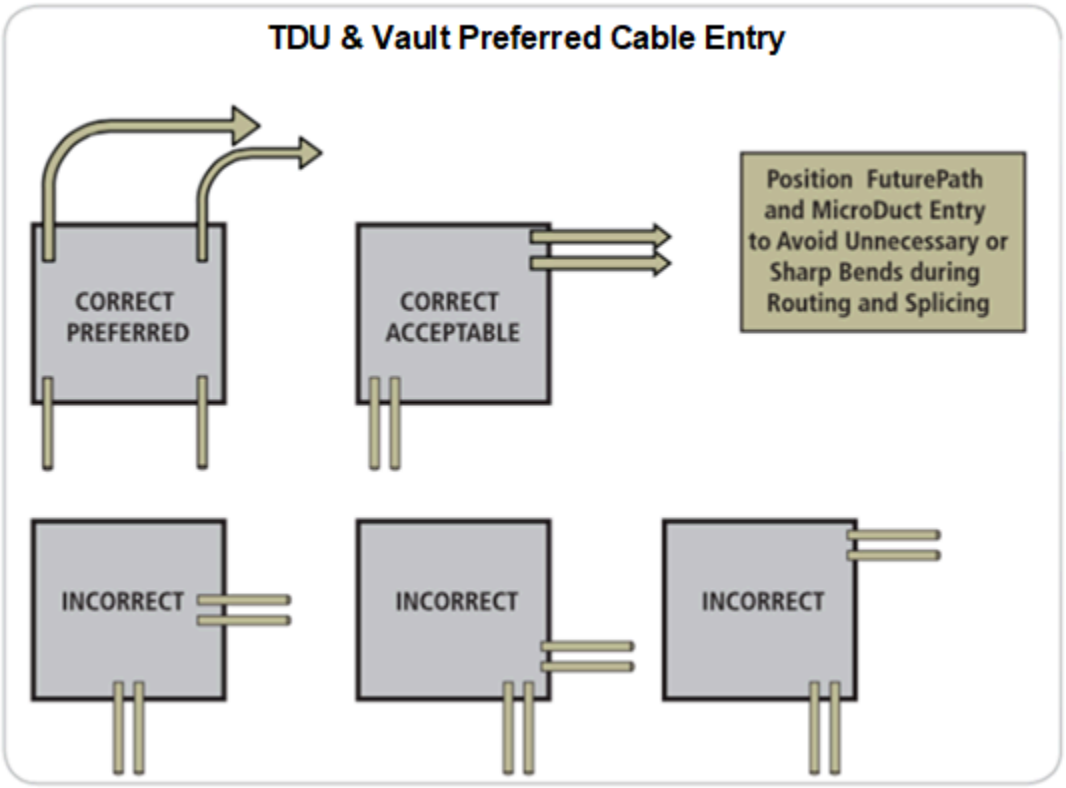
    1. Air Flow Testing
    2. Pressure Testing
    3. Continuity Testing
    4. (Subsequently, the installed fiber to undergo either or both Level I (OLTS) and possibly Level II (OTDR) with Level I test results.

S. The General Contractor and their Subcontractors must 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 must be professionally dressed and that each tube is properly coupled.

V. Any open tubes in a TDU must be secured with micro end caps, not plugs, whether the General Contractor and their Subcontractors 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 must 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 pathway installations must be repaired, topsoil replaced and groomed to the original condition to match the immediate surroundings.
F. UNLV/NDE, UNLV/FM, and UNLV/P&C must jointly perform a visual inspection and complete a walk-through with the General Contractor and their Subcontractors and the design team. Any discrepancies must be addressed on a 'punch list' to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty (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 must notify the UNLV/NDE PM and UNLV/FM PM. This is a requirement to complete the UNLV/NDE closeout documentation.

3.14 Cleaning

A. All installed maintenance holes (MH)/ vaults (V), handholes (HH)/pull boxes (PB) must 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 General Contractor and their Subcontractors are still responsible for the “sweep clean” of the existing vault to remove and empty trash on a daily basis around the associated work areas.

3.14 Closeout Submittals

A. Testing and inspection of precast concrete utility structures must be under the jurisdiction of A. UNLV Facilities Management (FM) and/or P&C based upon but not limited to ISO 9000/9001, ASTM C1037 and SCTE 77 standards.
B. Within thirty (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 twenty-five (25) years covering all components, materials, and equipment plus the General Contractor and their Subcontractors’ one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.
C. If requested by UNLV FM and/or P&C 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 27 05 44

Firestopping Systems for Communications; Sleeves and Sleeve Seals

for Communications Pathways and Cabling

PART 1: GENERAL

1.1 Summary

A. This Section applies to firestopping systems for communications, including sleeves and sleeve seals for communications pathways and cabling. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) for firestopping systems used in new or retrofit construction.

B. The General Contractor and their Subcontractors must provide all labor, materials, and equipment required for complete installation of firestopping systems for communications, including sleeves and sleeve seals, within the Contract Scope of Work (SoW) for the UNLV/NDE ICT Structured Cabling System (SCS).

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

D. UNLV/NDE provides guidelines and participates in joint inspections for low-voltage telecommunications firestopping. UNLV/NDE and UNLV/P&C must join UNLV/FMS during rough-in and final acceptance inspections.

E. The work of these two (2) Sections includes, but is not limited to, firestop systems (including sleeves and seals) and their installation 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 UL-listed, fire-rated materials into penetrations in fire-rated barriers to reestablish the barrier's fire-resistance rating.

H. A 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 surface of only one side of a barrier (e.g., a work area telecommunications outlet on a fire-rated wall).
   2. A **through penetration** pierces or interrupts both sides of a barrier (e.g., a fire-rated floor/ceiling or wall penetrated by cable tray, ladder racking, cables, sleeves, or conduit).

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

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

K. The authority having jurisdiction (AHJ) enforces Federal and State building codes and firestopping requirements intended to ensure occupant safety.
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 grommets.
M. Use products from a single manufacturer. Do not mix firestop materials within each building defined in the Contract SoW.
N. Products must be UL Listed, manufactured by an ISO 9000/9001-certified manufacturer, and RoHS 2011/65/EU compliant.
O. Transmission performance parameters must 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 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 Systems for Communications*
    6. Section 27 05 44; Sleeves and Sleeve Seals for Communications Pathways and Cabling
C. Materials and work must comply with 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 and 27 05 44) is similar to, but does not replace, 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. ANSI/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 Penetration Firestop Systems
    8. ASTM C920; Standard Specification of Elastomeric Joint Sealants Jul 2026 UNLV Division 27 Campus Wiring Design Guide V.1.4 Page 80 of 241 SECTION 27 05 00 - Sections 27 05

41 and 44 - Firestopping Systems for Communications, Sleeves and Sleeve Seals for Communications Pathways and Cabling.

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 Polyvinyl chloride (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. NECA 1; Standard for Good Workmanship in Electrical Construction (ANSI)
14. SSBCCI; Southern Building Code Congress International
15. UBC; Uniform Building Code
16. UL 263; Fire Tests of Building Construction Materials
17. UL 723; Surface Burning Characteristics of Building Materials
18. UL 1479; Fire Tests of Through Penetration Firestops
19. UL 2079; Standard for Fire Tests of Joint Systems

G. This Section applies only to penetrations in fire-rated walls and floors. Penetrations in non-fire-rated walls and floors are not applicable (N/A).
H. Cable fill calculations must be included to show the maximum cable fill ratio for each firestopping system and cable type.

1.3 Pre-bid Submittals

A. Provide manufacturer standard catalog technical data sheets for each UL-specified product demonstrating compliance with referenced standards. Include anticipated quantities and intended locations of use.
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. Provide proof of manufacturer training/qualification, including certifications for both the company and installers.
E. Submit a schedule identifying firestopping locations, penetrating items, and required UL-listed system/part numbers to maintain fire-resistance ratings.
F. Provide manufacturer warranty documentation.

1.4 Quality Assurance and Warranty

A. Firestop products must bear the classification marking of the qualified testing and inspection agency (e.g., UNLV/NDE recognizes Underwriters Laboratory or “UL”).
B. Firestopping systems must conform to UL Flame (F) and Temperature (T) ratings and, where required, Leakage (L) ratings, as applicable to local building codes. Systems must be tested by an NRTL in accordance with ASTM E814 or UL 1479 in configurations 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 or time to UNLV.
F. Avoid breakage, denting, and scoring of finishes. Do not install damaged products.
G. Install only firestop products bearing the UL classification marking of qualified testing and inspection agencies that must be used.
H. Firestop materials must be installed prior to expiration of shelf life.
I. Products must be furnished with manufacturer's instructions and mounting hardware.
J. Products must be UL Listed and be manufactured by an ISO 9000/9001 approved manufacturer and be RoHS 2011/65/EU compliant.
K. Provide adhesive firestop identification labels/placards and attach at least one label on one side of each through penetration.

1.5 The General Contractor and their Subcontractors Qualifications

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered ss Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must 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 must determine the specific type of firestop material or assembly that must be used:
    1. Substrate type (ceiling, wall, floor, or combination)
    2. Penetrating item (cable tray, conduit, pipe, innerduct, or any other pathway)
    3. Barrier material (acoustic, brick, concrete, framed wall, or wood)
    4. Environment (wet, dry, cold, hot, hazardous, dusty)
    5. Barrier fire rating (typically 2-hour)
    6. Required manufacturer part number and UL system details must be included with 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 ventilation.
E. Do not use materials containing 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 must 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: Coordinate with UNLV/P&C and Security, as required, to disable fire alarm/smoke detectors during drilling, grinding, or cutting.

PART 2: PRODUCT

2.1 General

A. Fire-rated cable pathways devices must 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 (PCBs).
D. Most common sealants are non-halogenated that limit heat by forming a char effect.
E. The manufacturer's firestop system must 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. Systems must be maintenance-free once installed, except when modifications are required for cabling moves, adds, and changes (MACs).
J. On insulated pipe, fire-rating classification does not require removal of insulation.
K. Materials must 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 (telecommunications) cable(s) penetration through any fire-rated wall or floor alone is not permitted and must be placed in an approved firestop pathway.
M. Ensure technicians have access to Safety Data Sheets (SDS) (formerly MSDS).
N. Sealants must 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 Systems that are needed to install fill materials and to maintain ratings required.
B. Use only those components specified by penetration firestop manufacturer. This must include permanent and temporary forming/damming/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. Refer to “E. Firestop 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. Must 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, use either endothermic (absorbs) or intumescent (expands) sealant.

2. Non-hardening, dielectric, water resistant; containing no solvents or 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 cable re-entry.
6. Available in bulk, bars or sticks.
7. Provides a consistent smoke seal.
8. May be used with backing material such as mineral wool.

F. Caulk:
    1. Depending on the application, use either endothermic (absorbs), intumescent (expands), or ablative (resists erosion by fire and flame) sealant.
    2. Dispensed from tubes or pails.
    3. Use solid grade on walls/ceilings and self-leveling grade on floors).
    4. Intended for permanent installation Not typically intended for cable re-entry.
    5. Some solvent-based caulks may be off-gas until cured. Provide ventilation and warning placards as required.
    6. Commonly used to seal the exterior of conduit and pipe.
    7. May be used with backing material such as mineral wool.
    8. Provide flexibility where movement is expected (e.g., expansion joints), per the UL system.
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 fire 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 must 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, foams must be either endothermic (absorbs) or intumescent (expands), and ablative (resist erosion by fire and flame).
    3. Dispensed from a two (2)-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 0-100%) 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 must never 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 must 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. Follow the manufacturer's installation instructions. Do not deviate from published UL system details.
C. Both sides of the wall must be firestopped.
D. More is not always better.
E. In retrofit and new projects, the Contract 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 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. Use prime substrates only where it is recommended by the manufacturer, using their suggested products and methods. Confine primers to areas of bonding and prevent spillage or 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 Safety Data Sheets (SDS).
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 must be in full contact with and adhere to substrate openings and penetrating items. Material must not be peeling, loosely adhered, or insufficient in quantity.
    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 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 and their Subcontractors (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 must 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) the main distribution frame (MDF) and/or the telecommunications room (ER) the 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 telecommunications 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. The General Contractor and their Subcontractors names, addresses, and phone numbers 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. Installer's 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 General Contractor and their Subcontractors must be responsible for repair to its original condition without any extra cost to UNLV.
C. After inspection, remove all equipment and ladders.
D. General Contractor and their Subcontractors must practice good “sweep clean” housekeeping and remove and empty trash on a daily basis from both the telecommunications 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 must be performed jointly between UNLV/FLS, UNLV/NDE, and UNLV/P&C with the General Contractor and their Subcontractors, and the design team. Any discrepancies must be addressed on a ‘punch list’ to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (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 third-party General Contractor and their Subcontractors must inspect and certify that firestopping and fire caulking has been installed in an approved method.
B. All firestopping locations may not be indicated in the Contract Documents. The drawings must have indicated the fire rating of the wall, floor or ceiling, which would include any penetrations. Fire and smoke dampers are indicated in the Contract Documents,
C. Unless otherwise requested by UNLV/FLS, the only photos required for submittals must be the location for each fire and smoke damper.
D. Manufacturer’s minimum warranty is three (3) months to one (1) year depending on the manufacturer. For extended warranty requests, the General Contractor and their Subcontractors must contact the manufacturer’s regional firestopping specialist/manager for written documentation.
E. The General Contractor and their Subcontractors must supply one (1) 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 Systems for Communications, Sleeves and Sleeve Seals for Communications 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 Part 1 (General), Part 2 (Products), and Part 3 (Execution) for the identification or labeling of communications systems in new or retrofit construction.

B. The General Contractor and their Subcontractors must 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 provided in this document. None of these take precedence over the labeling manufacturer's instructions.

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

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

F. Installer must provide a complete and accurate set of 'As-Built' drawings. The As-Built drawings must record the identifiers for major infrastructure components including the intrabuilding and interbuilding pathways, spaces, work area (WA) telecommunications outlets (TO) and disseminate the application, IP data and voice. Wi-Fi, cameras, and alarms. These notations must 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 must be installed in a neat and workman-like manner. All methods of labeling that are not specifically described or indicated in the Contract Documents must be subject to the control and approval of UNLV/NDE.

I. UNLV/P&C must provide and be responsible for mounting Telecommunications Rooms or other telecommunications 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* include 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; *Intrabuilding Optical Fiber Backbone Cabling*
    9. Section 27 13 23.02; *Interbuilding 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 must 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 must 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-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 The General Contractor and their Subcontractors Qualifications and Responsibilities

A. The assigned Project Manager for the low-voltage General Contractor and Subcontractors must have at a minimum a BICSI Registered Communications Distribution Designer (RCDD) certification and the onsite 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's preference is for the General Contractor and their Subcontractors must assign the same one (1) or two (2) technicians to perform all the labeling throughout the project.
C. General Contractor and their Subcontractors must refer and have full understanding of the Contract 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 and their Subcontractors (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 must 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, must comply with the current version of UL 969A.
B. Labels must be resistant to the environmental conditions at the point of installation for moisture, heat, wind, dust, and ultraviolet light.
C. Products must be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*
D. Products must 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 must 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. must be UV, weather, and chemical-resistant sized so that the clear shield tail end overlaps the entire printed legend for protection.
    3. Nominal Sizes: Three-eighth inch (3/8") (10 mm) and one-half inch (1/2") (12-14 mm).
B. Self-Adhesive Labels:
    1. Vinyl flexible labels with acrylic pressure-sensitive adhesive.
    2. Must 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: Three-eighth inch (3/8") (10 mm), one-half inch (1/2") (12-14 mm), and three-quarter inch (3/4") (19 mm).

2.4 Snap-Around Bands

A. Slit, pretensioned, flexible, acrylic sleeves, minimum two-inch (2") (51 mm) long, with diameters sized to suit the raceway or cable they identify, including 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 must 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 must be permanent and not be subject to damage by burial operations.
C. Tape material and ink must 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 five (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 half-inch (1/2") (13 mm) or three-quarter inch (3/4") (19 mm) black on white self-adhesive tape "Telecommunications".

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

A. Must 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 are to ensure that the identifiers are easily read. Labels must be visible during the installation of and normal maintenance of the infrastructure.
B. Labels are generally of either the adhesive or insert type. Labels must 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 must 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 must be appropriate for the environment in which it is used and must be used in the manner intended by the manufacturer.
E. Handwritten labels or the use of masking tape for permanent applications are NOT acceptable.

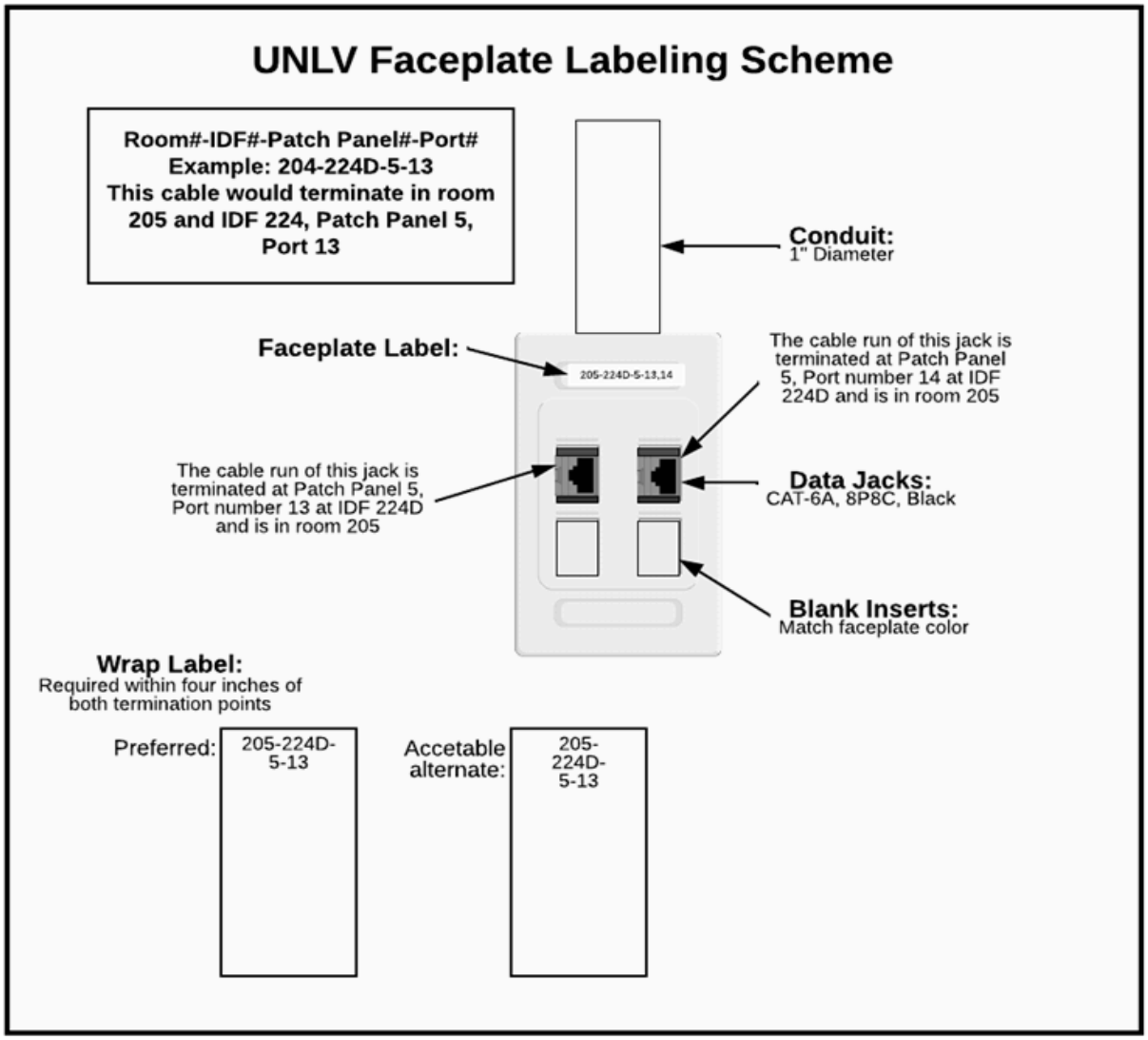
3.3 Label Installation Guidelines

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 tightly to the surface at a location having high visibility and accessibility.
    2. Provide labels within 1. four-inches (4”) (102 mm) from the cable end.
D. Self-Adhesive and Insertion Labels:
    1. Each item of the Structured Cabling System (SCS) must have its own unique designation label that is consistent with the wiring diagrams.
    2. Three-eighths inch (3/8”) (10 mm) wide insertion-style labels must 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, three-eighths inch (3/8”) (10 mm) wide self-adhesive labels are used for patch panel port identification.
    4. Any patch panel port, Telecommunications Outlet (TO) port as well as the cabling run between both terminations must have:
        a. Work Area ID # - MDF/IDF ID # - Patch Panel (PP) ID # - Port ID #
    5. One-half inch (1/2”) (12-14 mm) wide labels for designation ID on patch panels, enclosures, busbars and TDUs.
    6. Three-quarter inch (3/4”) (19 mm) wide labels for racks, cabinets, pathways, and busbars.
E. Snap-Around Bands:
    1. Secure tightly to surface at a location with high visibility and accessibility.
    2. Provide labels within six-inches (6”) (152 mm) from the cable end outside the TDU.
F. Tags:
    1. Tie-wrap labels or tags are 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 eighteen-inches (18”) (457 mm) directly above cable inside four-inch (4”) HDPE piping/conduit. At a three-foot (3’-0”) (914 mm) freeze line, this equates to being eighteen-inches (18”) (457 mm) below finished grade.
    2. Use multiple tapes where the width of multiple lines installed in a common trench or concrete envelope exceeds sixteen-inches (16”) (400 mm) in overall width .

3. For other smaller size buried raceways having copper inside (e.g., Wi-Fi bollards), “Warning Tape” is not required.

3.4 Identification Schedule

A. Install identification materials and labels at locations that allow convenient viewing without interference with operation and maintenance of equipment.
B. Each permanent link must be 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 intrabuilding premises “permanent link”. This consists of labeling within four-inches (4”) (102 mm) on both horizontal Category 6 or 6A, four (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 must clearly identify all components of the horizontal Structured Cabling System (SCS):
    1. The labeling system must designate the cable's origin and destination.
    2. Station identifiers must match the corresponding patch panel port number for each drop.
    3. The drops must be in consecutive order whenever possible.
    4. The labeling scheme must be used for test documentation and coincide port-to-port with the As-Built drawings.
E. Identify covers of junction and pull boxes with one-half-inch (1/2”) (17 mm) or three-quarter-inch (3/4”) (19 mm) self-adhesive labels containing wiring system legend; “Telecommunications”.
F. Four (4)-port wall plate/faceplate; or commonly referred to as Telecommunication Outlet (TO) ‘station labels’:
    1. Must 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 must 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 must always be the top left faceplate port and the second patch panel port number must 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 must follow the same guidelines when used. When unused, the label must be left blank. The font size must be the largest size that fits the required information but no smaller than ten (10)-point font.

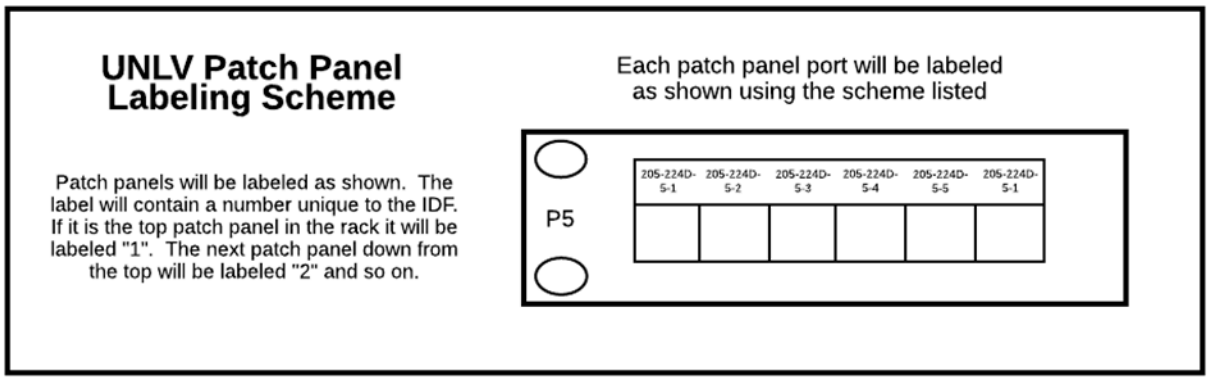


27 05 53 Fig 1: *UNLV Faceplate Labeling Scheme*

G. Equipment Room-Main Distribution Frame (ER-MDF) and Telecommunications Rooms-Intermediate Distribution Frame (TR-IDF) copper modular patch panels' identifiers must 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 must 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 must be identified with the number "P1", the second with the number "P2", "P3", "P4" and so forth.
    2. Note: Between any two (2) or more copper modular patch panels install a one (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 must be identified with the number “F1”, the second with the number “F2”, “F3”, “F4” and so forth. Optical fiber enclosures must be labeled front and rear.
5. Use one-half-inch (1/2”) (12 mm - 14mm) wide labels for both modular patch panels and optical fiber enclosures.

H. The modular patch panel port identifier labels must 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 must 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 must be the largest size that fits the required information, but no smaller than 8-point font.
3. These labels must be center-justified and located directly above the port they are labeling or in other manufacturer-
4.
5. provided locations for port labels. Do not cover the patch panel printed port numbers.



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

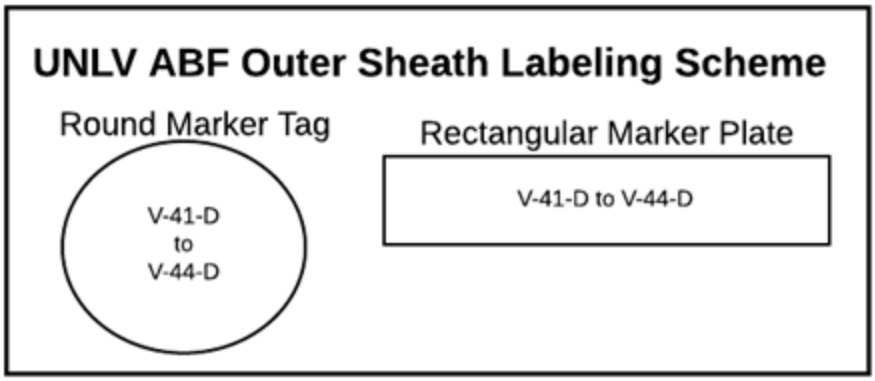
I. Cable wrap identifier labels must be secured on the rear of the modular patch panels and faceplates and are required within four-inches (4”) (102 mm) of the cable's termination point at both ends:
1. Cable wrap labels must follow the format listed in **27 05 53** Fig 1: *UNLV Faceplate Labeling Scheme*;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

J. The only conduit systems that need identifiers are:
    1. Interbuilding four-inch (4”) (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 Telecommunications Rooms-intermediate distribution frames (TR-IDF) and horizontal work area (WA) outlets. "Designate their ‘to and from’ origin”.

K. Unless noted otherwise in the Contract Documents, all other intrabuilding pathways are exempt from having identifiers.

L. Outside plant (OSP) ABF blown fiber cabling identifiers must 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 one-inch by three-inch (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, waterproof cover for use with pre-printed labels and attached with a plastic tie wrap.
    3. The marker plate must be placed approximately twelve-inches (12”) (305 mm) outside from the outer sheath (entry side) into the TDU.
    4. The marker plate label must be in the format of V-41-D to V-44-D; where V stands for vault, MH for maintenance hole, and forty-one (41) is the previous vault number whereas forty-four (44) is the next vault number.
    5. The marker plate must be placed approximately twelve-inches (12”) (305 mm) outside from the outer sheath (exit side) of the TDU and secured with tie-wraps.
    6. The marker plate label must 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 must indicate the run being routed into the building’s ER-MDF/TR-IDF room number where the ABF blown fiber must be terminated.
    8. The letter D shows which section of campus the vault is located in.

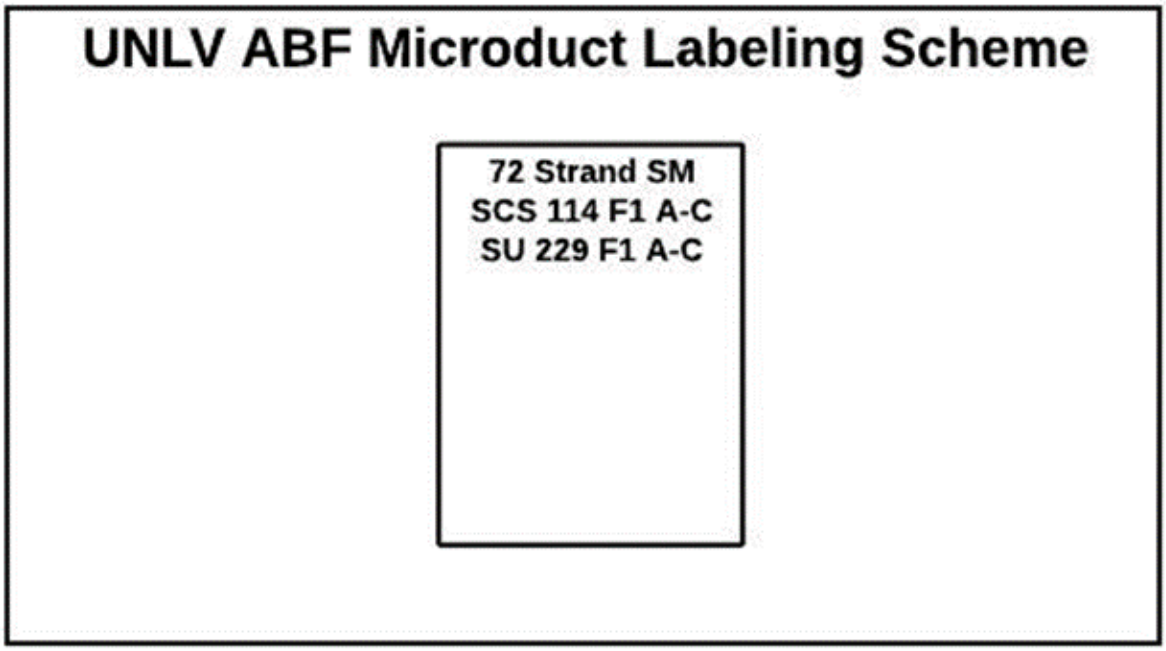


27 05 53 Fig 3: *UNLV ABF Outer Sheath Labeling Scheme*

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 one-inch by three-inch (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 must be placed approximately twelve-inches (12”) (305 mm) outside of the sheath from the entry into the TDU and secured with tie-wraps.
    4. The marker plate label must be in the format of MH-45-D; where V stands for vault, MH for maintenance hole, and forty-five (45) is the last OSP vault/maintenance hole numbered TDU.
    5. The letter D shows which section of campus the vault is located in.
    6. Note: The microducts inside must then be broken out from the sheath inside the wall-mounted TDU, labeled, exit the TDU on the opposite side, placed in orange (minimum one and one quarter- inch (1 1/4”) (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 three-quarter-inch (3/4”) (19 mm) wide label tape. Flag labels are not acceptable.
    2. Installer to label within six-inches (6”) (152 mm) the microduct(s) leaving the ABF outer sheath inside the TDU.
    3. The label must be three lines.
        a. The first line (line number one (#1)) displays the number of strands and type of fiber (UNLV/NDE specifies only OS2 single-mode)
        b. The second line (line number two (#2)) to show the origin for this microduct
        c. The third line (line number three (#3)) to show the destination for the microduct

4. The enclosure information (lines number two and three (#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 must be used for test documentation and coincide port-to-port with the As-Built drawings.

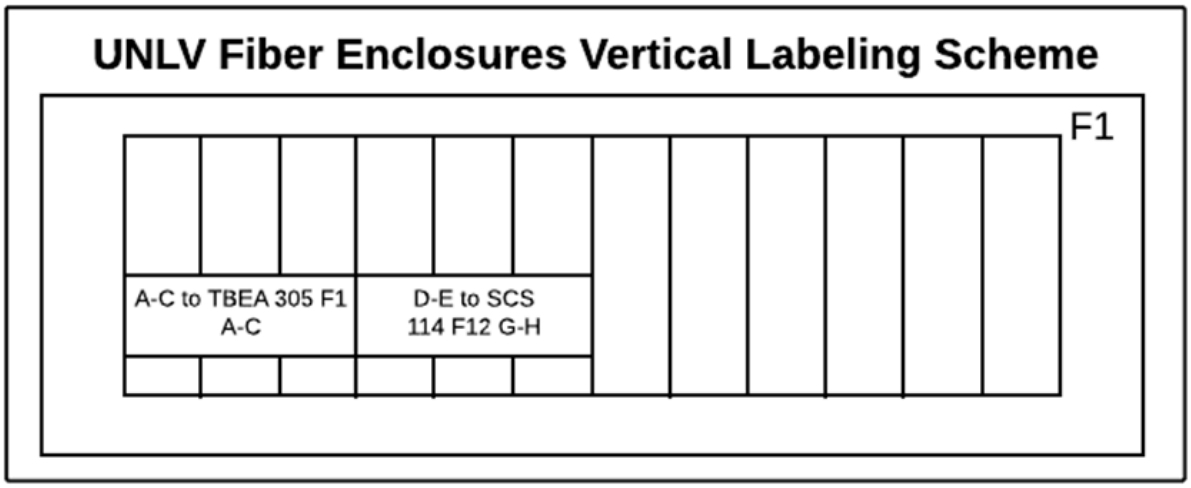


27 05 53 Fig 4: *UNLV ABF Microduct Labeling Scheme*

P. Optical fiber termination and labeling identifiers (inside the optical fiber enclosure):
   1. Optical fiber enclosures with hinged metal or smoked plexiglass front doors provide easy access for maintenance. The cassette termination summary spreadsheet must be placed in a slot, or directly affixed to the inner surface of the hinged door. .
   2. Label each blown fiber microduct with a self-adhesive wraparound ¾-inch (19 -mm) label indicating the origin location of the backbone cable:
      Row One (1): “Bldg. abbreviated name and room #”
      Row Two (2): “Fiber enclosure # and cassette letter”
      Row Three (3): “Type of optical fiber or SMF and # of strands”
   3. Fiber strand numbering must be consistent with the Consecutive Fiber Numbering (CFN) polarity sequence as identified in the latest version of ANSI/TIA 568.1-E. This fiber strand numbering sequence between each fiber link must be adhered to at each

terminated end of the optical fiber cable; straight-through 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.

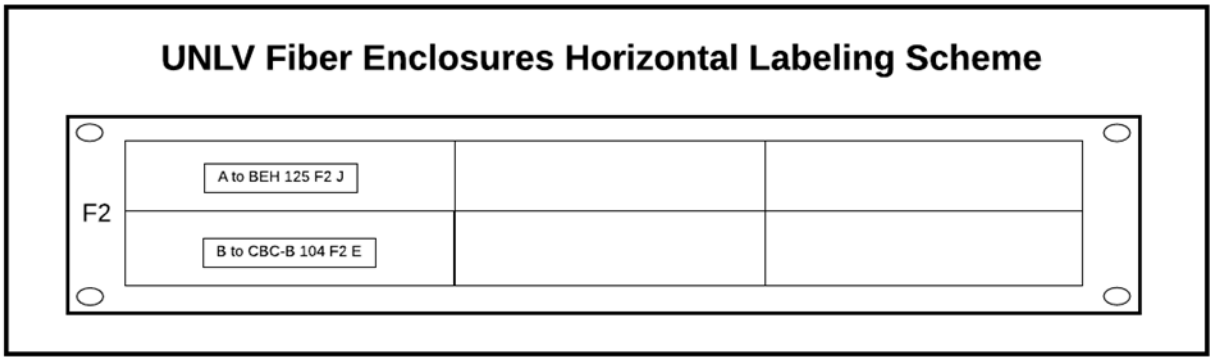
Q. Optical fiber enclosures labeling with vertically-mounted cassettes (See Section 27 05 53 Fig 5: *UNLV Fiber Enclosures Vertical Labeling System*):
   1. UNLV has standardized on optical fiber cassettes with pigtails for fusion splicing and not adapter plates.
   2. Fiber strand number one (#1) (blue) to occupy fiber port number #1; located in the upper most left position of the first duplex cassette.
   3. Fiber strand number two (#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 twelve (12) each duplex (LC) connectors.
   5. Note: From the rear, the view must be opposite, having cassette "A" on the far right and the port number one (# 1) is the top right position.
   6. Each subsequent cassette must 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 seventy-two (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 one (#1) (blue) to occupy fiber port number one (#1) located in the uppermost 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 one (1) cassette is on the far right and port one (#1) is the top right position.
4. Fiber strand number two (#2) (orange) to occupy fiber port number two (#2) of the same LC duplex cassette. This number two (#2) port is immediately below fiber port number one (#1) facing the front of the housing.
5. Notice that when comparing the vertical to the horizontally-mounted cassettes the number one (#1) and number two (#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 must be mounted the same in the top left slot, however number one (#1) (blue) port is below (not above) number two (#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 (4") (102 MM) height Telecommunications Primary Bonding Busbar (PBB) must be labeled with Equipment Room (ER)-Main Distribution Frame (MDF) room number; "PBB for ER-MDF 101" or "PBB for MDF 101"
   2. Secondary two-inch (2") (51 mm) Busbars (SBB)/Telecommunications Grounding Busbar label with Telecommunications Rooms (TR)-Intermediate Distribution Frame (MDF) room number; e.g., "SBB for TR-IDF 212" or "SBB for IDF 212"
   3. Busbar labeling must 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 that 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. General Contractor and their Subcontractors must practice "good sweep" clean housekeeping and remove and empty trash on a daily basis from both the Telecommunications Rooms and the associated work areas.

3.6 Examination and Acceptance

A. UNLV/NDE must perform a visual inspection and complete a walk-through with the General Contractor and their Subcontractors, and the design team. Any discrepancies must be addressed on a 'punch list' to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (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 must notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.7 Closeout Submittals

A. None are required, except for visual inspection to ensure that proper labels are used and that identifier content is correct.

SECTION 27 05 00: COMMON WORK RESULTS FOR COMMUNICATIONS

——— End of Section 27 05 53 ———

Identification for Communications 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 copper system performance testing and documentation. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) related to copper system testing and documentation, as-built drawings, warranty submittals, and acceptance by UNLV/NDE in new or retrofit construction.

B. The General Contractor and their Subcontractors must provide all labor, materials, equipment, and execution 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. The General Contractor and their Subcontractors must survey the work areas and provide all labor, materials, tools, field-test instruments, and equipment required for 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 General Contractor and their Subcontractors must notify UNLV/NDE of any additional tests that are deemed necessary to guarantee a fully functional system. The General Contractor and their Subcontractors must 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. General Contractor and their Subcontractors must provide complete end-to-end testing for the awarded copper Structured Cabling System (SCS) based on the latest document standards and references.

G. All test results must be submitted to NDE in chronological order, separated by the assigned Telecommunications Rooms.

H. All test results must 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 with punch list test results documentation must be corrected before final submittals.

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

K. Testers must 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 drawings documentation, and manufacturer warranties.
B. Final acceptance by UNLV/NDE is subject to completion of the installation during the final walk-through, receipt of required final test documentation, adjustments to Computer-Aided Design (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* include 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 must 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 must 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 Electrical 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 The General Contractor and their Subcontractors Qualifications and Responsibilities

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must 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's preference is for the General Contractor and their Subcontractors must assign the same two (2) or three (3) technicians to perform all the copper testing throughout the project.
D. It is preferable that the General Contractor and their Subcontractors show proof of being trained and certified by the UNLV approved tester manufacturer.
E. At least one (1) member of the testing team must be a cable/connector manufacturer and BICSI certified technician at all times.
F. General Contractor and their Subcontractors must refer and have full understanding of the Contract Documents 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 and their Subcontractors (GC) .

1.5 Copper UTP Testing Criteria: Permanent Link

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

B. The permanent link consists of one (1) of two (2) horizontal Category 6 or 6A, four (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 must be tested at 250 MHz and Cat 6A/Class EA at 500 MHz.

D. Maximum length is not to exceed two-hundred-ninety-five feet (295’-0”) (90 meters).

E. Channel testing with patch cords three-hundred-twenty-eight feet (328’-0”) (100 meters) are not applicable unless required in the specifications by the cable manufacturer.

F. Backbone/riser multi-pair testing is not applicable.

G. Other categories of cable whether UTP, STP, FTP, and ScTP including Cat 3, Cat 5, Cat 5e and Cat 7 are not 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 Wi-Fi)

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

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

K. These criteria do not apply to hybrid DC power/optical fiber cables or 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. The tester manufacturer must be UL Listed and ISO 9000/9001 registered and be RoHS 2011/65/EU compliant.

B. The copper UTP certification tester must conform to the current versions of ANSI/TIA-1152 and IEC 61935-1, Level IIIe, rated to 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. All Level IIIe balanced twisted-pair field testers must be factory calibrated each calendar year, or as stipulated by the field tester equipment manufacturer.
E. The tester and all related testing components/test reference cords (TLCs) must be in current calibration, firmware updated, and all components be of high-quality condition. Compliance must 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 must not interfere with the construction operations of other trades.
B. Main and remote devices must be synchronized and fully charged when testing begins.
C. General Contractor and their Subcontractors must 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 must be redone on completion of the work.
D. Cabling installation in Telecommunications Rooms must 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 finds that the cable run is not properly routed or supported. Any defects in cabling system installation must be repaired or replaced to ensure one hundred percent (100%) usable condition at no additional cost or time to UNLV.
F. After the submission of test result documentation and the associated As-Built drawings, UNLV must 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 General Contractor and their Subcontractors, under supervision of the representative, must repeat one hundred percent (100%) of the testing at no additional cost or time 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 must 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 must be synchronized and fully charged when testing begins.
D. Set-up must include, but not be limited to, using the current version of the ANSI/TIA 568 standards.

E. ***Test settings selected from the Options menu provided in the field testers must 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 fourteenth (14th) test includes foil/ground wire continuity end-to-end.

H. Tester setup must 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 autotest mode, one-hundred percent (100%) of the following parameters are to PASS:

1. Continuity or **"wire map"** check tests for opens, shorts, crossed and reversed pairs. Any discrepancies must be corrected before system testing can 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 measured from the 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 must 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 General Contractor and their Subcontractors'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 walk-through with the General Contractor and their Subcontractors (and architect if requested). Any discrepancies must be addressed on a 'punch list' to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (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 must notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.3 Cleaning

A. General Contractor and their Subcontractors must practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the Telecommunications Rooms and the associated work areas.
B. Once the Telecommunications Rooms are complete with terminated modular patch panels yet still be exposed to sanding, dust and debris, the General Contractor and their Subcontractors must use painters' blue tape or an approved equivalent to cover the patch panel ports at no additional cost or time to UNLV/NDE. Only UNLV/NDE is authorized to remove the tape at the start of the cutover.

3.4 Closeout Submittals and Documentation

A. Test Documentation
    1. Test results, based upon the cable/connector manufacturer part numbers and NVP, must be downloaded directly from the test unit or from a download file using an application from the test equipment manufacturer.
    2. Test results must be provided in both PDF and native tester manufacturer software format.
    3. Test files must be sorted by ER-MDF/TR-IDF and in numerical order, and test results are to match port-to-port with As-Built drawings.
    4. Test results to include the minimum application of:
        a. Cat 6/Class E 1GBase-T per IEEE 802.3ab
        b. Cat 6A/Class EA 10GBase-T per IEEE 802.3an
    5. Within thirty (30) days of Substantial Completion of the project or prior to project closeout, whichever comes first, provide manufacturer(s) system warranty(s) for minimum twenty-five (25) years covering all components, materials, and equipment plus the General Contractor and their Subcontractors' one (1)-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.
    6. Electronic format copies only are required. No hard copies are permitted.
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 must be on UNLV-provided floor plan sized to "E1" Thirty-by-forty-two-inches (30" x 42") (762 x 1067 mm).
    3. Electronic format copies only. No hard copies

4. "As-Built Data": Identify all telecommunications outlets (TOs) by cable room number. Include cable pathways of conduit greater than two inches (2") (51 mm), pull boxes/junction boxes, cable trays routes and sizes, plus the Telecommunications Rooms layouts of racks, cabinets, and TDUs orientation.
5. "As-Built Wi-Fi/Security": Identify all Wi-Fi 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 buildings 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. General Contractor and their Subcontractors must use the legend provided in the UNLV AutoCAD in .dwg format drawing for layered documentation to separate Data, Wi-Fi/Security, and Pathways. Also used as a reference for scale.
11. Any AutoCAD in .dwg format to show conduit interbuilding/intrabuilding greater than two inches (2") (51 mm) must 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 presents the requirements for post-installation optical fiber system performance testing and documentation. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) related to optical fiber system testing and documentation, As-Built drawings, warranty submittals, and acceptance by UNLV/NDE) in new or retrofit construction**.**

B. The General Contractor and their Subcontractors must provide all necessary labor, materials, and equipment required for the complete and proper installation of *Optical Fiber Cable Testing and Documentation* as outlined in the Contract Scope of Work (SoW) for the UNLV/NDE ICT Structured Cabling System (SCS).

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

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

E. Certification tests verify that the optical fiber cabling in the ICT Structured Cabling System (SCS) meets the transmission performance requirements of the cable/connector 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 must be performed at dual wavelengths (1310 nm and 1550 nm) and in both directions (bidirectional).

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. OTDR testing for Fiber Optic runs less than five hundred feet (500) are not needed, unless required by the manufacturer for warranty purposes.

J. General Contractor and their Subcontractors must provide complete end-to-end testing for the awarded optical fiber Structured Cabling System (SCS) based on the latest related document standards and references.

K. The first phase of testing documentation must list all tests in numerical order:
    1. Interbuilding test results must be separated by the building’s name
    2. Intrabuilding test results must be separated by the Telecommunications Rooms.

L. All test results must be in both PDF and native tester manufacturer software format and sent electronically. Test results must coincide port-to-port later with As-Builts drawings.
M. Any punch list items related to test documentation must be corrected before final submittals.
N. The second phase of the final testing submittal package must include final test documentation, As-Built drawings (in AutoCAD .dwg format), and cable/connector twenty-five (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 drawings documentation, and manufacturer warranty.
B. Final acceptance by UNLV/NDE is subject to completion of the installation during the final walk-through and receipt of final test documentation, updated AutoCAD drawings (.dwg), 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* include the following:
    1. Section 27 01 00; *Operation and Maintenance of Low-Voltage Communications Systems*
    2. Section 27 11 16; *Communications 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; *Intrabuilding Optical Fiber Backbone Cabling*
    5. Section 27 13 23.02; *Interbuilding 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 must 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 must 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 Electrical 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 The General Contractor and their Subcontractors Qualifications and Responsibilities

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must be full-time from the initial walk-through, during the entire project installation, 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's preference is for the General Contractor and their Subcontractors must 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 General Contractor and their Subcontractors show proof of being trained and certified by the UNLV approved tester manufacturer.
E. At least one (1) member of the testing team must be optical fiber cable manufacturer-certified and BICSI certified at all times.
F. General Contractor and their Subcontractors must refer and have full understanding of the Contract Documents 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. Do not make direct visual contact with any port being tested, in accordance with 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 (mandatory for submittals)
    3. Preventive maintenance testing (warranty protocol if required)
    4. Troubleshooting (as needed)
C. Optical fiber cable must be all-dielectric and be a dedicated "homerun" with no splices except for termination splicing on each end to the cassettes/plates.
D. Intrabuilding premises optical fiber must have a plenum fire-rating (OFNP) after fifty feet (50') (15.2 m) 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 must be in accordance with the current version of ANSI/TIA 598-D.
F. Tier 1 certification 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 Visual Fault Locator (VFL) used for continuity/polarity can be separated 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 must be specified in the project specifications and is typically required for distances over five hundred feet (500') (152.4 meters).

I. Both Tier 1 and Tier 2 require “dual-wavelength” testing at both 1310 nm and 1550 nm, as well as bi-directional testing.
J. If requested, DWDM out-of-band (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 must be used for referencing the cable test identification.
L. These criteria do 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 the 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 must be labeled in accordance with the following standard:
    1. 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 must 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
        ... continue
B. **Tier 2 OTDR:** Each individual strand must be labeled following the below standard:
    1. The label for each strand in the test result for **OTDR** testing must 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
        ... continue
        c. 72 Strand SM - SEB 1132 F2 A-C to CHE 224 F1 D-F OTDR (dB) Strand 71
        d. 72 Strand SM - SEB 1132 F2 A-C to CHE 224 F1 D-F OTDR (dB) Strand 72
        ... continue

PART 2: PRODUCT

2.1 Performance Requirements

A. The tester must be UL Listed and RoHS 2011/65/EU compliant, and its manufacturer must be ISO 9000/9001 registered.
B. When using ABF fiber, the outer sheath jacket is permitted to be orange inside and outside. In inside plant (ISP) or intrabuilding applications, standard optical fiber cable the outer jacket and patch cords must be yellow unless outside plant (OSP) interbuilding applications are black.
C. Copper UTP certification tester must 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, light source/loss test set, OLTS and OTDR must conform to ANSI/TIA 568.3-D, GR-196-CORE, and the procedures in ANSI/TIA 526-7-A
E. Any Level IIIe balanced twisted-pair field testers using optical fiber adapters must 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 and OTDRs must be from the same manufacturer.
H. OLTS to provide:
    1. 1310 nm and 1550 nm +/- 20 nm wavelength accuracy/tolerance.
    2. Measure range must be +10 to -60 dBm
    3. Accuracy must be at least +/- 5% 0 to -50 dBm and +/- 10% to -60 dBm
    4. Resolution must be up to 0.1 dB
    5. Optical test ports must be “SC” transmitting (TX) and interchangeable “LC” and “SC” receiving (RX) ports.
I. OTDR to provide:
    1. 1310 nm and 1550 nm wavelength accuracy/tolerance. 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 must be a minimum thirty-five (35)dB measurement range of eighty (80) km @1310 nm and thirty-five (35) dB measurement range of one-hundred-twenty-five (125) km @ 1550 nm.
    6. (Between) Event Dead Zone and (After) Attenuation Dead Zone determined by each model feature - the determinant for suitable length launch cables.
J. Fiber Inspection Scope to Provide:
    1. Automate PASS/FAIL to IEC 61300-3-35 specification
    2. Graphical digital indication of problem areas

3. Ability to save, label, and download .pdf reports or JPEG photos of each connector endface.

PART 3: EXECUTION

3.1 Summary

A. Testing must not interfere with the construction operations of other trades.
B. Main and remote devices must be synchronized and fully charged when testing begins.
C. The General Contractor and their Subcontractors must verify each cable run is installed, terminated, labeled, and is usable per industry best practices prior to testing. Any testing performed on incomplete systems must be redone on completion of the work. This ensures the manufacturers' warranty.
D. Cabling installation in Telecommunications Rooms must 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 must be carried out with safety precautions in accordance with ANSI Z136.2.
F. Note: Even if a cable installation run passes its tests, UNLV/NDE may fail the run during an inspection or audit if it is found to be improperly routed or supported. Any defects in cabling system installation must be repaired or replaced to ensure one hundred percent one hundred percent (100 %) usable condition at no additional cost or time to UNLV.
G. After the submission of test result documentation and the associated As-Built drawings, UNLV must 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 General Contractor and their Subcontractors under supervision of the representative to repeat one-hundred percent (100%) testing at no cost or time to the UNLV.

3.2 Optical Fiber Examination and Acceptance Testing Parameters

A. OS2 and OS1A single-mode fiber must be tested with a one-hundred percent (100%) PASS rate.
B. Paired duplex fibers in multi-fiber cables must 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) and documented using an OLTS.
C. Set-Up Mode:
    1. To include, but not limited to, using only the current version of the ANSI/TIA 568.3-E and ANSI/TIA 526-7-A standard.
    2. Test settings selected from the Options menu provided in the field testers must be compatible with the installed cable/connector manufacturer cable part number(s) under test.
    3. Test Operators: At least one (1) must 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 not 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 must 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 must be reviewed with the test results. Exceeding these criteria requires 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 526-7-A, 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 must 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. OTDR measurements must be performed with stable launch conditions:
   1. Use only high-quality, low-loss, dual launch boxes (minimum one thousand (1000) meters) but based upon tester manufacturer recommendations) having the same optical cable and connectors as being tested.
   2. Two (2) are required: one at the transmitting end and one at the 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 Figure 1: *Maximum Loss for OS1A and OS2 SMF Fiber Cable*

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

L. End-to-end cabling must be considered defective if it does not "PASS" tests and must be replaced at no additional cost or time 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. UNLV/NDE 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 General Contractor and their Subcontractors'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 walk-through with the General Contractor and their Subcontractors, and the design team. Any discrepancies must be addressed on a 'punch list' to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (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 must notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.3 Cleaning

A. General Contractor and their Subcontractors must practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the Telecommunications Rooms and the associated work areas.
B. Once the Telecommunications Rooms are complete with terminated optical fiber enclosures, yet still exposed to sanding, dust and debris, the General Contractor and their Subcontractors must use blue painters' tape or equivalent to cover the open sides of the enclosure at no additional cost or time to UNLV/NDE. Only UNLV/NDE is authorized to remove the tape at the start of the cutover.

3.4 Closeout Submittals and Documentation

A. Test Documentation
    1. Test results must be downloaded directly from the test unit or from a download file using an application from the test equipment manufacturer.
    2. Test results must be provided in both PDF and native tester manufacturer software format.
    3. Tester manufacturer, model, and serial number.
    4. Calibration date (current).
    5. Version of the tester firmware.
    6. Test results must 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 thirty (30) days of final submittals.
    9. Only electronic format copies are 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 must be on UNLV-provided floor plan sized to “E1” thirty-by-forty-two inches (30”x 42”) (762 x 1067 mm).
   3. Only electronic format copies are required. No hard copies
   4. “As-Built Data'': Identify all interbuilding and intrabuilding fiber link terminations in the fiber enclosures (and any telecommunications outlets (TOs) by cable room number if any). Include cable pathways of conduit greater than two-inches (2”) (51 mm), pull boxes/junction boxes, cable trays routes and sizes, plus the Telecommunications Rooms layouts of racks, cabinets, and TDUs orientation.
   5. “As-Built Wi-Fi/Security”: Identify all Wi-Fi 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 must be assigned a unique identification number (“identifier”) designating both ends of the cable as follows:
      (Origin): Building Name - ER/MDF/TR/IDF ID# - Fiber Enclosure ID# - Cassette/Plate Letter – Port ID# “to” (Destination): Building 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 room numbers. Only when the port address listing is too congested on the outside perimeter of the building can they be listed within the buildings 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. General Contractor and their Subcontractors must use the legend provided in the UNLV AutoCAD drawing for layered documentation to separate Data, Wi-Fi/Security, and Pathways. Use as a reference for scale.
   11. Within thirty (30) days of Substantial Completion of the project or prior to project closeout, whichever comes first, provide manufacturer(s) system warranty(s) for minimum twenty-five (25) years covering all components, materials, and equipment plus the General Contractor and their Subcontractors’ one (1)-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 interbuilding or intrabuilding greater than two (2) inches (51 mm) must be identified and labeled to their origin.
   13. Only electronic format copies are 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 presents the requirements for Telecommunications Rooms and Backboards. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) related to telecommunications rooms and backboards in new or retrofit construction.

B. The General Contractor and their Subcontractors must 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 must design, approve, and manage the installation process. UNLV/NDE is providing guidelines and auditing services for the design and construction of *Telecommunications Rooms and Backboards.*

D. The General Contractor and their Subcontractors must include in their bid price, communications cabling that have become abandoned as part of a renovation project, previous renovation projects, or temporary communications cables used during the construction process must be completely removed.

E. Telecommunications Rooms are considered critical operations centers and are defined in two categories:

1. Equipment Rooms (ER): Main Distribution Frames (one each):
    a. Can be adjacent to or incorporate an 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 interbuilding cabling entering the building.
    b. It is usually located on the ground floor but may be located in the basement.
    c. It operates as the main cross-connect traditionally referred to as the Main Distribution Frame (MDF) serving the TR-IDFs.
    d. The central location for the outside plant (OSP) interbuilding cabling (stub-up) conduits which must be located 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 includes OSI Model Layer Two (2) network switches and Layer Three (3) core router (active devices) based on the network architecture and backup power system.
    g. May be larger than the TR-IDF to accommodate the additional services. Desired size requirements are ten feet (10'-0") by twelve feet (12'-0") (3 meters x 3.6 meters). Check project specifications and drawings to confirm the size.

2. Telecommunications Rooms (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 work area (WA) telecommunications outlets (TOs).
    b. Typically contains the Layer Two (2) active devices and on occasions Layer Three (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) four (4)-inch (102 mm) EMT conduit as well as the grounding system.
    d. Desired size requirements are ten feet (10'-0") by ten feet (10'-0") (3 meters x 3 meters). Check project specifications and drawings to confirm the size.

1.2 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* and 27 10 00; *Structured 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 Backboxes*
    5. Section 27 05 36; *Cable Trays*
    6. Section 27 05 41; *Firestopping Systems 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; *Communications 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; *Intrabuilding Optical Fiber Backbone Cabling*
    13. Section 27 13 23.02; *Interbuilding 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*
C. Material and work must 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 Room design and installation must 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 must have at least one (1) Telecommunications Rooms per floor depending on building size, footprint, and design.
B. Distance Limitation**:** The building design must not permit permanent horizontal cable runs exceeding two-hundred-ninety-five feet (295’-0”) (90 meters).
C. Centralized: The Telecommunications Rooms must be as close to the core of the building as possible. They should be located near elevators, where possible.
D. Stacked: Multi-story buildings’ Telecommunications Rooms must be vertically aligned or “stacked”. If not feasible, Telecommunications Rooms must be connected to each other with minimum two (2) four-inch (4”) (102 mm) EMT conduits.
E. Conduit:
    1. A minimum of two (2) four-inch (4”) (102 mm) EMT conduits or ‘sleeves’ must be provided from the ER-MDF to the other TR-IDF on the same floor on the higher levels.
    2. Both ends must have a four-inch (4”) (102 mm) EMT set-screw threaded connector ‘endcap’ 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 ten-by-twelve feet (10’-0”x 12’-0”)(3 meters X 3.6 meters) for the ER-MDF and a minimum ten-by-ten feet (10’-0” x 10’-0”)(3 meters x 3 meters) for the TR-IDF.
H. Rule of Thumb: Provide minimum three-quarter square feet (3/4 s.f.) (697 sq. cm) of equipment room floor space for every one hundred square feet (100 s.f.) (9 sq. meter) of user workstation area. Accordingly, this size of room is designed to accommodate up to ten thousand square feet (10,000 s.f.) (900 sq meters) of usable office floor space having up to two hundred (200) each work areas (WAs).
I. Ceiling:
    1. Minimum ceiling height must be eight-feet-six-inches (8’-6”) (2.6 m) above finished floor (AFF). The ceiling must provide sufficient clearance to accommodate racks and respective overhead raceways, up to ten feet (10’-0”) (3 m) in height.
    2. Ceiling must 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 five feet (5’-0”) (1.5 meter) of the nearest equipment rack(s) or communications cabinet(s).
J. Floor drains: Floor drains from the room directly above must be piped into the building’s water drainage system.
K. False Ceilings and Windows: False ceilings must not be installed and there must be 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) thirty (30)-amp, two-hundred-forty (240) VAC outlets with NEMA L6-30R (single-gang).
2. Four (4) each twenty (20)-amp, one-hundred-twenty (120) VAC outlets with NEMA 5-20R (double gang "quad").
3. Mount one (1) each single-gang two-hundred-eight (208) VAC and one (1) double gang one-hundred-ten (110) VAC on opposite sides of the ladder racking and on each side of the four (4)-post rack front and rear. (four (4) total).
4. Use only EMT conduit.
5. These dedicated electrical boxes must be labeled with the electrical room#, panel#, and circuit breaker#.

N. Electrical "Convenience Outlets"
1. Convenience Outlets: Defined as those located around the wall perimeter for general use (not telecommunications equipment), to have the EMT conduit and electrical boxes installed either (1) inside the walls and be recessed and flush with the plywood, or two (2) surface-mounted on the outside of the plywood.
2. Located every six (6) feet (1.8 meters) around the perimeter of the room, but not behind the ladder racks or cabinets.
3. Electrical box cutouts must be located fourteen (14") inches (330 mm) above finish floor (AFF) or eighteen inches (18") (457 mm) below the ceiling AFF. Allow boxes to protrude out three-quarter inches (3/4") (19 mm) beyond the gypsum board must be flush-mounted to the fire-rated plywood walls
4. Side Clearance: Provide a minimum three feet (3'-0") (0.9 meter) of clearance in the aisle and thirty-two inches (32") (812 mm) between the (proposed) rear of active devices or the four (4)-post rack (whichever is closest) and the wall.
5. Sleeve Protrusion: Per UNLV/NDE specification, any conduit trade sizes including four-inch (4") (102 mm) conduits metal or HDPE piping/conduit floor sleeves/stub ups to protrude a minimum three-inches (3") (76 mm). Each to have a threaded adapter to install a plastic grommet and cover with an end-cap. Those of metal must have a grounding collar.
6. Cable Bend Radius: Minimum seven-inches (7") (178 mm) clearance between the four-inch (4") (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 thirty-six inches by eighty inches (36"x 80") (914 mm - 1219 mm) lockable doors to open ninety-to-one-hundred-eighty-degrees (90° to 180°) outward. Door sills and with locked security card access.
8. Other Trades:
    a. No piping, ductwork, mechanical equipment or power cabling must be allowed to pass through the equipment room.
    b. If necessitated, Sprinkler pipes must be provided with drip pans installed but not within five feet (5'-0")(1.5 meters) of the nearest equipment rack or communications cabinet.

c. Additionally, sprinkler heads must be provided with cages to prevent accidental operations.
d. Floor drains from the room above must be piped into the building's water drainage system.

9. Firestopping: All sleeves or devices entering the Telecommunications Rooms must be properly fire stopped both on the outside and inside of the pathway.
10. Floors:
    a. Carpets are not permitted in any telecommunications spaces.
    b. Cement floors must be treated with static free sealant that prevents dust.
    c. Static-controlled vinyl composition tile (VCT) is the preferred floor cover and to have a rating greater than one-hundred pounds per square foot (100 lbs./sq. ft.).
11. Environmental Control:
    a. Dedicated HVAC twenty-four (24) hours a day, three-hundred-sixty-five (365) days a year with an allocated thermostat to maintain a temperature between sixty-four degrees Fahrenheit (64°) to seventy-five degrees Fahrenheit (75° F) (18° C to 24°C)
    b. Maintain relative humidity between thirty percent (30%) and fifty-five percent (55%).
    c. There must be at least one (1) air exchange per hour to maintain positive pressure.
    d. Wall mounted units must 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 must be minimum five feet (5'-0") (1.6 meter) from the nearest equipment rack or communications cabinet.
    f. Alternatively, provide a dedicated HVAC supply duct system for each Telecommunications Rooms and having its own thermostat.
12. Lighting:
    a. Lighting fixtures must be mounted at a ceiling height of eight-feet-six-inches (8'-6") (2.6 m) and provide 356 lux at three-feet (3'-0") AFF.
    b. Minimum two (2) 2 ft. X 4 ft. (0.6 m x 1.2 m) light fixtures must 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. Must be on a separate circuit from the circuit feeds to the room's electrical convenience outlets.
13. EMI: Fluorescent lights (non-LED) must 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 ANSI/TIA 607-D (J-STD-607-A), each Telecommunications Rooms must be equipped with a grounding busbar connected to the building's grounding system.
    i. The ER-MDF must house the telecommunications Primary Bonding Busbar (PBB) sized to one-quarter inch (1/4") thickness and minimum four-inches (4") (102 mm) in height by "X" length.
    ii. The TR-IDF must house the Telecommunications Secondary Bonding Busbar (SBB) - Secondary Busbar (SBB) sized to one-quarter inch (1/4") thickness and minimum two (2) inches in height by "X" length.
b. Each busbar must be labeled per assigned Telecommunications Rooms number.
c. Each busbar must accommodate double-hole, double-crimp #6 AWG grounding lugs.

15. Dust: Dust is defined as more than one hundred (100) micrograms/cubic meter/twenty-four (24)-hour period.
16. Walls or Backboards: All perimeter walls;
    a. Lined with four-feet by eight-feet (4'-0" x 8'-0") (1.2 m x 2.4 m) three-quarter inch (3/4") void-free A-C grade (or better) fire-rated plywood. The fire-rated plywood must be fire-retardant or treated with at least two (2) 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 it to a wall towards the top of the paneling.
    c. The bottom of the fire-rated plywood must be mounted six-inches (6") above the finished floor (AFF) so that the top of the fire-rated plywood is flush with the top of the wall-ceiling at eight feet-six-inches (8'-6") (2.6 meters).
    d. Cut out the wall perimeter fire-rated plywood to expose these electrical outlets that must be flush with the fire-rated plywood. Alternatively, use three-quarter inch (3/4") extension mud rings.
    e. Secure fire-rated plywood using a minimum one-quarter inch (1/4") galvanized fasteners placed within two (2) inches of the edges and at a maximum of twenty-four inches (24") (610 mm) on center. Secure the center as required to eliminate warping. Fastener heads must not protrude beyond the plywood surface.
    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; *Communications cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Poke through Devices.*

1.4 Room Numbers

A. UNLV must be responsible for the obtaining and mounting of the Telecommunications Rooms 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 Rooms complete with backboard installation, electrical, lighting, HVAC and ducting.

1.6 Contractor Qualifications

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must 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 III) certification(s).

1.7 Quality Assurance and Warranty

A. Electrical work must be in full compliance with the current version of ANSI/TIA 607-D and NFPA 70 (NEC), as well as Division 26.
B. The Telecommunications Rooms must be installed in a neat and workman-like manner. This includes:
    1. Layout Responsibility: Preparation and layout of the Telecommunications Rooms per the project drawings must be under direct supervision of General Contractor's and their Subcontractor's RCDD.
    2. Fire-rated Plywood is vertically aligned, properly secured, and abutted without gaps.
    3. Fire-rated Plywood is mounted six inches (6") (152 mm) above AFF and extends to eight feet-six-inches (8'-6") (2.6 m) above AFF.
    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 must be installed per specifications, and must be operational and provided with adequate, confined drainage.
    7. Doors open outward ninety to one-hundred-eighty degrees (90°-180°), no sills, and have security locks installed.
    8. Any writing, stickers, pencil/pen measurements, or graffiti on the walls must 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 Telecommunications Rooms entering from the wall or ceiling must be properly secured and labeled as to their origin. Grounding collars are required on the Telecommunications Rooms' side, with plastic grommets installed.
11. Conduit floor conduits are located along the outside wall(s) corner and have a minimum four inches (4) (102 mm) AFF stub-up, capped and labeled as to their origin. Any metal interbuilding conduit also must have grounding collars installed.
12. Products must be furnished with manufacturer's instructions and mounting hardware.
13. SPECIAL NOTE: All completed pathway installations either in whole or in sections must be inspected and approved by UNLV/NDE RCDD prior to any cables being installed.
14. Products must 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 Contract Documents for the Telecommunications Rooms.
B. Products must be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*

PART 3: EXECUTION

3.1 Cleaning

A. General Contractor and their Subcontractors must practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the Telecommunications Rooms and the associated work areas. This includes keeping inventoried material staging areas in the Telecommunications Rooms organized.
B. Once the Telecommunications Rooms are complete with terminated modular patch panels, if still exposed to sanding, dust, or debris after termination, dust and debris, the General Contractor and their Subcontractors must use blue painters' tape or an approved equal to cover the patch panel ports at no additional cost or time to UNLV/NDE. Only UNLV/NDE is authorized to remove the tape at the start of the cutover.
C. Upon completion of a project, all debris, empty boxes, excess material inventory, installation equipment and tools must be removed leaving the premises clean, neat, and orderly. Floors must 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 Contract Documents.
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 must be subject to the control and approval of UNLV/NDE.
D. UNLV/NDE must perform a visual inspection and walk-through with the General Contractor and their Subcontractors, and the design team. Any discrepancies must be documented on a punch list and submitted to the assigned UNLV/P&C Project Manager (PM). The General Contractor and their Subcontractors must respond within forty-eight (48) with a mutually agreed up-to-date schedule for corrections. Completion of this process is required for UNLV/NDE closeout documentation.

3.3 Close-out Submittals

A. If requested, providing written proof that the Telecommunications Rooms(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 Part 1 (General), Part 2 (Products), and Part 3 (Execution) for communications cabinets, equipment racks, brackets, cable management, ladder racking, and radius guides in new or retrofit construction.

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

C. The General Contractor and their Subcontractors must 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, including two (2)-post and four (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 (1)-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 two (2)-post and four (4)-post equipment racks.
        c. Not applicable to 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 frame width is nineteen inches (19”) (482 mm) wide. Note: Twenty-three inches (23”) (584 mm) is not applicable.

G. Zone four (4) or seismic applications are not applicable.

H. Wall-mounted swing communications cabinets may serve as a small Telecommunications Rooms horizontal or intermediate cross-connect facility when specified.

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

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 11 00; *Communications Equipment Room Fittings*, 27 13 00; *Communications Optical Fiber Backbone Cabling,* and 27 15 00; *Communications Copper Horizontal Cabling* include 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 must 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 design must 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 Telecommunications 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 communications cabinets.
    2. Include rated capacities, operating characteristics, and ancillary accessories and specialties that may be deemed 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 Rooms.
    2. Grounding: Indicate the location of the equipment grounding lug and the one-inch (1”) (25 mm) rack bonding busbar (RBB) on the equipment rack and communications cabinet.

1.4 The General Contractor and their Subcontractors Qualifications

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent and authorized to act on behalf of the General Contractor and their Subcontractors. They must 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 a manufacturer authorized installer of the manufacturer’s equipment racks and/or communications cabinets.

1.5 Quality Assurance

A. All pathways must be installed in a neat and workman-like manner.
B. The General Contractor and their Subcontractors must strictly adhere to all current versions of Building Industry Consulting Service International (BICSI),
   Telecommunications Industry Association (TIA), and National Fire Protection Association (NFPA-70),
C. Products must be furnished with manufacturer’s instructions and mounting hardware.

D. Products must be UL listed and be manufactured by an ISO 9000/9001 approved manufacturer and be RoHS 2011/65/EU compliant.
E. Communications cabinets must 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 must be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*

2.2 Distribution Frame Equipment Racks Specifications

A. Freestanding two (2)-post aluminum open frame equipment rack:
    1. Two (2) L-shaped top angles, two (2) L-shaped base angles, and two (2) C-shaped equipment-mounting channels.
    2. The equipment rack must be assembled with manufacturer-supplied nut and bolt hardware.
    3. The base angles for two (2)-post equipment racks must be pre-punched for attachment to the floor.
    4. Equipment vertical mounting channels must be punched on the front and rear three-inch (3”) (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 one and three-quarter inch (1-3/4”).
    6. Dedicated bonding points for proper grounding and bonding to ANSI/TIA 607-D.
    7. Freestanding equipment racks must be seven feet (7’-0”) (84 inches) (2,134 mm) and forty-five (45) RUs in height.
    8. The RU spacing must be printed vertically along the outer side of the channel starting with “45RU” on top and descending towards the bottom.
    9. Equipment racks must be equipped with a one-inch (1”) wide, forty-nine (49) each two (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 nineteen-inch (19”) (483 mm) panels and equipment.
    11. Must be approximately twenty-three-point-four to twenty-four-inches (23.4”-24.00”) (597-600 mm) wide with seventeen-point-seventy-two-inches (17.72”) (450-mm) between rails.
    12. Dedicated bonding points for proper grounding and bonding to ANSI/TIA 607-D.
    13. Painted with a polyurethane black powder-coat, semi-gloss paint.
    14. Two (2)-post equipment racks rating: Eight hundred to one-thousand pounds (800 lbs. - 1,000 lbs.) (363 - 453 kg) of equipment.
B. Freestanding four (4)-post steel equipment open frame rack:
    1. Two (2) L-shaped top angles, two (2) L-shaped base angles, and two (2) C-shaped equipment-mounting channels.
    2. The equipment rack must be assembled with manufacturer-supplied nut and bolt hardware.
    3. Steel four (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 must be punched on the front and rear three-inch (3”) (76 mm) wide flange with the EIA/ECA-310-E universal mounting hole pattern.

5. Freestanding equipment racks must be seven feet (7'-0")(84 inches)(2,134 mm) and forty-five (45) RUs in height.
6. One (1) EIA equipment 'rack unit' or RU is measured at one-point-seventy-five inches (1.75") (45 mm) between mounting holes.
7. Steel four (4)-post equipment racks to have three-eighths inch (3/8") square-punch holes and must include a minimum of forty (40) each #12-24 x 1⁄2" mounting screws and forty (40) each snap-in #12-24 cage nuts.
8. Made to accommodate the mounting of nineteen-inch (19") (483 mm) panels and equipment.
9. The RU spacing must 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 must be equipped with a one-inch (1") wide forty-nine (49) each two (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. Must be approximately twenty-three-point-four to twenty-four-inches (23.4"-24.00") (597-600 mm) wide with seventeen-point-seventy-two-inches (17.72") (450-mm) between rails.
13. Dedicated bonding points for proper grounding and bonding to ANSI/TIA 607-D.
14. Four (4)-post equipment racks rating: two thousand pounds (2,000 lbs.) (907 kg) of equipment and a maximum depth of approximately twenty-nine point five to thirty inches (29.5"-30.00") (749 - 762 mm).

2.3 Communications Cabinet Specifications

A. Freestanding aluminum communications cabinet:
   1. The front door must be either smoked plexiglass or solid steel, with locking, flush latches and concealed hinges. The choice is dependent on the environmental application. Verify on the Telecommunications drawings as to the type that is specified.
   2. Options to allow for split doors and side panels ventilated and unventilated.
   3. The equipment rack must 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 communications cabinets from the same manufacturer, floor or wall-mounted, and assigned to the same project, key latches must be keyed the same.
   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 as required for freestanding equipment
      c. Options for fans, vented roofs, and side panels.
      d. Ability to mount dual vertical PDUs.

8. Cable entry knockouts with rubber grommets or brushes must be located on the top, sides, and bottom.
9. The front rack must 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 must be punched on the front and rear with a three-inch (3”) (76 mm) wide flange with the EIA/ECA-310-E universal mounting hole pattern.
11. Vertical rails must be pre-tapped for #12-24 screws or nut plates spaced one-point-seventy-five-inches (1.75”) (44.45 mm) or one (1) RU.
12. Freestanding communications cabinets must be seven feet (7’-0”) (84 inches)(2,134 mm) and forty-five (45) RUs in height. Labeled in descending order from top to bottom.
13. One (1) EIA equipment ‘rack unit’ or RU is measured at one-point-seventy-five-inches (1.75”) (45 mm) between mounting holes.
14. Communications cabinets must be equipped with a one-inch (1") wide forty-nine (49) each two (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. Must be approximately twenty-three-point-four to twenty-four-inches (23.4”-24.00”) (597-600 mm) wide with one-point-seventy-five-inches (1.75”) (450-mm) between rails.
17. Dedicated bonding points for proper grounding and bonding to ANSI/TIA 607-D.
18. Adjustable legs.
19. Cable entry knockouts with rubber grommets or brushes must 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 pivoting steel communications cabinets and equipment racks:

1. The freestanding NEMA 250 Type 4/IEC 60529 IP65 rated pivoting communications cabinets must be constructed with galvanized-steel having removable side panels and front and rear hinged doors. This panel must be used in both interior and exterior applications.
2. Must be maximum twenty-four-inches (24”) (610 mm) wide.
3. Standard cabinet heights: twenty-four-inches (24”) (610 mm) to forty-eight inches (48”) (1219 mm) and depth of twenty-inches (20”) (508 mm) to twenty-six inches (26”) (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 Rooms’ location considerations and applications.
6. Minimum static load capacity for a wall-mount communications cabinet is four-hundred pounds (400 lbs.) (182 kg) and seventy pounds (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. Must be made of welded steel construction.
9. Vertical front rails must be pre-tapped for #12-24 screws or nutplates spaced one-point-seventy-five-inches (1.75”) (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 knockouts with rubber grommets or brushes must 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 must have a provision for mounting to an accessory mobile base for use as a floor-standing unit. Mobile base must be available separately.
17. Dedicated bonding points for proper grounding and bonding to ANSI/TIA 607-D and NFPA-70 (NEC).

2.4 Hinged Wall Brackets

A. 2RU hinged wall bracket:
   1. Nineteen inches (19”) (483 mm) wide x 2RU (three and one-half inches) (3-1/2”) (89 mm) in height x six to seven inches (6”-7”) (152 mm - 178 mm) depth.
   2. One (1) EIA equipment ‘rack unit’ or RU is measured at seventy-five-inches (1.75”) (44.45 mm) between mounting holes.
   3. Typical application for a 2RU forty-eight (48)-port modular patch panel.
   4. No horizontal cable managers are necessary.
   5. Vertical rails must be pre-tapped for #12-24 screws or nutplates spaced at seventy-five-inches (1.75”) (44.45 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-inch (7”) to nine-inch (9”) (177.8 -228.6 mm) wide and rear-ring depth of six-inch (6”) to seven-inch (7”) (152.4 -177.8 mm).
   2. Hard-plastic mounting plate with evenly spaced pass-through with rounded edges holes to allow front-to-rear cabling access.
   3. must have the means to attach to the 1. two (2)- or four (4)-post equipment racks.
   4. Flexible, rounded, and evenly spaced equipment racks.
   5. Flexible, rounded, and evenly-spaced plastic fingers or guides.

6. Baked-polyester powder black coat finish.
7. 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 nineteen-inch (19”) (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 four inches (4”) (90 mm).
7. Available in 1RU and 2RU versions using #12-24 mounting screws.

2.6 Steel Ladder Racking

General

A. Ladder rack type design having nine-inch (9”) (229 mm) rung spacing and a black powder spray semi-gloss finish.
B. Materials must be steel rungs having a continuous, smooth mig or tig weld to the side rails to protect cable insulation and handling by the installers.
C. Side rails and rungs must be of a box construction must meet the NEMA Class 10 having the capacity to carry a uniformly distributed load of fifty pounds (50#) (22.67 kg) per ft. on six feet (6’-0”) (1.8 meter) support spans. A safety factor of one-point-five (x 1.5) requires support brackets every four feet (4’-0”) (1.22 meters).
D. Minimum size is eighteen inches (18”) (457 mm) wide by one-and-one-half inches (1 1/2”) (38 mm) in height by ten feet (x 10’-0”) (3 meter) length commonly referred to as “sticks”.
E. Width of twelve inches (12”) (305 mm) based upon project specifications or by subsequent approval of UNLV/NDE, in turn, based upon the cable pathway application and cable density.
F. If used outside the Telecommunications Rooms, special-order colors may be specified based upon exposed ceiling color coordination.
G. Radius drops are required for drop off into equipment racks or communications cabinets, sized to the width of the ladder rack, and from the same manufacturer of the ladder rack.
H. Dedicated bonding points for proper grounding and bonding 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 interbuilding outside plant (OSP) underground buried cabling systems.

C. Cabling installation in Telecommunications Rooms must be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.

3.2 General

A. Two (2)-post or four (4)-post equipment racks or communications cabinets must be placed with a minimum of thirty-six-inch (36”) (914 mm) clearance from the walls on both sides, aisleways, 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 (1) side to have the thirty-six-inch (36”) (914 mm) clearance and the rear of the four (4)-post a minimum of twenty-four-inches (24”) (610 mm).

B. Equipment racks and communications cabinets grounded to the telecommunications grounding busbar 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 communications 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, etc. must 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 so 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 Freestanding Open Frame Two (2)-and Four (4)-Post Equipment Racks and Communications 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. For two (2)-post equipment racks single or in a row, maintain a minimum of thirty-two-inches (32") (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 two-foot square (2'-0"x2'-0") floor panels 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 must be securely attached to the concrete floor in four (4) places (minimum), two (2) on each front and rear floor angle. If possible, use hardware and instructions supplied by the manufacturer.
    1. Recommended drilling three-eighths inch by two-inch (3/8" x 2") (51 mm) hole for a drop-in anchor grommet.
    2. Caution must be taken not to drill more than two inches (2") (51 mm) deep into the concrete so as not to penetrate the rebar or pre-stressed rods.
3. Install the three-eighths inch by one-and-one-half inch to one-and-three-quarter inch (3/8" x 1 1/2" – 1 3/4") (38mm - 44 mm) long anchor bolts with three-eighths inch (3/8") flat and locking washers.
E. Grounding lugs on each distribution frame equipment racks or communications cabinets must 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 Rooms grounding busbar.
F. The one inch (1") (25 mm) horizontal rack grounding busbar (RBB) must be located;
    1. On the backside on the rear vertical channels of a two (2)- or four (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 Freestanding Communications Cabinets

A. Assemble communication cabinet and accessories per manufacturer's instructions.
B. The one-inch (1") (25 mm) horizontal rack grounding busbar (RBB) must be located;
    1. On the backside on the rear side of the communication cabinet's vertical channels
    2. 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 communications cabinets location(s).

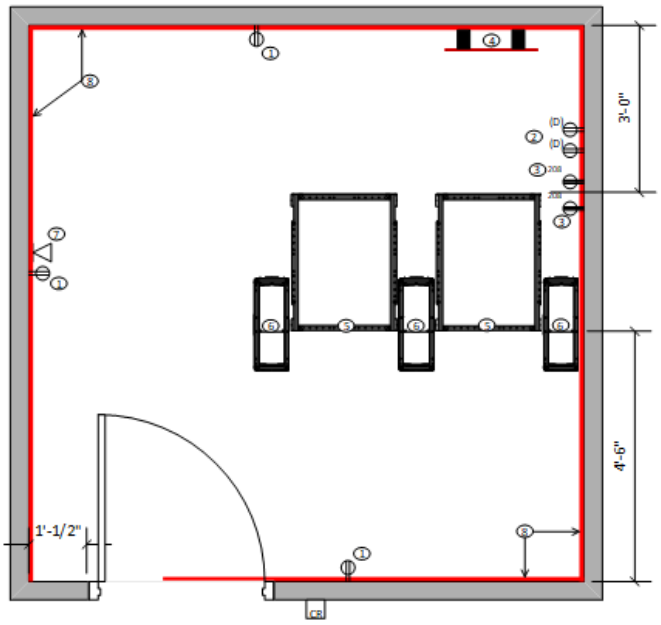
3.5 Installation Guidelines for Wall-Mount Pivoting Communications Cabinets

A. Must be mounted on a three-quarter inch (¾") (19 mm) AC void-free fire-rated plywood 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 communications 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 (twenty-four (24) each) terminated copper UTP cables. Use half inch (1/2") black Velcro™ or an approved equal to secure cables, not tie-wraps, to ensure proper bend radius.
C. Provide seven-inch (7") (178 mm) wide by six inches (6") (153 mm) double-sided vertical cable managers:
    1. On the sides and in between two (2)- or four (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

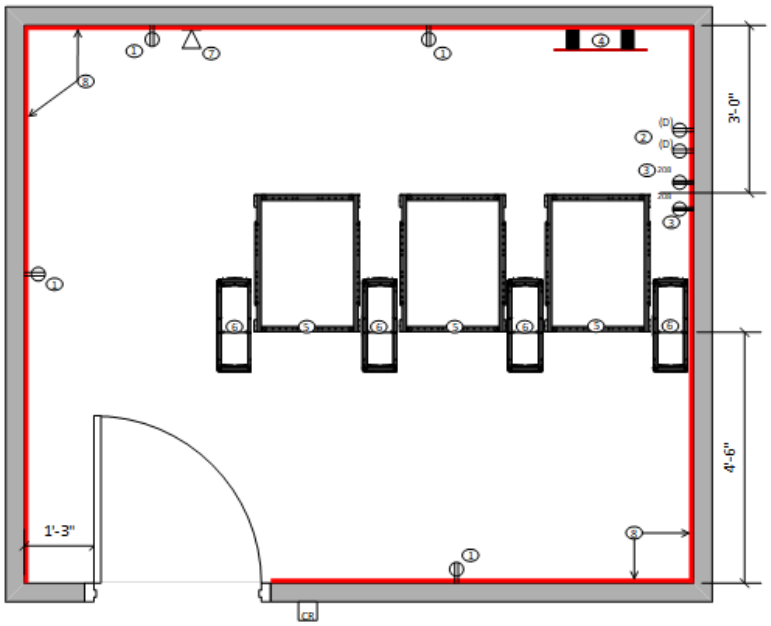
Other Requirements: Access to cable trays.

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. three-quarters inch (3/4”) (19 mm) AC void-free fire-rated plywood backboard.
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. Must 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 Telecommunications Rooms busbar PBB or SBB per Division 27 05 26: *Grounding and Bonding for Communication Systems.*
C. Ladder racking must be mounted per manufacturer’s 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 inches (7”) (178 mm) between the ladder racking and any four-inch (4”) (102mm) conduit sleeves (measured from the end of the adapter collar and plastic grommet) protruding from the ceiling.
E. Ladder racking must be mounted to and supported by the Telecommunications Rooms plywood backboards. Use angle or “elbow” support brackets from the same manufacturer with properly sized anchors, spaced at a minimum every five feet (5’) (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 (2) sections.
H. Ensure the ladder racking is at the same height and level throughout the Telecommunications Rooms.
I. If painted, remove paint and clean the area where the two (2)-hole double-crimp jumper is required to bond between each section or “sticks”. Use appropriately 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 anodized ladder rack/cable tray assemblies must 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 Telecommunications Rooms four-inch (4”) (102 mm) conduit stub-up as to their origin.
B. Facing front left to right; place three-quarters inch (3/4”) (19 mm) self-laminating adhesive label in the center top “L” bracket “RACK ONE (1)” and then “RACK TWO (2)” and so forth for multiple equipment racks.
C. Any communications cabinets must have the same pattern; “CABINET ONE (1)” and so forth for multiple cabinets.
D. UNLV/NDE may require a custom labeling system that must be noted in the Contract Documents.

3.10 Cleaning

A. Keep the telecommunications spaces/rooms clean. Practice good housekeeping. Sweep, clean, and remove trash on a daily basis.
B. Fiber Trough Runners, if any, must be thoroughly cleaned inside using a vacuum cleaner with a HEPA filter.
C. Comply with Section 27 01 00 Part 3; EXECUTION 3.5: At end of the Telecommunications Rooms buildout, the General Contractor and their Subcontractors agrees to thoroughly clean and vacuum all dust and debris using a vacuum cleaner with a HEPA filter; this includes, but is 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 must be placed per project specifications floor drawings, plumb, aligned with each other and square to the room. Equipment racks must be properly secured to the floor using the four (4) mounting holes.
B. Cabling installation in Telecommunications Rooms must be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.
C. Communications cabinets must 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 Rooms 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 one inch (1”) (25 mm) Rack Bonding Busbar (RBB) mounted on the rear topside of the channel posts.
F. Communications cabinets to have the one inch (1”) (25 mm) Rack Bonding Busbar mounted on the rear topside of the channel posts or whatever means is more practical.
G. UNLV/NDE to perform a visual inspection and complete a walk-through with the General Contractor and their Subcontractors, and the design team. Any discrepancies must be addressed

on a 'punch list' to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (48) hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. The UNLV/P&C PM must notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

3.12 Closeout Submittals

A. Product data sheets should be the same as the pre-bid Submittals.
B. Within thirty (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 twenty-five (25) years covering all components, materials, and equipment plus the General Contractor and their Subcontractors' 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 27 11 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 Part 1 (General), Part 2 (Products), and Part 3 (Execution) for Communications Copper Modular Patch Panels, Optical Fiber Enclosures, or a combination of both, applicable to communications systems components in new or retrofit construction.

B. The General Contractor and their Subcontractors must 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 forty-eight (48)-port modular patch panels field configurable for both digital IP voice and data applications
   2. Optical fiber enclosures for intrabuilding and interbuilding 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 with nineteen-inch (19”) (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 is to provide a grounding lug for optical fiber conductive (OFC) cable. In turn, the cabinet must be bonded to the one-inch (1”) (25 mm) rack bonding busbar (RBB) using #6 AWG stranded cable.

G. Products must be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.

H. Transmission performance parameters must be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.

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* include 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; *Communications Cabinets, Equipment Racks, Brackets, Cable Management, Ladder Racking, and Radius Guides*
10. Section 27 13 23.01; *Intrabuilding Optical Fiber Backbone Cabling*
11. Section 27 13 23.02; *Interbuilding 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 must 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 must 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-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 Electrical 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 must include material descriptions, dimensions of individual components, profiles, color (black) and finishes that comply with this Division Twenty Seven (27) document.
B. Provide architectural 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 General Contractor and their Subcontractors Qualifications

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must 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. General Contractor and their Subcontractors required must be a manufacturer authorized installer of the modular patch panels (and work area outlets and connectors) and/or optical fiber enclosures.
D. General Contractor and their Subcontractors must 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 must 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 system 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, not stranded copper cable, must be terminated.
F. Installed products must be free of defects in material and workmanship.
G. Both modular patch panels and enclosures must have mounting holes/slots spaced in accordance with EIA standards at one-and-three-quarter inches (1-3/4") (44 mm), or one rack unit (1 RU), and must be installed in a neat and workmanlike manner using black #12-24 screws.
H. Products must be furnished with manufacturer's instructions and mounting hardware.
I. Provide the twenty-five (25)-year manufacturer warranty for the particular project.
J. Products must be UL Listed and be manufactured by an ISO 9000/9001 approved manufacturer and be RoHS 2011/65/EU compliant.
K. Transmission performance parameters must be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.

PART 2: PRODUCT

2.1 General

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

2.2 Copper Modular Patch Panels:

A. General
    1. Materials must be of high quality and features as indicated in the pre-bid submittals.
    2. Panel frames must be black-powder coated with textured finish minimum fourteen (14)-gauge steel with rolled edges top and bottom for proper stiffness.
    3. Ports must be silk-screened with white labels and arranged in two (2) horizontal rows. Ports must be numbered sequentially left-to-right across the top row, then continuing left-to-right across the bottom row (e.g., One to twenty-four (1–24) top row, twenty-five to forty-eight (25–48) bottom row for a forty-eight (48)-port panel). The terminated cable routing must correspond to the designated two (2)-row port identification layout.
    4. Use of a single standard or four (4)-pair custom one-hundred-ten (110)-style Insulation Displacement Contact (IDC) termination 'punch down' tool.
    5. Designed for terminating four (4)-pair, balanced one hundred (100)-ohm UTP twenty-three to twenty-four (23-24) AWG cable onto tapered one-hundred-ten (110)-style IDCs that can be configured to 568B wiring.
    6. Contacts must be flat and have a minimum fifty (50) microns of gold to accept a minimum five hundred (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 must be in compliance with connector manufacturer instructions (straight out or 90-degrees).
9. The 2-RU, forty-eight (48)-port modular patch panel can be either fully PCB-loaded or unloaded/open. The faceplates and modular keystone-style jacks must come from the same connector manufacturer. The cables must be from the same connector manufacturer or an approved equal and documented equivalent from a 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 must support Wi-Fi 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 must be visible from the front side when installed. The rear side is preferred but not mandatory.
15. High density 1RU forty-eight (48)-port 2RU configurations are not acceptable without express authorization from UNLV/NDE.

B. Fully loaded forty-eight (48)-port modular patch panel
    1. Standard is the 2RU forty-eight (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 must be fully enclosed front and rear for physical protection.
    4. Contacts must be flat and have a minimum fifty (50) microns of gold to accept a minimum five hundred (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 must be flat and have a minimum fifty (50) microns of gold to accept a minimum five hundred (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 must be mounted pins up/tab down.
    10. Stuffer caps must have retention snap to ensure conductor strain relief after termination.
C. Unloaded or open forty-eight (48)-port modular patch panel
    1. Standard is the 2RU forty-eight (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 must 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 must be mounted pins up/tab down.
    6. Built-in hinged dust covers are acceptable.

7. Stuffer caps must have a retention snap to ensure conductor strain relief after termination.
8. Note: The last patch panel in the Telecommunications Rooms equipment rack or communications cabinet must be the unloaded/open type.

2.3 Optical Fiber Enclosures:

A. General

1. Fiber patch panels are to provide termination and interconnectivity for the campus optical fiber architecture network.
2. The fiber optic patch panel must be designed to accommodate pre-terminated standard "LGX-style" modules, featuring either twelve (12)-strand fiber with six (6) ports or high-density twenty-four (24)-strand fiber with twelve (12) ports. The Telcordia-approved, fully enclosed 'snap-in' cassette modules must contain duplex UPC-polished LC connectors with a pigtail for fusion splicing onto standard, 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 not 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' on the top left side (blue strand) and fiber '2' on the right side (orange strand). This pattern continues downward to '3-4', '5-6', and so forth, up to '11-12' (rose/aqua), totaling 24 fiber strands.
7. When viewed from the front, each duplex port must be identified horizontally, with fiber “1” at the far-left bottom (blue strand) and fiber “2” at the far-left top (orange strand). This numbering pattern must continue across as “3-4,” “5-6,” and so forth, through “11-12” (rose/aqua), for a total of 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. Must be available in:
    a. 1RU horizontal cassette mount; three (3) modules a. 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 (12) 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. The first modular patch panel must be installed after the optical fiber enclosure(s).
B. If two (2) equipment racks, modular patch panels must be mounted on the left equipment rack (and the active devices on the right equipment rack).
C. If three (3) equipment racks, modular patch panels must be split evenly as possible between equipment Rack #1 and #3 (with the active devices between in Rack #2).
D. Install 1RU horizontal cable manager between and at the bottom of each modular patch panel.
E. Mount a rear cable wire lacing bar or manufacturer cabling guide bar to support the forty-eight (48) ports of terminated Cat 6 Class E/Cat 6A Class EA ports using black Velcro™.
F. Modular patch panels must not accept FCC compliant six (6)-position (RJ-11) plugs.

3.2 Installation Guidelines for Optical Fiber Enclosures:

A. Mount optical fiber enclosures on top of equipment racks or communications cabinets above modular patch panels.
B. Allow 1RU empty space or gap immediately above each optical fiber enclosure.
C. If two (2) equipment racks, an optical fiber enclosure must be mounted on the top left equipment rack (and the active devices on the right equipment rack).
D. If three (3) equipment racks, optical fiber enclosures must 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 manager at the bottom of each optical fiber enclosure.
F. Where applicable, the optical fiber conductive (OFC) or armored cable, along with the ABF shielded outer sheath, must be properly bonded to the enclosure's ground lug according to the manufacturer's instructions. Additionally, the enclosure must be connected to the one (1")-inch (25 mm) rack bonding busbar (RBB).

3.3 Cleaning

A. The General Contractors and their Subcontractors must use blue painters' tape or approved equal to cover exposed modular patch panel and switch ports if dust, drilling, and sanding is prevalent or planned.
B. Keep the Telecommunications 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., Wi-Fi bollards).

B. Optical Fiber Enclosures:
   1. Install the housing and the assigned module cassettes.
   2. Affix a half-inch (½") (12-14 mm) self-laminating adhesive black-on-white label with "F1" on the first modular patch panel and"F2 ","F3 " on each successive optical fiber enclosure.
   3. Optical fiber enclosures must be labeled front and rear.
   4. Place on the far-left side centered between the mounting holes/slots.
   5. Place the half-inch (½") (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 must be consistent with the Consecutive Fiber Numbering (CFN) sequence as identified in the latest version of ANSI/TIA 568.2-D. This fiber strand numbering sequence between each fiber link must be adhered to at each terminated end of the optical fiber cable; straight-through 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

A. UNLV/NDE to perform a visual inspection and complete a walk-through with the General Contractor and their Subcontractors, and the design team. Any discrepancies must be addressed on a 'punch list' to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (48) hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. The UNLV/P&C PM must notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation .

3.6 Closeout Submittals

A. None are required. Testing with the modular patch panels and optical fiber enclosures must 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 thirty (30) days of Substantial Completion of the project or prior to project closeout, which
ever comes first, provide manufacturer(s)' system warranty(s) for minimum twenty-five (25) years covering all components, materials, and equipment plus the General Contractor and their

Subcontractors' one-year workmanship documentation. Warranty documentation to specify project number and building IDF(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 intrabuilding and Interbuilding Optical Fiber Backbone

PART 1: GENERAL

1.1 Summary

A. This Section is specific to communication intrabuilding and interbuilding optical fiber backbone for communications systems. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) for communication intrabuilding and interbuilding optical fiber backbone systems components in new or retrofit construction.

B. The General Contractor and their Subcontractors must provide all labor, materials, and equipment required for the complete and proper installation of *Communication intrabuilding and Interbuilding Optical Fiber Backbone* within the Contract Scope of Work (SoW) for the UNLV/NDE ICT Structured Cabling System (SCS).

C. The General Contractor and their Subcontractors must 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 must be completely removed.

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

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

F. Whereas the intrabuilding optical fiber backbone cable provides the interconnections between the equipment rooms, main distribution frames (ER-MDF), Telecommunications Rooms, and intermediate distribution frames (TR-IDF) 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 must 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 interbuilding (between) or outside plant (OSP) 'campus standard' is Air-blown/jetted (ABF) fiber having nineteen (19)-cell micro-ducts with a minimum forty-eight (48) fiber strands of 8.3/125 µm single-mode optical glass.

J. Other reduced tube/cell counts must 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 fifty feet (50'-0") (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 include:
    1. Rodent-resistant pullover flex-braided plastic or metal sox or,
    2. Armored shield jacketing is classified as optical fiber conductive (OFC).
M. The intrabuilding (within) or inside plant (ISP) 'premises' standard is 900 µm 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 must be mounted in equipment rack or communications cabinet-mounted optical fiber enclosures
Q. Vertical runs of backbone cables inside Telecommunications Rooms must 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 must be supported at the top of the cable run with wire mesh Kellum™ grips on the third (3rd) floor and every alternating floor.
S. Products must be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
T. Transmission performance parameters must 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) must conduct a visual walk-through inspection of the identified pathways of the project inclusive of the maintenance holes (MHs) and vaults (Vs).
B. Open inspection without entry to an OSHA defined "confined space" is permissible for top-view inspection only. A 'pre-entry checklist' must 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 must contact the exterminator before entry can be conducted.
D. UNLV/P&C must include in the request for quotation (RFQ)
    1. The prerequisite that the General Contractor and their Subcontractors provide in their submittals their in-house confined space protocol (as required)

2. They are to include the assigned onsite technicians' confined space certifications
3. General Contractor and their Subcontractors must 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 must be manned and equipped with rail guards, personnel, blowers, tripod crank retrieval, and more.
4. This documentation must be reviewed and must be approved by UNLV/FMS before the General Contractor and their Subcontractors can conduct business in any maintenance hole (MH) or vault (V).

E. The low-voltage General Contractor and their Subcontractors must provide a projected schedule of maintenance hole (MH)/vault (V) work that must be completed. This schedule must be forwarded by UNLV/P&C to UNLV/FMS Project Manager and UNLV/NDE.

F. Once the project is awarded, the General Contractor and their Subcontractors need 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 twenty-four (24)-hour advance notice.
3. Have your schedule and checklists onsite and readily available for inspection by UNLV and State Inspectors.

G. The General Contractor and their Subcontractors must 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; *Communications 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 must 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 intrabuilding and interbuilding 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 Association (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 must be installed within the Contract Scope of Work (SoW).
B. General Contractor and their Subcontractors must provide documentation as an authorized cable manufacturer along with the certifications of the assigned onsite technicians installing the cabling. The percentage of certified technicians onsite is dictated by the cable manufacturer for warranty purposes.
C. Contract Documents to identify each optical fiber cable type and location, TDUs, fiber end-link locations, and related pathway routes.

1.5 The General Contractor and their Subcontractors Qualifications

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must 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 BICSI Installer II, Optical Fiber (INSTF) or preferred Level III Technician (Tech 3) certification(s).
C. The General Contractor and their Subcontractors must have successfully performed at least three (3) projects of low-voltage cable installation with similar size and Scope of Work (SoW) within two (2) 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 General Contractor and their Subcontractors must provide all labor, materials, tools and equipment required for the complete installation of the optical fiber cabling system without any additional costs or time to UNLV.

E. The General Contractor and their Subcontractors must provide proof that their onsite 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 must be inspected and approved by UNLV/NDE RCDD prior to any cables being installed.
B. Installed cabling must be free of defects in material and workmanship.
C. Installation must be under the direct supervision of the assigned General Contractor and their Subcontractor's BICSI-certified supervisor(s)-lead(s) who, in turn, reports to the assigned RCDD Project Manager.
D. Both must be versed in the preparation of the shop drawings, cabling administration drawings, and field-testing program.
E. Testing performed by one (1) member of the installation team must be a BICSI certified and cable manufacturer-certified.
F. All intrabuilding and interbuilding cabling must be installed in a neat and workmanlike way.
G. Install the standard and/or ABF optical fiber systems to meet the requirements of ANSI/TIA 568-C.0, ANSI/TIA/EIA 568-C.3, and field test to ANSI/TIA 526-7-A 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 twenty-five (25)-year manufacturer warranty for the particular project.
J. Products must be furnished with manufacturer's instructions.
K. Products must 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

A. Products must 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 must 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 twenty-five (25) years.

2.3 Project Conditions

A. General Contractor and their Subcontractors are responsible for verifying actual footage and distances as identified on Contract Documents.
B. The General Contractor and their Subcontractors must 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 must 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 must be yellow in color.
C. Both ABF and traditional optical fiber must be all-dielectric unless armored (OFC) for rodent protection.
D. The cable cordage jacket, fiber, unit, and group color must be according to TIA-598-D.
E. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed forty inches (40”) (1016 mm).
F. The standard distribution cable must have nine hundred (900) µm tight-buffered twenty four (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 the Authority 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 twelve (12) or twenty-four (24) fiber cassettes with two-hundred-fifty (250) µm pigtails for splicing.
B. Cassette to house and secure the fusion splices while maintaining cable wrap bend radius.

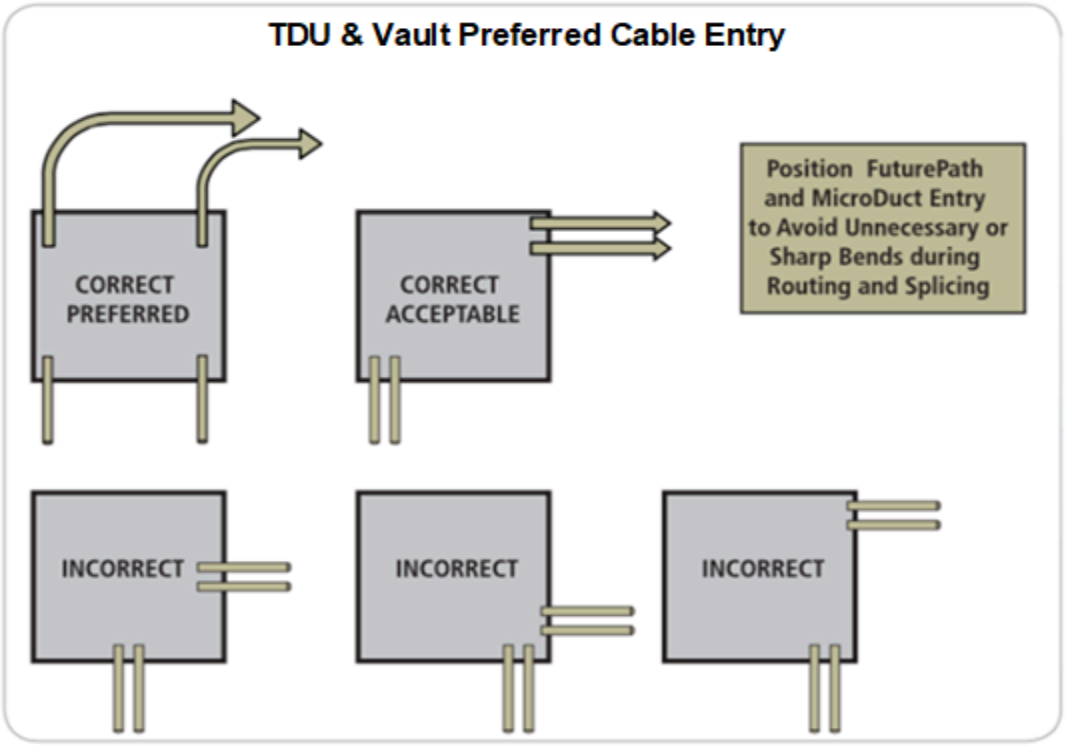
C. Cassettes to ‘snap into’ the cradle sleeves of the same manufacturer’s optical fiber enclosure; horizontally into 1RU and 2RU or vertically in 4RU housings.
D. Follows the color code of ANSI/TIA-598.D-1.

PART 3: EXECUTION

3.1 Pathway Preparation and Cable Installation Guidelines

A. Practice only OSHA-approved safety procedures when working in handholds, vaults, and maintenance environments; inclusive of tripods, sniffers, blowers, and cattle guards where applicable.
B. Outside plant (OSP) interbuilding and providers transition point(s) determined and labeled properly.
C. Maintenance Holes/Manholes (MH) and Vaults' (V) TDUs and related four-inch (4”) (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 must be either shielded, armored, or use a pullover "rodent resistant" screen mesh sock.
E. All installed conduit (prior to installing cable) must be free of debris and must be clean, dry, unobstructed, labeled with destination (both ends) and, if applicable, firestop.
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 or time to UNLV.
H. All OSP conduit runs must pass the mandrel test; cleaned with sponge-like chase, and minimum half inch (1/2") one-thousand-two-hundred-fifty pound (1,250 lb.) minimum capacity 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 four-inch (4”) (102 mm) conduit along with a chase mule tape. This must allow for the retrofit of fabric sleeve innerduct when required.
J. When ABF cabling is routed into a TDU, the design should ideally position all cable turns outside of the box. However, if circumstances require otherwise, the turn may occur at the far opposite side or corners, as shown in **27 13 23.01 and .02, Figure 1: TDU & Vault Preferred Cable Entry**.

Under no circumstances must turns be made in the middle or near-side corners.



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

K. ABF outer sheath must be secured onto the TDU with Kellum Grips™ mounted on the outside. This must 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 fifty feet (50’-0”) (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 is 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 twenty times (20x) bend radius for pulling optical cable and ABF outer sheaths and ten times (10x) for storage.

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

P. Provide a ten foot (10’-0”) (3 meter) service loop for interbuilding 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 ten foot (10’-0”) (3 meters) service loop requirement applies to intrabuilding 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 free play to ensure enough fiber slack for possible re-configuration of the micro-ducts inside the TDU.

S. Install intrabuilding 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 must not run through structural members or in contact with pipes, ducts, or other potentially damaging materials from other trades.

V. The General Contractor and their Subcontractors are 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 or time to UNLV.

W. UNLV considers all intrabuilding areas to be plenum-rated environments. All optical fiber cables must be plenum-rated (OFNP)**.**

X. Use only silicon-based or hydra-lube pulling lubricants. The use of Yellow 77 lubricant is strictly prohibited, as it voids the manufacturer warranty/installation standards.

Y. Monitor cable pull tensions per cable manufacturer guidelines, but not to exceed:

1. Six hundred pound-force (600 lbf) for traditional outside plant (OSP) rated cables.
2. One hundred to two hundred pound-force (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 must 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 must be terminated onto UPC duplex LC twelve (12) or twenty-four (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 must be slide-n-lock mounted in an optical fiber enclosure from the same manufacturer.
F. No cable run must be left unterminated unless specifically instructed by UNLV/NDE.
G. Fiber strand numbering must be consistent with the Consecutive Fiber Numbering (CFN) sequence as identified in the latest version of ANSI/TIA 568. This fiber strand numbering sequence between each fiber link must be adhered to at each terminated end of the optical fiber cable. Straight-through 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 must visually inspect (in phases) cable placement, cable termination, (grounding and bonding if applicable), and labeling of all components before testing can begin. Should any cable be found to be routed incorrectly, bruised, kinked, scored, deformed, or abraded the General Contractor and their Subcontractors must remove and discard cable and replace it with new cable at no additional cost or time to UNLV.
B. Adhere to the guidelines of Section 27 10 20.20 and .30; *Optical fiber Cable Testing and Documentation*. The following is an overview.
C. Recommend that any spooled cable(s) of optical fibers be verified prior to system installation using an OTDR dual-wavelength one-directional. If the General Contractor and their Subcontractors install faulty cable(s) without testing, the General Contractor and their Subcontractors are liable to replace without any additional cost or time to UNLV. Additionally, the replacement process is not to disrupt the construction schedule without penalty for delay.
D. Optical fiber cables (and termination hardware) must 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 intrabuilding and interbuilding applications, Tier One (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 interbuilding outside plant (OSP) applications, Tier Two (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 526-7-A 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 must 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 must be considered defective if it does not "PASS" tests and inspections.
K. Remove and replace cabling at no additional cost or time 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 Telecommunications Rooms.
M. Electronic format copies only. No hard copies
N. Per the Contract Scope of Work (SoW), provide photos of each labeled optical fiber endface or those requested for examination at no additional charge or time to UNLV.
O. UNLV/NDE to perform a visual inspection and complete a walk-through with the General Contractor and their Subcontractors, and the design team. Any discrepancies must be addressed on a 'punch list' to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (48) hours to establish a time schedule in a mutually agreed upon timeframe to affect the corrections and notify the UNLV/P&C PM. The UNLV/P&C PM must 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) must be clean of all debris, leftover material, garbage, dirt and gravel, tools and equipment.
B. General Contractor and their Subcontractors must practice good "sweep clean" housekeeping and remove trash on a daily basis from both the Telecommunications 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 must have a waterproof one-by-three-inch (1" x 3") (25-76 mm) plastic snap-on label secured with tie-wraps. The label on the entry side must identify its last handheld,

maintenance hole, or vault "From," origin and its "greater than" 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 sleeve's/tube's microducts inside the TDU connecting the entry and exit ABF outer sheaths must 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 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 fiber strands #1–24 having a row of twelve (12) each duplex UPC LC connectors.
    3. Each subsequent cassette must 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 intrabuilding and interbuilding cable runs separated by the building's Telecommunications Rooms and then numerical order in PDF and native tester manufacturer software format. The completed installation must be approved by UNLV/NDE.
B. Within thirty (30) days of Substantial Completion of the project or prior to project closeout, whichever comes first, provide manufacturer system warranties for minimum twenty-five (25) years covering all components, materials, and equipment plus the General Contractor and their Subcontractors' one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.
C. The General Contractor and their Subcontractors must provide:
    1. one (1)-year parts and labor warranty against defective workmanship and cable system component failure.
    2. The associated cable manufacturer's twenty-five (25) -year warranty for the project.
D. Hand drawings are not acceptable.
E. Network equipment including voice, data, A/V, security and Wi-Fi services must 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 must be created or updated which must be used to document the below. It includes, 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 intrabuilding and Interbuilding Optical Fiber Backbone

SECTION 27 15 00

COMMUNICATIONS 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 (Wi-Fi). It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) for installing, terminating, testing, and labeling horizontal copper cabling in new or retrofit construction.

B. The General Contractor and their Subcontractors must 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 General Contractor and their Subcontractors must include in their bid price, communications cabling that have become abandoned as part of a renovation project, previous renovation projects, or temporary communications cables used during the construction process must be completely removed.

D. The only copper applications for outside plant (OSP) interbuilding applications are for outside-rated four (4)-pair UTP cabling for wireless security and Wi-Fi applications.

E. At no time must splicing be allowed.

F. UNLV typically does not use the following:
   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 must 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:
   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 must 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 (2) cable runs to each Telecommunications Outlet (TO)
F. A copper UTP cable run must be a '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 two hundred ninety-five feet (295'-0") (90 meters).
I. Terminations between the UNLV standard 2RU, forty-eight (48)-port flat modular patch panel and the four (4)-port station application are henceforth referred to as the work area (WA) Telecommunications Outlet (TO).
J. Cat 6A/Class EA patch panels can be configured with a forty-eight (48)-port PCB version or blank for inserting modular jacks. Note**:** The last patch panel being installed, as required, must be a blank panel.
K. Telecommunication four (4)-port outlet (TO) faceplate two (2) top ports are designated for termination while the two (2) lower ports for two (2) 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 V1.4.
M. Modular patch panels must be located in Telecommunications Rooms and mounted on 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 not applicable unless specifically authorized by UNLV/NDE.
O. The 2RU forty-eight (48)-port modular patch panel, fully PCB loaded or blank, the faceplates and modular Keystone-style jacks must be from the same connector manufacturer. Cable must 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 following Power over Ethernet (PoE) Wireless applications:
    a. IEEE 802.3af PoE Type 1 (15.4W)
    b. IEEE 802.3at PoE+ Type 2 (25.5W)
    c. IEEE 802.3bt PoE++ Type 3 (60W) - compliance testing to this minimum
    d. IEEE 802.3bt Poe++ Type 4 (90W)
    e. Power over HDBaseT (PoH) (95W)
    f. 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.
E. 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 must be in compliance with TIA TSB-162-A standards.

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 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* include 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 Backboxes*
    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 Systems 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; *Communications 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 must 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 must 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 Association (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 must be installed within the Contract Scope of Work (SoW).

B. General Contractor and their Subcontractors must provide documentation as an authorized cable/connector manufacturer along with the certifications of the assigned onsite technicians installing the cabling. The percentage of certified technicians onsite 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, Wi-Fi, 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 The General Contractor and their Subcontractors Qualifications

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must 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 General Contractor and their Subcontractors must have successfully performed at least three (3) projects of low-voltage cable installation with similar size and Scope of Work (SoW) within two (2) years of the bid date. If requested, provide proof of performance with a brief job description, start and end dates, and contact information.
D. The General Contractor and their Subcontractors must provide 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 General Contractor and their Subcontractors must provide proof that their onsite personnel have the necessary training and certification(s) to satisfy the testing requirements to cable manufacturer warranty requirements and industry-recognized standards.
F. General Contractor and their Subcontractors must 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. Three (3)-week schedule of work

1.7 Quality Assurance and Warranty

A. SPECIAL NOTE: All completed pathway installations either in whole or in sections must be inspected and approved by UNLV/NDE RCDD prior to any cables being installed.
B. Installed cabling must be free of defects in material and workmanship.
C. Installation must be under the direct supervision of the assigned General Contractor and their Subcontractors's BICSI-certified supervisor(s)/lead(s) who, in turn, reports to the assigned RCDD Project Manager.
D. Both must be versed in the preparation of the shop drawings, cabling administration drawings, and field-testing program.

E. Testing performed by one (1) member of the installation team must be a BICSI certified and cable manufacturer certified.
F. All intrabuilding premises cabling must be installed in a neat and workmanlike way.
G. Any new and existing cabling in the work area must be protected from wall texture or paint, and any new or existing cabling that has been textured or painted must be cleaned using water only (no chemicals) or replaced at no cost or time or time to UNLV.
H. Any existing cabling within the work area that does not comply with applicable codes, standards, or guidelines, yet remains in use or passes through the area, must be upgraded to meet the most current code, standard, and guideline requirements.
I. Install the horizontal copper UTP cabling, 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.
J. Provide a copper UTP testing plan and subsequently, the test results and As-Builts to the satisfaction of UNLV/NDE.
K. Products must be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
L. Products must be furnished with manufacturer's instructions and mounting hardware.
M. Subsequently, the General Contractor and their Subcontractors must provide a one (1) year Parts and Labor Warranty along with the connector manufacturer's twenty-five (25)-year warranty for the particular project.
N. Transmission performance parameters must be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.
O. UNLV/NDE recommends a UNLV/NDE RCDD inspection of the pathways before any cabling is installed. This prevents 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 must 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 must 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 must 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 must 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 eight (8)-position by eight (8) conductor (8P8C) un-keyed RJ-45 jacks wired/terminated to 568B standard.
3. Use a standard one-hundred-ten (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 must 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 must be fully encased to protect the PCB or printed circuit board and ultrasonically welded for tamper resistance.
8. Connector pins must be flat and have an industry-standard fifty (50) mil of gold plating that allows for a minimum five hundred (500) mating cycles.
9. Black: UL Listed to UL 1863.
10. Cat 6/Class E must be able to support 1GBase-T application per IEEE 802.3ab
11. Cat 6A/Class EA must 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 four (4)-port, vertical, single-gang faceplate designed to mount onto a single-gang mud ring affixed to a "five (5)-square" two-and-three-quarters inch (2 3/4") 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 technical design guidelines and related environment.
E. Color determined by UNLV/P&C technical design guidelines. 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 must 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 IDFs into secured rooms.
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 must be installed for protection. UNLV/NDE to determine quantity and locations that may limit parking space size. Location(s) must 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, including station applications (telecommunications outlets or TOs), Power over Ethernet (PoE) connections to Wireless Access Points (WAPs), and security cameras.
B. Cabling installation in Telecommunications Rooms must be neatly placed in cable trays, cable runways, ladder racking, horizontal and vertical cable managers.
C. General Contractor and their Subcontractors must verify each cable run is installed, terminated, labeled, and is usable per the industry's best practices prior to testing.
D. Communications horizontal copper cabling that crosses power cables or conduits must cross at a ninety (90)-degree angle and must not make physical contact.
E. At no time must copper horizontal cabling be routed in plastic wall-mount or 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 must be repaired or replaced to ensure one hundred percent (100%) usable condition at no additional cost or time 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 or time 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 two (2)-days of the request.
I. UNLV/NDE recommends a UNLV/NDE RCDD inspection of the pathways before any cabling is installed. This prevents any improper pathway infrastructures and having to remove cabling to correct the situation.

3.2 Communications Horizontal Copper UTP Installation Guidelines in the Telecommunications Rooms

A. In cold-weather conditions, bring cable to room temperature before de-reeling. Heat lamps must not be used for heating the cable. Subsequently, installing any kinked or cracked cable must be replaced at no additional cost or time to UNLV.
B. Install cabling in the Telecommunications Rooms with horizontal and vertical cable manager guides with terminating hardware and interconnection equipment.
C. Allow for ten feet (10'-0") (3 meters) of cable slack inside the Telecommunications Rooms: Use the extra ladder racking first for storage by creating one (1) or multiple "U" shape(s) in the dressed cabling bundle(s). If necessary, create a large figure-eight (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. Do not exceed ninety-five (95) Cat 6A/Class EA cables in sleeves entering Telecommunications Rooms.
F. Allow a minimum seven inches (7”) (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. The use of Yellow 77 lubricant is strictly prohibited, as it voids the manufacturer warranty/installation standards. .

3.3 Communications Horizontal Copper UTP <u>Termination Guidelines in the Telecommunications Rooms</u>

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 Telecommunications Rooms, data centers, J-Hook systems, ladder rack and cable tray systems. Tie-wraps and electrical tape must not be used. Tie-wraps permitted only for securing ABF outer sheath inside the Telecommunications Rooms communications cabinet or below in raised-floor environments.
C. The horizontal UTP cables inside the Telecommunications Rooms must be professionally organized and sorted, dressed, and aligned similar to a ‘cigarette pack’.
D. Velcro™ must be installed soft side against the cables, cut side hidden from view, and be consistent with each Telecommunications Rooms. Evenly spaced, aligned, plumb and level both vertically and horizontally. Use plenum-rated Velcro in plenum-rated environments.
E. Ensure terminations are at one-hundred-eighty degrees (180°) 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 one-eighth inch (1/8”) (3 mm) of untwisting and no more than one-quarter inch (1/4”) (6 mm) of unjacketing.
F. Requires a one-hundred-ten (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 forty-eight (48) terminated cables have two (2) options:
    1. The preferred method must split right and left; Ports #1-12 and #25-36 must 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 must be routed to the left vertical cable manager.
    2. The optional method, based on cable congestion, is to route the top row (cables #1-24) to the left or right vertical cable manager, while routing the lower row (cables #25-48) to the opposite 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). Pulling only one (1)cable to a location must be approved by UNLV/NDE RCDD, the exception being specifications typically used for badge readers.
B. Place horizontal communications UTP cables in pathways and spaces dedicated for communications cables.
C. This permanent link is not to exceed two-hundred-ninety-five feet (295’-0”) (90 meters).
D. Cables not in conduit or basket trays must use metal J-hooks:
    1. J-hooks (with "bat wings" for the stringers), wall-mounted metal, and plenum-rated plastic J-Hooks to have retainer clips.
    2. Must be spaced horizontally @ four to five feet (4’-0”-5'-0”) maximum 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 four or six feet (4"or 6") wide 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 must 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. Cables must not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Materials from other trades must not be used as cable pathways, nor must pipes and ductwork serve as a trapeze for support.
H. Pull one (1) additional “Mule Tape” or one-quarter inch (1/4”) nylon rope pull-string chase when pulling cables through any conduit larger than one-inch (1”) (25 mm) and having no more than four (4) cables.
I. Nine-inch (9”) (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-inches (4”) (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 must determine what practical alternatives are necessary to adjust the clearances.
K. Maximum bend radius for UTP is four times (4x) the outside diameter (OD) of the cable and no less than one inch (1”) (25 mm).
L. Maximum pulling tension is twenty-five pound-feet (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 inches

(6”) (152 mm) from most EMI sources and twelve inches (12”) (305 mm) away from fluorescent lights fixtures/transformers.

N. Professionally dressed horizontal distribution cable bundles must be maintained. Grouped together without twists and no ‘banjo string’ or ‘straggler’ 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 Rooms. 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) telecommunications wall outlet (TO) must be level with adjoining electrical outlets and the same color. When the telecommunications wall outlet (TO) is in solo locations, the cut-out must be fourteen inches (14") (bottom) above finished floor and eighteen inches (18") (top) above finished floor.

Q. Use faceplates designed for the particular modular furniture.

R. Cables routed to the work area (WA) telecommunications outlets (TOs) must be placed in minimum one-inch (1”) (25 mm) EMT conduit between the walls and having a forty-five or ninety-degree (45 or 90) stub-out on top towards the pathways going to the assigned Telecommunications Rooms. For masonry or solid wood walls, vertically route and secure the conduit on the surface along with the surface mounted five (5)-square electrical boxes.

S. Use only five (5)-square, two and three-quarter inch (2-3/4”) deep boxes for work area outlets (WA), junction boxes and as pull boxes. Double-gang for six to ten (6-10) cables. Outside plant (OSP) boxes with grommets and faceplates must be outdoor weather-proof rated. For Inside/Outside applications, inclusive of below top floor parking lots and garages, UNLV/NDE and UNLV/P&C must determine if a clear plastic weatherproof outlet cover assembly is required.

T. Inside the five (5)-square box, allow just enough slack to be able to terminate/re-terminate the modular connectors inside.

U. Allow a minimum twelve inches (12”) (305 mm) of UTP cable slack in a single-loop and secured on top near the stub-out abiding the four-by (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 twelve inch (12”) (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:

1. 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).
2. Use manufacturers rounded outside/inside corner spoke assembly or plastic radius guide inserts when cable is transitioning around “T” or ninety-degree (90°) basket tray intersections.
3. Route cables away from vertically supported threaded rods or use appropriate plastic radius guides.

X. No horizontal communication cable must be left unterminated or 'coiled' in the ceiling unless authorized by UNLV/NDE. These coils must then be 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 inch (1") (25 mm) EMT conduit for maximum four (4) cables and maximum two (2) each ninety-degree (90°) bends or requiring a pull box.

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

A. Ensure terminations are at one-hundred-eighty degrees (180°) 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 one-eighth inch (1/8") (3 mm) of untwisting and no more than one-quarter inch (1/4") (6 mm) of unjacketing.

B. Each vertical four (4)-port faceplate to accept two (2) each Cat 6A/Class EA UTP 23-24 AWG cables.

C. Requires a one-hundred-ten (110)-style punch down tool for termination. Use the lower setting for PCB applications.

D. The top two (2) ports are designated for terminations. Attempt to ensure the 'odd' number is in the upper left-hand corner. The lower two (2) 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 must not be plugged into an 8P8C RJ-45 jack that would cause inside pin interface damage.

G. Mount faceplate onto the five (5)-square, two and three-quarter inch (2-3/4") deep electrical box whether flush or surface-mount.

3.6 Work Area Outlet Density Requirements

A. The General Contractor and their Subcontractors must install one (1) data outlet for every seventy square-feet (70 sf) in offices. One (1) for every one-hundred-fifty square feet (150 sf) in labs (excluding computer labs, which must be based on the number of workstations). One (1) for every two-hundred-fifty square feet (250 sf)

3.7 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.

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

A. General

1. The General Contractor and their Subcontractors are 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. Patch cords for WAPs must be provided by the contractor (CFCI).
3. UNLV/NDE must deliver all packaged WAP devices and associated mounting and device patching materials to the General Contractor and their Subcontractors. General Contractor and their Subcontractors then accept 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 General Contractor and their Subcontractors must immediately notify the UNLV/NDE for remediation and direction.
5. General Contractor and their Subcontractors must supply all tools, ladder, lifts and other associated materials, equipment, and/or consumables required to complete the installations.
6. The General Contractor and their Subcontractors must make field adjustments and resolve conflicts between the Contract Documents and field conditions before beginning any installation.
7. Install WAP devices and associated hardware per manufacturer's specifications, instructions, and recommendations. Use Contract Documents, cable records and UNLV/NDE documentation to determine mounting locations and configurations.
8. Note: UNLV/NDE must coordinate with the General Contractor and their Subcontractors must ensure the exact locations for the WAP in reference to the Contract Documents before drilling preparation begins.
9. In order to ensure a successful deployment outcome, certain criteria and design parameters must be met. The deployment plan calls for the General Contractor and their Subcontractors must place and activate devices. UNLV/NDE must provide the General Contractor and their Subcontractors 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 must not be altered, removed or exchanged without approval from the UNLV/NDE.

B. Intrabuilding Premises Applications:

1. Data cabling at wireless access point (WAP) locations must 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 must be directly routed from the Telecommunications 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 (1)-gang-to-double (2)-gang mud ring secured to the five (5)-square, two and three-quarter inch (2-3/4") deep electrical box.
4. This permanent link is not to exceed two-hundred and ninety-five feet (295'-0")(90 meters).
5. The five (5)-square, two and three-quarter inch (2-3/4") deep electrical boxes to have a minimum clearance of fourteen inches (14") x fourteen inches (14") x eight inches (8") (356 mm X 356 mm X 203 mm).
6. For premises (ISP) drop ceiling WAP locations, the electrical box must be secured directly above drop ceiling WAP preferably within twelve inches (12") (102 mm) of the WAP designated position. The Contract Documents must 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 feet (4'-0") (1.2 meter).
8. Wireless locations that are placed in hard-lid ceilings, cables must 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 must be five (5)-square boxes with a depth of two and three-quarter inch (2-3/4"). Each box to maintain the minimum four-times (4x) bend radius of the cable.
9. Installation must be performed by the low-voltage contractor.
10. Any unused UNLV owned material and/or WAP devices must be promptly returned to UNLV upon completion of work.

C. Interbuilding Outside Plant (OSP) applications

1. Use only five (5)-square, two and three-quarter inch (2-3/4") deep electrical boxes for the WAP Work Area (WA).

2. For OSP building wall locations, the electrical box must be located directly inline 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 mounting surface.
4. Recent design configurations may require all or a select number of WAP locations must be secured in an enclosed lockable, hard-plastic, NEMA-rated cabinet not disrupting any RF signaling. Check the Contract Documents.
5. Verify the proper mounting of the OSP WAPs with eleven and one-half inch (11-1/2”) (292 mm) antennas. The antennas are typically vertical two (2) up and two (2) down. The mounting keyholes must have the larger hole on bottom with the narrower slot on top. The brand name must be viewed horizontally and not upside down nor sideways. All must 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 twenty-four inches (24”) (610 mm) of the WAP. If this exceeds the twenty-four inches (24”) (610 mm) distance because of structural considerations, location is not-to-exceed, thirty-six inches (36”) (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 twelve inches (12”) (305 mm) of the AP. The AP must be located on the pole, ten to twelve feet (10'-0”-12'-0”) (3 - 3.7 meters) above finished floor (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 twelve inches (12”) (305 mm) of the WAP. Standard electrical boxes are not permissible.
11. For inside garage applications there are two (2) options: (a) use only weatherproof electrical boxes mounted within twelve inches (12”) (305 mm) of the WAP as stated for parking lot applications, or (b) use standard electrical boxes, paired with a clear or smoked plastic watertight 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 "floated" two (2) each, four (4)-pair terminated RJ-45 jacks (568B) inside the 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 (2) 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 two and one-half inch (2-1/2") (63.5 mm) "Square Box Extension Ring" with knockouts to accommodate the liquid-tight connector, so it can be secured to the bottom knockout.
17. This permanent link is not to exceed two-hundred ninety-five feet (295 ft.) (90 meters).
18. Note: The weather-resistant manufacturer patch cord threaded port must 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 must be filled with metal inserts or plugs.
22. Installation of the WAPs must be performed by the low-voltage General Contractor and their Subcontractors at the locations specified on OIT/NDE approved drawings.

3.9 Cleaning

A. The General Contractor and their Subcontractors must practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the Telecommunications Rooms and the associated work areas. This includes keeping inventoried material staging areas in the Telecommunications Rooms organized.
B. Once the Telecommunications Rooms are complete with terminated modular patch panels yet still exposed to sanding, dust and debris, the General Contractor and their Subcontractors must use blue painters' tape or an approved equivalent to cover the patch panel ports at no additional cost or time to UNLV/NDE. Only UNLV/NDE is authorized to remove the tape at the start of the cutover.
C. Upon completion of a project, all debris, empty boxes, excess material inventory, installation equipment and tools must be removed leaving the premises clean, neat, and orderly. Floors must 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.

3.10 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 inches (4”) (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.

3.11 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 must visually inspect (in phases) cable placement, cable termination, grounding and bonding (if applicable), and labeling of all components before testing can begin. Should any cable be found to be routed incorrectly, or bruised, kinked, scored, deformed, or abraded, The General Contractor and their Subcontractors must remove and discard cable and replace it with new cable at no additional cost or time 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 must be compatible with ANSI/TIA 568 and the installed cable/connector manufacturer cable part number(s) under test.

E. Tester setup must also include IEEE 'Compliant Network Standards' for either:

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

F. When testing for Wireless Access Points (WAPs) PoE ensures the tester is programmed for what is specified in the Contract Scope of Work (SoW): The UNLV/NDE current standard is Type Two (2) or 25.5W, but the next generation must be Type Three (3) or 60.0W that must be in compliance with:

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 are required to PASS;

1. Continuity or **“wire map**” check tests for opens, shorts, crossed and reversed pairs. Any discrepancies must be corrected before system testing can 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 must be tested with a one hundred percent (100%) PASS rate. *PASS is not acceptable. End-to-end cabling must 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 or time to UNLV.

3.12 Closeout Submittals

A. UNLV/NDE to perform a visual inspection and complete a walk-through with the General Contractor and their Subcontractors, and the design team. Any discrepancies must be addressed on a 'punch list' to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (48) hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. The UNLV/P&C PM must notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

B. Test results must be provided in both PDF and the native tester manufacturer software format.

C. Test files must be sorted by buildings, then their respective ER-MDF/TR-IDF and in numerical order. Test result must match port-to-port with As-Built drawings in PDF format.

D. Within thirty (30) days of Substantial Completion of the project or prior to project closeout, which ever comes first, provide manufacturer(s) system warranty(s) for minimum twenty-five (25) years covering all components, materials, and equipment plus the General Contractor and their Subcontractors' 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 connectors and cassettes. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) for installing/terminating the work area (WA) telecommunications outlets (TOs) in new or retrofit construction:
   1. Communications horizontal copper cabling terminating onto 8P8C modular, unkeyed RJ-45 jacks inserted into the four (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 not applicable.

B. The General Contractor and their Subcontractors must 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 Connectors 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. Four (4)-pair, one hundred (100)-ohm, balanced, unshielded twisted-pair (UTP).
   2. Cat 6A/Class EA 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 but must be authorized by UNLV/NDE.
   3. A minimum of two (2) cables run to each work area (WA) information outlet, referred to as the Telecommunications Outlet (TO).
   4. The Telecommunications Outlet (TO) is defined as the (four (4)-port) faceplate mounted onto a five (5)-square two and three-quarter inches (2-3/4”) deep electrical (single-gang) box mud ring or a (deep) surface mount box.
   5. A copper UTP cable run installation is a ‘permanent link’ without (‘channel’) patch cords between the modular patch panel and the Telecommunications Outlet (TO).
   6. Maximum distance is two hundred ninety-five feet (295’-0”)(90 meters).

7. Permanent link terminations between the UNLV standard 2RU 48-port flat modular patch panel and the four (4)-port station application henceforth referred to as the work area (WA) Telecommunications Outlet (TO).
8. The Telecommunications four (4)-port outlet (TO) faceplate's two (2) top ports are designated for termination while the two (2) lower ports are used for two (2) blank color-matching inserts.
9. The modular jacks are 8P8C RJ-45 jacks with 110 IDC terminations with wiring to the 568B standard and being able to accommodate 23-24 AWG UTP cable.
10. At the time of release of this Division 27 Specification, Version 1.4, the document does not take into consideration EPON, single-pair industrial ethernet applications, nor horizontal optical fiber to the desk (FTTD). All are not applicable.
11. Faceplate' is referred to as a 'wall plate'.
12. Krone LSA™ and Nortel BIX™ IDCs are not acceptable.

B. The forty-eight (48)-port modular patch panel, fully PCB loaded or open/blank, the faceplates and modular Keystone-style jacks must 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 must be either from the same connector manufacturer or an approved and documented equivalent business partner.

1.3 Communication intrabuilding and Interbuilding Optical Fiber Backbone and Components Defined

A. Use 8.3/125 µm single-mode fiber, OS1A (indoor) or OS2 (indoor/outdoor), optical-rated glass.
B. The interbuilding optical fiber backbone cabling system provides 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 interbuilding optical cable type is air-blown/jetted optical fiber (ABF) with nineteen (19)-cell microducts and a minimum 2RU forty-eight (48)-fiber strands each of 8.3/125 µm single-mode optical glass.
D. The intrabuilding optical fiber backbone cable provides the interconnections between the equipment rooms, main distribution frames (ER-MDF) and the Telecommunications Rooms, intermediate distribution frames (TR-IDF) in the telecommunications cabling system infrastructure.
E. The UNLV campus standard for intrabuilding premises cabling is traditional distribution, non-breakout, tight buffer 900 µm optical fiber cable although ABF fiber may be applicable. Check Contract Documents for riser-rating OFNR (optical fiber nonconductive riser-rated) or plenum-rated OFNP (optical fiber nonconductive plenum-rated).
F. Unless stipulated in the Contract Documents , armored optical fiber conductive riser-rated (OFCR) or plenum-rated (OFCP) and any related housings needing grounding and bonding are not applicable.

G. Both intrabuilding and interbuilding backbone cabling terminate/fusion splice onto pre-terminated optical fiber pigtail cassettes having duplex single-mode UPC LC connectors.

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 13 00; *Communications Optical Fiber Backbone Cabling,* and 27 15 00; *Communications Copper Horizontal Cabling* include 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; *Intrabuilding Optical Fiber Backbone Cabling*
    6. Section 27 13 23.02; *Interbuilding 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 must 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 current version and standard practices.
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 Association (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, faceplates, surface-mount boxes, and fiber cassette with UPC duplex LC connectors must be installed within the Contract Scope of Work (SoW).
B. The General Contractor and their Subcontractors must provide documentation verifying authorization as a cable/connector manufacturer along with the certifications of the assigned onsite technicians installing the copper and/or optical fiber terminated housings. The percentage of certified technicians onsite is dictated by the cable manufacturer for warranty purposes.
C. Contract documents to identify each building's floor plan Telecommunications Outlet (TO) locations for data, Wi-Fi, security and testing cameras, and optical fiber termination points (inside optical fiber enclosures and telecommunications distribution units [TDUs]).
D. Labeling schedule.

1.6 The General Contractor and their Subcontractors Qualifications

A. The awarded General Contractor and their Subcontractors must have a certified BICSI Registered Communications Distribution Designer (RCDD) on staff.
B. The onsite foreman/supervisor must be competent with authority to act on behalf of the General Contractor and their Subcontractors. They must 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 General Contractor and their Subcontractors must have 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 General Contractor and their Subcontractors must provide proof that their onsite personnel have the necessary training and certification(s) to satisfy the testing requirements to cable manufacturer warranty requirements and industry-recognized standards.

E. The General Contractor and their Subcontractors must 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 cassette housings must be free of defects in material and workmanship.
B. All intrabuilding premises cabling and terminations must be installed in a neat and workmanlike way.
C. Installation must be under the direct supervision of the assigned General Contractor and their Subcontractors's BICSI-certified supervisor(s)/lead(s) who, in turn, reports to the assigned RCDD Project Manager.
D. Both must be versed in the preparation of the shop drawings, cabling administration drawings, and field-testing program.
E. Testing of the installed systems must be performed by a member of the installation team who is BICSI and cable manufacturer certified.
F. Install and terminate the horizontal copper UTP cabling at work area (WA) telecommunications outlets 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 General Contractor and their Subcontractors must provide a one (1) year Parts and Labor Warranty along with the connector manufacturer's twenty-five (25)-year warranty for the particular project.
J. Products must be furnished with manufacturers' instructions and mounting hardware.
K. Products must be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
L. Transmission performance parameters must be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.
M. Installation work and materials must 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 must 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 five (5)-square, two and three-quarter inch (2-3/4") (70 mm) deep electrical box (with single-gang mud ring) or a single-gang surface-mount box.
    2. Covered with a four (4)-port faceplate; having the top two (2) ports designated for termination of the cable and the lower two (2) 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, one hundred (100)-ohm balanced, solid twenty-three to twenty-four (23-24) AWG four (4)-pair cable.
    4. Surface-mount boxes, faceplates, and modular RJ-45 jacks must 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 must be:
    1. Must be able to terminate unshielded Cat 6A/Class EA 4-pair UTP cable termination having solid twenty-three to twenty-four (23-24) AWG conductors.
    2. Female eight (8)-position by eight (8) conductor (8P8C) unkeyed FCC-compliant RJ-45 jacks wired/terminated to 568B standard.
    3. Use of a standard one-hundred-ten (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 must 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 must be fully encased to protect the PCB or printed circuit board and ultrasonically welded for tamper resistance.
    8. Connector pins must be flat having an industry-standard fifty (50) mil of gold plating that allows for a minimum five hundred (500) mating cycles.
    9. The IDC contact must 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 Wi-Fi IEEE 802.3bt for PoE++ Type 3 (60W).
    15. Krone LSA™ and Nortel BIX™ IDCs are not acceptable.
    16. In-line couplers/adapters are not acceptable.

2.3 Work Area Housing: Modular Faceplate Characteristics

A. Flush-mount flat four (4)-port, vertical, single-gang faceplate designed to mount onto a single-gang mud ring affixed to a five (5)-square, two and three-quarter inch (2-3/4”) 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 must not accept FCC-compliant 6-position (RJ-11) plugs or coaxial connectors.
G. Custom Wi-Fi access points faceplates are 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 technical design guidelines. 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 a metal surface-mount raceway must be used. No plastic.
C. Minimum size is one-and-one-half inch (1-1/2”) high x two-and-three-quarter inch (2-3/4”) wide (38 mm X 70 mm) to accommodate proper fill ratio and maintain copper UTP four-by (4x) bend radius.
D. Must use deep surface mount boxes (five(5)-Square) minimum two-and-one-half inch (2-1/2”) to two-and-three-quarter inch (2-3/4”) deep (64 mm- 70 mm). Can be plastic or metal.
E. Surface-mount options include extenders or stand-off rings, which provide the proper depth for mounting RJ-45 jacks. Angled faceplates or wall plates can also be used to achieve this depth.
F. Surface-mount plastic box color and finish determined by UNLV/P&C technical design guidelines. Typically, beige/almond/ivory.

2.5 Optical Glass

A. OS1A and OS2 8.3/125 µm
B. Optical fiber glass must comply with ANSI/TIA-492CAAB requirements for Class IVa dispersion-unshifted single-mode fiber.
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°C (-22°F) to +75°C (+167°F) 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 µm 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 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. Expected life expectancy is twenty-five (25) years.
G. See 2.7 Connector, LC for specifications.

2.7 Connector, LC

A. Transmission requirements for patch cable connectors, cassette 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. Must 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 must be crimped or fusion-spliced individually, whereas LC cassettes with pigtails must be fusion-spliced. No field polishing.
    11. Minimum five hundred (500) mating cycles.

PART 3: EXECUTION

3.1 Summary

A. The General Contractor and their Subcontractors must provide 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. Communications copper horizontal cables, as well as optical fiber backbone cables, must not be bruised, kinked, scored, deformed, or abraded cable. Splices are not allowed between either termination points.
C. The General Contractor and their Subcontractors must verify that each communications horizontal copper and optical fiber backbone cable run is correctly installed, terminated/spliced into the proper termination housings before testing can 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) Cat 6A/Class EA CMP cables to each work area (WA) telecommunications outlet (TO) location (the second cable is designated as a spare). The only exception allowing a single cable to be pulled must be approved by the UNLV/NDE RCDD or be specifically indicated in the specifications, such as those typically used for badge readers.
B. Communication horizontal UTP cables must be placed in pathways and spaces dedicated for communications cables.
C. This permanent link is not to exceedtwo-hundred0ninety-five feet (295'-0") (90 meters).
D. Maximum bend radius for UTP is four times (4x) the outside diameter (OD) of the cable and no less than one inch (1") (25 mm).
E. The height of a work area (WA) telecommunication wall outlet (TO) must be level with adjoining electrical outlet and the same color. When the telecommunication wall outlet (TO) is in solo locations, the cutout must be fourteen inches (14") (356 mm) AFF (bottom)/eighteen inches (18") (457 mm) AFF (top).
F. Cables routed to the work area (WA) telecommunications outlets (TOs) must be placed in minimum one-inch (1") (25 mm) EMT conduit between the walls and having a forty-five or ninety degree (45°-90°) stub-out on top towards the pathways going to the assigned Telecommunications Rooms. For masonry or solid wood walls, vertically route and secure the conduit on the surface along with the surface mounted five (5)-square electrical boxes.
G. Use only five (5)-square, two and three-quarters inches(2-3/4") (70 mm) deep boxes for work area (WA) outlets. Double-gang for six to ten (6-10) cables.
H. Outlet boxes must 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 must be outdoor weather-proof rated. For Inside/Outside applications, inclusive of below top floor parking lots and garages, UNLV/NDE and UNLV/P&C must determine if a clear plastic weatherproof outlet cover assembly is required.
J. Allow a minimum twelve inches (12") (305 mm) of UTP cable slack in a single-loop and secured on top near the stub-out abiding the four by (4x) bend radius and without kinking the cable.
K. If cable is in a dedicated conduit run from the Telecommunications Rooms to the work area's telecommunications outlet there must be no more than two (2) each ninety-degree (90°) bends without a pull box.

L. Inside the five (5)-square box, allow just enough slack in order 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 must be completed using no epoxy/no polish connectors. For individual fiber 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 must be slide-n-lock mounted in an optical fiber enclosure from the same manufacturer.
E. The enclosure must be mounted towards the top of an equipment rack or communications cabinet.
F. Fiber strand numbering must be consistent with the Consecutive Fiber Numbering (CFN) sequence as identified in the latest version of ANSI/TIA 568. This fiber strand numbering sequence between each fiber link must 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. The General Contractor and their Subcontractors must practice good "sweep clean" housekeeping and remove and empty trash on a daily basis from both the Telecommunications Rooms and the associated work areas.
B. Extra care must be 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 must be removed leaving the premises clean, neat, and orderly. Floors must 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 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 twelve (12) each duplex (LC) connectors.
3. Each subsequent cassette must 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 inches (4”) (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 Closeout Submittals

A. Test documents/results and As-Builts for both intrabuilding and interbuilding cable runs separated by the building's Telecommunications Rooms and then numerical order in PDF and native tester manufacturer software format. The completed installation must be approved by UNLV/NDE.

B. UNLV/NDE to perform a visual inspection and complete a walk-through with the General Contractor and their Subcontractors, and the design team. Any discrepancies must be addressed on a ‘punch list’ to the UNLV/P&C assigned Project Manager (PM). The General Contractor and their Subcontractors have forty-eight (48) hours to establish a time schedule in a mutually agreed upon timeframe to make the corrections and notify the UNLV/P&C PM. The UNLV/P&C PM must notify UNLV/NDE. This is a requirement to complete the UNLV/NDE closeout documentation.

C. Within thirty (30) days of Substantial Completion of the project or prior to project closeout, whichever comes first, provide manufacturer(s)’ system warranty(s) for minimum twenty-five (25)-years covering all components, materials, and equipment plus the General Contractor and their Subcontractors’ one-year workmanship documentation. Warranty documentation to specify project number and building ID(s)/floor(s) locations.

D. The General Contractor and their Subcontractors must provide:
   1. A one (1)-year parts and labor warranty against defective workmanship and cable system component failure.
   2. The associated cable manufacturer’s twenty-five (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 applies specifically to copper four (4)-pair UTP Cat 6 Class E and Cat 6A Class EA modular patch cords (male plugs) and OS1A and OS2 duplex UPC LC connector optical fiber patch cords. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) for installing either copper or fiber optic patch cords in new or retrofit construction.
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. The General Contractor and their Subcontractors are not responsible for the purchase or installation of modular copper or optical fiber patch cords, the exception being the installation of WAP patch cords at the WA side.
D. Neither must 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. A channel configuration having port-dedicated four (4)-pair patch cords for testing is not applicable unless specifically required by the cable/connector manufacturer for warranty purposes.
F. Modular patch cords must meet the requirements of IEEE 802.3af Type I and IEEE 802.3at Type 2
G. The optical fiber backbone cabling is considered a single fiber link point-to-point connection without the interconnectivity of duplex patch cords. The exception must be specified in the project specifications for testing a complete 100GBase-LR4 system with "hops" up to ten (10) km.
H. Unless otherwise specified in the project specifications, modular copper and optical fiber patch cords do not require a fire rating and do not have a riser-rated option. 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 four (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 Electrical 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 must be UL Listed, manufactured by an ISO 9000/9001-certified manufacturer, and RoHS 2011/65/EU compliant.
B. Each optical fiber patch cable must be individually tested:
    1. Each cable must include an identification test result tag or equivalent, with the part number and serial lot number included in the packaging.
    2. The tag must include either the LC duplex cable's individual test results or the maximum insertion loss (IL) 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 must have dust caps installed.
C. Packaging for each modular copper and optical fiber patch cord:
    1. Must be individually bagged in clear plastic bags hermetically sealed against dust and moisture.
    2. Securely looped with two (2) to three (3) lightweight twist ties or equivalent.
    3. Include test results with optical fiber patch cords.
    4. Modular patch cord outer packaging or visible identification tag must 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 cord outer packaging or visible identification tag must identify:
   a. Connector 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 must be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
B. Transmission performance parameters must be independently verified by UL or ETL/Intertek or an accredited Nationally Recognized Testing Laboratory (NRTL).
C. Testing organization compliance for performance and fire rating must be depicted or labeled at a minimum of every eighteen inches (18) (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 with 26–28 AWG stranded conductors.
B. Male eight (8)-position by eight (8) conductor (8P8C) RJ-45 plug wired/terminated to 568B standard
C. Dielectric pre-alignment element to position the individual conductors in a manner to optimize near-end crosstalk (NEXT) performance.
D. The plug must include an integral molded snag-less 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. Must be compatible with a “Keystone”-style female jack snap-in mount.
G. Connector pins must be flat and have an industry-standard fifty (50) mil of gold plating that allows for a minimum five hundred (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 (60 W).
M. Must be available in 4 ft., 6 ft., and 8 ft. lengths.

2.3 Optical Fiber Patch Cords

A. Must be constructed with aramid-yarn reinforced PVC loose jacket 900 µm duplex cable using heat-cured epoxy to mechanically secure the cordage to provide the 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. Must support 100GBase-LR4 per IEEE 802.3ba @1310 nm on UPC duplex LC connectors
P. Must be available in 1m, 2m, 3m, 5m, and 7-meter lengths

PART 3: **EXECUTION** **(Not 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 30 00

COMMUNICATIONS EQUIPMENT STANDARDS

PART 1: GENERAL

1.1 Summary

A. This Section applies specifically to Communications Equipment Standards. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) for installing Communications Equipment in new or retrofit construction.
B. The General Contractor and their Subcontractors must provide all labor, materials, and equipment required for the complete and proper installation of Communications Equipment within the Contract Scope of Work (SoW) for the UNLV/NDE ICT Structured Cabling System (SCS) unless noted otherwise (UNO).
C. Section Includes: Planning, construction, hardware specifications, and installation standards for telecommunications and emergency calling equipment across UNLV owned
and leased properties.
D. Scope of Work:
    1. Business, classroom safety, and conference IP telephony end-points.
    2. Emergency phones, towers, and specialized wall-mount enclosures.
    3. Custom mounting hardware, weatherproofing, and ADA-compliant pathways.
    4. Emergency lighting and power inverter systems dedicated to telecommunications equipment.
E. Related Requirements:
    1. UNLV Campus Wiring Design Guide.
    2. UNLV Police Services (UPD) Security and Egress Planning Directives.

1.2 References

A. ANSI/TIA-568: Commercial Building Telecommunications Cabling Standard.
B. ANSI/TIA-606: Administration Standard for Telecommunications Infrastructure.
C. Americans with Disabilities Act (ADA): Standards for Accessible Design.
D. NFPA 70: National Electrical Code (NEC).

1.3 Quality Assurance & Acceptance

A. System Integration: All provided equipment shall be native IP-based and fully capable of direct integration with UNLV’s existing network infrastructure and call processing systems.

B. Pre-Acceptance Protection: The contractor shall protect all enclosures, lighting assemblies, phones, wiring, and conduit from physical hazards, weather, and construction debris.
C. Damage Remediation: Any equipment or materials damaged prior to formal project acceptance and turnover shall be repaired or replaced by the contractor at no additional cost to the University.
D. Field Acceptance: Systems shall undergo functional field testing and receive written sign-off from UNLV Telecommunications prior to final acceptance.

1.4 Regulatory Requirements & Exceptions

A. Adherence: Compliance with these standards is mandatory for all retained architects, engineers, and installation contractors.
B. Deviations: Any proposed deviations must be submitted in writing and jointly reviewed by UNLV Police Services and UNLV Telecommunications prior to implementation. Equal or superior alternative concepts will be evaluated upon pre-installation submission.
C. Exception Requests: Formal requests for exceptions to these telecommunications standards must be submitted directly to the Director of Telecommunications.

PART 2: PRODUCTS

2.1 Approved Manufacturers

A. Business & Classroom Safety Phone: Cisco Systems, Inc.
B. Emergency Phone Stations: Talkaphone.
C. Uninterruptible Power Inverters: Myers EPS.

2.2 Telephony Endpoints & Mounting Hardware

A. Desktop & Classroom Safety Phones:
    1. *Standard Desk Phone:* Cisco 9861 (SKU: DP-9861-K9=), Carbon Black.
    2. *Classroom Safety Phone:* Cisco 9861 (SKU: DP-9861-K9=), Carbon Black.
    3. *Classroom Wall Mount Hardware:* Cisco 9800 Series Wall Mount Kit (SKU: DP-9800-WMK=).
B. Conference Room Phones:
    1. *Conference Station:* Cisco 8832 (SKU: CP-8832-3PCC-K9) with multiplatform phone firmware.
C. Emergency Call Stations:
    1. *Call Station Unit:* Talkaphone Single Button IP Call Station (SKU: VOIP-600E).

2.3 Emergency Phone Enclosures & Towers

A. Free-Standing Towers:

1. *Standard Tower:* Talkaphone SKU UNLV-002A Revision 1.0 (Free-standing tower with custom UNLV specification package).
2. *Multi-Function Tower:* Talkaphone SKU UNLV-009 (Tower platform with integrated armpost for Wi-Fi Access Points or surveillance cameras).

B. Wall-Mount Enclosures:

3. *Standard Wall Enclosure:* Talkaphone SKU UNLV-007A.
4. *Mass Notification Enclosure:* Talkaphone SKU UNLV-005 (Wall-mount enclosure with custom UNLV features and WEBS/EM integration).
5. *Aquatic Safety Enclosure:* Talkaphone SKU UNLV-008 (Pool safety variant).

C. Custom Accessories & Retrofit Mounting:

6. *Camera Arm Retrofit:* Talkaphone SKU OPTION-4P-ARM-UNLV-01 (Camera arm with integrated 2.5-inch OD post for mounting third-party antennas or wireless access points).
7. *Pony Wall Mounting:* Custom L-bracket assembly engineered to support wall-mount emergency enclosures on low structural/pony walls.

2.4 Power Inverters (Protected Power)

A. System Requirements: Myers EPS Illuminator LV Series mini-inverters connected to a dedicated 120 VAC branch circuit or UNLV Facilities-approved generator supply.

B. Approved Models:

Model Number	Dimensions (H x W x D)	Rated Capacity	Voltage Input
LV-2-R-2-B2003	22″ × 19″ × 9.25″	350W	120 VAC
LV-3-R-2-B2003	22″ × 19″ × 9.25″	550W	120 VAC
LV-4-R-2-B2006	22″ × 25.25″ × 9.25″	750W	120 VAC

PART 3: EXECUTION

3.1 Location & Placement Requirements

A. Classroom Safety Phones:
   1. Locate strictly within ADA-compliant reach ranges and operating heights.
      a. Maximum height to the top of the phone must not exceed forty-eight (48”) inches above finished floor (AFF).
      b. Wallplates must be installed horizontally.
   2. Position directly along the primary path of room egress.
   3. Coordinate placement with existing architectural features, spatial constraints, and furniture layouts.

B. Emergency Phone Towers & Wall Units:
   1. Placement locations must be pre-coordinated and jointly approved by UNLV Telecommunications and UNLV Police Services (UPD).
   2. Installation must ensure unobstructed ADA path of travel and access.
   3. Cat-6A cables installed must be OSP/ISP rated.

3.2 Installation & Weatherproofing

A. Enclosure Weather Sealing:
   1. Field-apply weather-tight seals on all field-drilled openings, structural penetration points, and backplate mounting holes on exterior-rated enclosures to eliminate water ingress.

B. Pony Wall Mounting:
   1. Mount designated L-bracket assemblies securely to structural pony wall framing, verifying that all load-bearing fasteners meet manufacturer torque and pull-out specifications.

3.3 Power Inverter Installation

A. Sizing & Calculations:
   1. The project electrical engineer must calculate required circuit ampacity, breaker counts, and fuse sizing, leaving one (+1) fully equipped spare breaker per unit.

B. Environmental & Mounting Clearances:
   1. Mount units exclusively in climate-controlled telecommunications spaces.
   2. *Mounting Height:* Measure 30 inches minimum to 48 inches maximum from finished floor to the bottom edge of the inverter cabinet.
   3. *Front Clearance:* Must maintain a minimum of 36 inches unobstructed clearance in front of the access door.

4. *Side/Top Clearance:* Must maintain a minimum of 12 inches clear air space on the top and both sides for heat dissipation.
5. *Plumbing Separation:* Must maintain a minimum 36-inch separation distance from any water source; never install directly beneath piping or fluid lines.

SECTION 27 30 00 - COMMUNICATIONS EQUIPMENT STANDARDS

– – – End of Section 27 30 00 – – –

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 Part 1 (General), Part 2 (Products), and Part 3 (Execution) General Requirements for Integrated A/V systems and equipment specifications in new or retrofit construction.
B. The Audio-Visual General Contractor and their Subcontractors (herein referred to as "A/V Contractor" or abbreviated "AVC") must 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 Contract Documents and that 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 Contract Documents, that ensures the installation is both fully functional and in compliance with all applicable laws, codes, rules, and regulations.
D. Per the scope of work (SoW), the AVC must provide a complete A/V system including delivery, installation, and warranty services as specified.
E. Subcontractors must not be authorized for A/V installations.

1.2 Definitions

A. The following abbreviations must apply:
    1. UNLV: University of Nevada Las Vegas is referred to contractually as the "Owner".
    2. A/V: Audio-Visual
    3. GC: The General Contractor and their Subcontractors
    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, General Contractor Installed refers to UNLV/CTS furnishing the equipment and supplying it to the AVC. The AVC 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 Documents and References

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

B. In particular, the subsections that are directly or indirectly related to the A/V cabling infrastructure include 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* include 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 Backboxes*
6. Section 27 05 36; *Cable Trays*
7. Section 27 05 41; *Firestopping Systems for Communications*
8. Section 27 11 10; *Telecommunications Rooms and Backboards*
9. Section 27 11 16; *Communications 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 must 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 must 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 Listener Areas*
6. AVIXA F502.01-2018; *Rack Building for Audiovisual Systems*
7. INFOCOMM F501.01-2015; *Cable Labeling for Audiovisual Systems*
8. ANSI/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 Ai*r

G. This Section has a direct correlation to Division 26 (Electrical)

H. If any change in the Contract Documents is required to comply with governmental regulations, the General Contractor and their Subcontractors must notify the UNLV/CTS at the time of submitting the construction schedule.

I. See Appendix A; *Codes, Standards, and Regulations.* This includes, but is 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 Materials
    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 for Standardization
    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 Association
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; Underwriters Laboratories (UL) Standards
30. UMC; Uniform Mechanical Code by IAPMO
31. UNLV Planning and Construction (P&C) technical design guidelines

1.4 The Roles of UNLV/NDE and UNLV/P&C

A. The UNLV/CTS A/V cabling system must 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 must 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, Telecommunications Rooms, and the horizontal copper cabling to a variety of work area (WA) telecommunications outlets permanently installed in floors, walls, and ceilings.
C. UNLV/P&C may be managing the design of the power connections. They must hire only licensed UNLV-approved electrical contractors (and AVC contractors). These high-voltage contractors are the ones who must install 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 includes conduit and boxes inside the walls, room lighting fixtures, dimmers, power receptacle outlets, and interconnecting wiring for these circuits.
E. UNLV/P&C must 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.

1.5 Scope of Work

A. The A/V project's Contract Documents 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 must 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. 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. a. Installation of lectern equipment, not mounted in rack space, on the lectern in UNLV/CTS specified location.
        b. b. Cable pass-through.
        c. c. Touch panel.
        d. d. Document camera.
        e. Lectern (CFCI), computer, monitor, mouse, and keyboard (OFCI) 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 (5) years documented experience in work of this Section. At least one member of the install team must have completed the dealer certification program before commencing installation.
    b. Authorized Manufacturer Representative: System must 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. Provide the AVC with access to buildings.
    3. Provide a Project Manager as the main project contact for the AVC provider team.
    4. Facilitate 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 must study the drawings and familiarize themselves with the work of the entire project scope. The work of this Section must 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 **in** accordance with 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 are 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 must ensure that the work performed 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 must generate all shop drawings and information for the complete installation and wiring of the system. The AVC must 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 must 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 must 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 themselves with all local conditions and the contract documents must not be accepted nor approved.

L. The AVC must 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 must provide all materials and assemblies and other work that is required, whether or not specifically mentioned in these specifications. All equipment must be completely installed with all the necessary interconnection and wiring to provide a fully functioning system(s).

N. The AVC must coordinate with GC/EC for all conduits, including 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 the Contract Documents, this document may supersede the drawings. The AVC must seek clarification and approval from UNLV/CTS. The AVC must consider all the information in combination and not consider one element alone to meet a minimum requirement.
B. The Contract Documents 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 fully operational systems.
C. If discrepancies occur between Contract Documents scope of work (SoW), local codes, Federal and State codes, utility requirements, most stringent requirements must apply.
D. Upon written request, the AVC must deliver proof that materials and/or workmanship meet or exceed requirements of the referenced standard(s).
E. No error or omissions in the Contract Documents or any related documents relieve the AVC from this responsibility to provide a complete and operational system .

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 must include:
        a. The 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 (1) 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 addition or removal of employees from the submitted project team must be approved in writing by UNLV/CTS and the design team.
7. Submit personnel résumés or curriculum vitae indicating detail that the Contractor has competent engineering, installation, service and maintenance personnel and facilities with reasonable stock of service parts. The Contractor to submit a warranty statement certifying that they are capable of conforming to specified warranty requirements.
8. Proof of documentation must be presented

B. The contractor must follow the project schedule as provided by the General Contractor (GC). Required adjustments to the schedule must 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 must 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 onsite 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 fifteen (15) business days after Award Letter and Notice to Proceed:
    1. All manufacturer data sheets (commonly referred to as “cut sheets”) must 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 must be from the manufacturer.
F. The Bar Chart Milestone, to include but not be limited to, time frames for the following:
    1. When work must 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 must be made available prior to any fabrication within the time schedule approved by the design team and the General Contractor and their Subcontractors. This must be noted on the electronics systems Bar Chart milestones submitted and approved during the Phase I Submittal Program.
H. Products must be furnished with manufacturer's instructions, mounting hardware, and warranty coverage.

1.11 Quality Assurance and Warranty

A. In the event of a conflict between cited standards and project specifications, notify UNLV/CTS; the more stringent requirement must govern. However, manufacturer instructions must take precedence over both .
B. At least one (1) AVIXA, Certified Technology Specialist (CTS) must be assigned, and must be onsite and oversee the complete installation of the system.
C. At least one (1) manufacturer certified programmer on staff.
D. The AVC's A/V technicians assigned to the systems must 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 must be free of defects in material and workmanship.
G. Products must be UL Listed and manufactured by an ISO 9000/9001 certified manufacturer and be RoHS 2011/65/EU compliant.
H. Products must be furnished with manufacturer's instructions and mounting hardware.
I. Transmission performance parameters must be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.
J. Shop Drawings must 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.
    1. Complete floor drawings, in the scale utilized in the Contract Documents, showing the locations throughout the project of all receptacles, pathways, wireways, pull boxes, junction boxes, equipment racks, microphone stations, speakers, visual displays and other devices associated with the specified systems .
    2. Complete system riser diagrams, showing all elevations, room numbers, pathway sizes, types and fills, box sizes and types, devices, equipment and rack designations.
    3. Full fabrication details of custom enclosure and millwork indicating size, material finish and openings for equipment.

4. Loudspeaker mounting details including hardware type, material and load capacity. Structural information to include design calculations and copy of engineer's seal.
5. 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.
6. Complete scaled (1/4"=1'-0") 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.
7. Complete heat generation details by device totaled per room must be compiled in spreadsheet form.
8. Run sheets or field wiring drawings: clearly show at each terminal point, the type of connector that must be used and include point to point wiring details of each connector. Take note of the connected shields and where they must float to ensure the integrity of the grounding system. Call out wire types and color-codes where appropriate.

K. Provide the manufacturer's warranty for the particular project.
L. Products must be UL listed and be manufactured by an ISO 9000/9001 approved manufacturer and be RoHS 2011/65/EU compliant.
M. Transmission performance parameters must 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 (1) unit of a specific product, all units purchased must be from the same manufacturer.
D. Equipment and material must be the current model and new (less than one (1) year from the manufacturer's manufacturing date), unused, and without blemish or defect.
E. Delivered materials and equipment to the project must be in the manufacturer's original, unopened, and labeled packaging. Packaging must provide protection against moisture, tampering, or damage from improper handling or storage. AVC must 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 must 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 must 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 a 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 must 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 must 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 must 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 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 must replace or repair the work at no extra cost or time 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 must be considered but subject to approval by UNLV/CTS. Unless approved by UNLV/CTS, AVC must not supply or install any equipment not specified.
C. Requests for substitutions must be submitted in writing to the UNLV/CTS and design team at the time of bidding. Suggested substitutions must be clearly identified, and product data sheets listing all relevant technical specifications must 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 must be received no later than one (1) week prior to the bid date. Any requests received after that date must not be accepted.
F. The bidding AVC must 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 must review the proposal and determine what course of action must 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 must 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 must be the sole responsibility of the AVC.

2.4 Major Equipment

A. If any specified product has reached end-of-life or is otherwise unavailable, AVC must provide an acceptable replacement that meets the requirements of the specified equipment. Any suggested replacements to specified equipment must be brought to the attention of UNLV/CTS and the design team as soon as the issue is identified and at no extra cost to UNLV.

B. Materials 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 must be considered a part of these specifications. Each material, device or piece of equipment provided must comply with all of the manufacturer's published specifications for that item.
    1. The A/V equipment specified consists of all major equipment for the project. The AVC must integrate all components and provide any additional components, wiring, or accessories required to complete a functional system.
    2. The manufacturer specifications must 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.
    3. 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.
    4. AVC must 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 the design team are not responsible for any additional costs related to restocking or delivery of non-functional equipment due to failure.
    5. Any and all potential product delivery delays that may cause equipment to be obtained less than four (4) weeks prior to its installation onsite must be brought to the attention of the UNLV/CTS and the design team within two (2) days of the delay notification by the supplier. AVC must make reasonable effort to order and secure

delivery of specified products, including alternates and substitutions, to meet the installation schedule.

6. UNLV/CTS and the design team must 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.
7. Refer to A/V wiring diagrams drawings for makes and models of all major pieces of equipment.

2.5 Additional Components

A. AVC is responsible for providing all necessary components and accessories to form complete working systems.
B. 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.
C. Provide required mounts and mounting hardware as referenced on A/V wiring diagrams and associated drawings including any necessary mounting hardware required.
D. Provide all miscellaneous hardware, fasteners, mounts, cable dressing, tie-downs, and safety cables to complete a permanent installation.

2.6 Cabling and Patch Cables

A. 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 must be from UNLV Appendix C; *Approved Telecommunications Manufacturers and Part Numbers.*
B. Transmission performance parameters must be independently verified by UL or ETL/Intertek or accredited Nationally Recognized Testing Laboratory (NRTL) testing organizations.
C. The standard fire-rating for communications horizontal copper UTP cable at all times is plenum or CMP-rated and in compliance with UL 910.
D. Cat 6A/Class EA UTP copper, 100-ohm balanced, solid 23-24 AWG 4-pair cable must be 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.
E. All patch cables must 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 must be installed but not purchased by AVC. The Work must 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, if 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 must include a list of all significant pieces of equipment with quantities in the documentation;
    1. 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, must be furnished and installed and to the highest quality of workmanship.
B. The performance of all equipment must 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 must provide a working project superintendent who must be an 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, Backboxes and pull boxes provided by others for the A/V cabling.
    2. Verifying onsite 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 any 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 and their Subcontractors (GC) including projection screens, screen low-voltage control interfaces, A/V Backboxes, 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 must be noted to the General Contractor and their Subcontractors (GC) not less than seventy-two (72) hours prior to the day of scheduled delivery stating the just cause in writing.
4. Must 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 UNLV/CTS. If requested, AVC must supply finished samples of each.
6. Coordinating with the millworker for any A/V items which must be built or mounted into millwork.
7. Cooperating at all times with the assigned General Contractor and their Subcontractors doing work on the same project. The purpose is to keep the project productive and ensure 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 must be detailed enough to reflect the same as shown in the UNLV/CTS A/V drawings and Contract Documents .

3.4 Fabrication and Installation

A. General
1. Installation practices must be in accordance with, but not limited to, the project's specifications and drawings. Installation must be performed in accordance with the applicable standards, requirements, and recommendations of authorities having jurisdiction. (AHJ).
2. Installation of the system must 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 must be made to UNLV/CTS. Modifications must not commence without written approval from UNLV/CTS.

4. The AVC must 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 must 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 must be repaired or replaced prior to installation at no additional cost or time to UNLV/CTS.
6. To ensure a proper finished appearance, the AVC must 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 must be finished to match the approved acoustic ceiling tile (ACT) ceiling grid system components. The AVC must 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 must 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 must 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 must be provided for all overhead items including but not limited to; lights, loudspeakers, video projector mounts, 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 must be matched in grade and be in conformance to U.S. Standard inclusive of ANSI, ASTM, and SAE. This includes, but is 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 must 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 must be included.
   4. Any equipment with front-panel controls that are not required for daily use must 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 must be removed, if possible.
      b. If removal is not possible, a custom method to affix security cover must be approved by UNLV/CTS.
   6. Ventilation and Cooling:
      a. A/V equipment racks must 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 must 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 must be tightened to a maximum torque of twenty-four inches per pound (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. All equipment mounted on shelves must have a security bar to prevent motion.
   8. Use only one-half inch (1/2") (13 mm) wide black Velcro™ with minimal one (1) inch (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 must be looped at the source device and secured with Velcro™ fasteners.

D. Wiring Cable Harnesses
   1. Shielded cables must be insulated. Shields not to have contact with conduit, raceways, boxes, panels, or equipment enclosures.
   2. Service loops must be maintained in or adjacent to all enclosures, termination cabinets, racks, and junction boxes. Service loops must not be excessive in length causing undue crowding in cable raceways. Cables must be neatly harnessed and dressed with Velcro™ fasteners having the appropriate amount to allow for future expansion.
   3. Cables must be harnessed according to professional best practices and to prevent

mechanical stress on electrical connections. No cable must 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 must be continuous and splice-free for the entire length of run between designated connections or terminations.
5. Care must 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 must exit the harness at the same elevation as the equipment to which the cables terminate.
7. Cables running in plenum spaces without conduit must 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 must be rated for the exposure and to match the performance characteristics of its equivalent cable as specified.
9. Wire bundles must be neat and combed free of cable crossovers.
10. As a general practice, power cables, control cables, and high-voltage level cables must be run on one side of an equipment rack. All other cables, especially those susceptible to interference must be run on the opposite side of an equipment rack.
11. Vertical cable bundles must 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 must 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 must be terminated in the appropriately rated termination enclosure (floor box). Termination of wires and cable, without an appropriately rated enclosure, must be considered defective, and must require replacement at no additional charge to UNLV/CTS.
2. Wiring connections must be secured so they cannot work loose under normal vibration conditions. Enclosures containing harnessed conductors must be sized so that the wiring harness may be neatly bundled together and distributed in an orderly fashion.
3. Bundled cable harnesses must not 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 must be used during the termination process. Crimping must be performed per the connector manufacturer’s instructions.

2. No terminations to have stress from cable weight or cable bending. Cabling must not be supported by a connection point.
3. Serial data interfaces must be wired using appropriate cable with an overall shield. These cables must be terminated with an appropriate connector that plugs directly into the serial-controlled device.
4. Except where noted otherwise in the specifications, bare wire terminations must not be accepted. Heat-shrink tubing must be used to insulate the ground or drain wire.
5. Unused wires at the end of a cable must remain unstripped and must 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 must 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 does not result in the reduction of electrical spacings.
7. Polarity (Audio) to comply as follows:
    a. a. The "high" side must be connected to “Pin Two (2)” on XLR connectors.
    b. b. The "low" side must be connected to “Pin Three (3)” on XLR connectors.
    c. c. Microphones must be wired so that an acoustic compression at the diaphragm produces a positive going signal on “Pin Two (2)” with respect to “Pin Three (3)”.
    d. Speakers must be wired so that when a positive going signal is applied to the “+” or red terminal an acoustic compression is produced.
    e. The system must 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 One (1) to the case of XLR connectors anywhere.
    b. Audio low-level signal lines must 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 must be located, oriented, and connected electrically so as to minimize hum and RFI interference. Further, plug-in type power supplies must be firmly attached using mechanical fasteners, such as lever-actuated splicing connectors unless

impractical, to its associated power receptacle. This must ensure against accidental removal and/or connection loss.

a. Joints and connections must be made with rosin-core electrical solder or with mechanical connectors and insulated with heat-shrink on each conductor as approved by UNLV/CTS.
b. Excess power cabling for devices must be looped at power source, with the exception of service loop at device.

3.5 Identification Schedule

A. Cable labeling must abide by INFOCOMM/AVIXA International Standard (F501.01:2015).
B. Cable labeling must follow cable schedules in A/V drawings.
C. The cable scheme is dictated by 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, could still be exposed to sanding, dust and debris, AVC must use blue painters’ or an approved equal to cover the patch panel ports at no additional cost or time to UNLV/CTS. Only UNLV/CTS is authorized to remove the tape at the start of the cutover.
D. Upon completion of a project, all debris, empty boxes, excess material inventory, installation equipment and tools must be removed leaving the premises clean, neat, and orderly. Floors must 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 must furnish the appropriate test equipment for testing and adjustments. Multiple functions listed below must be combined into a single instrument and be available onsite 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/audio test generator

units) providing HDMI output with a switchable signal enable function (on/off). The device must support High-bandwidth Digital Content Protection (HDCP), HDMI audio pass-through/generation, and Extended Display Identification Data (EDID) testing for connected sink devices. At a minimum, the test generator must support 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) Color bars, 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 must 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) must be flat 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) must be flat between 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 the loudspeaker channel to check for rattles, buzzing, and/or functional problems. Sweeps must 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. One-third (1/3) octave measurements taken at four inches (4”) (102 mm) 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 and bleed into the borders not exceeding one-quarter inch (1/4”) (7 mm) in any direction.
    2. Test Generator Grid: Grid is in focus across the 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 the 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 Thirty-Two (32) Segment Grayscale: All segments differentiate.
    5. Test Generator Two-Hundred Fifty-Five (255) Segment Grayscale: Smooth transition with no coloration.
    6. Test Generator 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.
    4. 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 Closeout Submittals

A. UNLV/CTS must 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 must submit marked-up Record Drawings as the as-built documentation.
    2. All changes to the Record Drawings must be indicated on these drawings.
    3. Drawings must be provided in .pdf for editing and the 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 in electronic spreadsheet format.
D. Training:
    a. Provide onsite training in the operation of the electronics systems for personnel designated by UNLV/CTS during the first thirty (30) calendar days of operation at no extra cost or time to UNLV/CTS personnel.
    b. Training must be able to start a minimum of five (5) working days prior to a system's completion date. Project training periods must be coordinated with UNLV/CTS and scheduled during regular business hours.
E. Inventory List and Documentation:
    a. The AVC must submit a spreadsheet listing the location, brand and model, description, serial number, firmware version, MAC address, and Ethernet ports must be connected to all network equipment by 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 the project, UNLV/CTS may be providing the necessary compiled Crestron program for selected classroom designs.

b. The AVC must 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 UNLV/CTS.
c. The AVC agrees that they must 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 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 must 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 must be for twelve (12) months from the date of final acceptance and be inclusive of all necessary parts and labor. The AVC must provide all equipment, material, and labor required to uphold a full system warranty at no charge to UNLV/CTS. Manufacturers' equipment warranties must be activated in UNLV/CTS's name and must commence on the date of final acceptance.
B. In conditions where the manufacturer's warranty has been voided, AVC must provide UNLV/CTS with a warranty equivalent to that of the original manufacturer.
C. AVC must respond with an onsite technician within twenty-four (24)-hours of a service call (including Saturday and Sunday) for all equipment and system failures that occur during the warranty period. The AVC must provide the name(s) and telephone number(s) of service personnel who must be contacted regarding repair and maintenance.
D. There must 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 manufacturers' warranties, the installed and aligned equipment must be serviced by only those installers authorized by the manufacturer. If the AVC is not authorized by the manufacturer, it is the AVC's sole responsibility to make the appropriate arrangements at no extra cost or time to UNLV/CTS.

———————— End of SECTION 27 40 00 ————————

INTEGRATED AUDIO/VIDEO SYSTEMS AND EQUIPMENT SPECIFICATIONS

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SECTION 27 51 23

ELEVATOR COMMUNICATIONS AND EMERGENCY MONITORING SYSTEMS

PART 1: GENERAL

1.1 Summary

A. This Section is specific to Elevator Communications and Emergency Monitoring Systems. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) General Requirements for Elevator Communications and Emergency Monitoring Systems specifications in new or retrofit construction.

B.

Vendor Turnkey Services:

1. System manufacturer/vendor (Kings III Emergency Communications) must furnish, install, and commission all elevator cab equipment, including the emergency phone unit, elevator cab camera, two-way messaging unit, and cellular gateway.
2. Kings III must provide 24/7/365 primary monitoring service for all voice, video, and text/messaging communications originating from the elevator cabs.

Division 27 Contractor Scope:

1. The Division 27 Contractor must furnish and install all supporting pathway infrastructure (conduits), category station cabling, pull strings, and patch field terminations required to connect the Kings III cellular headend unit to the Elevator Control Board, campus IDF room, and rooftop or appropriate exterior antenna location.

1. EQUIPMENT LOCATION AND SPATIAL REQUIREMENTS

A. Location Restrictions:

1. Per ASME A17.1 / NEC Article 620, non-elevator equipment and cellular transceivers must NOT be located inside the Elevator Machine Room/Control Room.
2. The equipment enclosure must be located in an adjacent, accessible telecommunications room (IDF), electrical closet, or designated wall space approved by UNLV Network Development & Engineering (NDE).

B. Wall Space & Enclosure Clearances:

1. Wall Enclosure Dimensions: 11" H x 9" W x 3.5" D maximum wall footprint for the Kings III cellular gateway/power enclosure.
2. Provide a minimum 36 inches of clear operational workspace in front of the wall enclosure per NEC standards.

3. Mount enclosure on a 3/4" AC-grade fire-retardant plywood backboard (painted white with two coats of fire-retardant paint, stamp left exposed).

2. POWER REQUIREMENTS

A. Division 26 Electrical Coordination:

1. Provide one dedicated 120V, 15A or 20A single NEMA 5-15R/5-20R electrical outlet mounted directly adjacent to (within 12 inches of) the Kings III equipment enclosure.
2. Power feed must be connected to a generator-backed emergency power circuit where available.

3. PATHWAY & CONDUIT (PER THE MOST RECENT UNLV CAMPUS WIRING DESIGN GUIDE [CWDG])

A. Conduit Specification: All pathways must consist of Electrical Metallic Tubing (EMT) complying with ANSI C80.3 and TIA-569-D standards.

B. Pathway Installations:

1. Equipment to Elevator Control Board: Install one 1-inch (1") EMT conduit extending from the Kings III wall enclosure location to the Elevator Machine Room / Elevator Control Board interface point.
2. Equipment to Roof/Exterior (Cellular Antenna): Install one 2-inch (2") EMT conduit running from the Kings III enclosure location to the roof deck or appropriate exterior location for the external cellular antenna run (if required due to building RF attenuation/penetration loss).

C. Conduit Execution Rules:

1. Conduit run must not exceed 100 feet or contain more than 180 degrees total in bends (two 90-degree bends) without an accessible pull box.
2. All conduits must be reamed, bushed, fitted with plastic end-cap grommets, and equipped with a minimum 200 lb. test nylon pull line.

4. CABLING REQUIREMENTS (PER THE MOST RECENT UNLV CAMPUS WIRING DESIGN GUIDE [CWDG])

A. Category Cabling Specification:

1. Provide two (2) dedicated Category 6A (CMR/CMP per plenum environment) cables per elevator extension from the Kings III equipment location to the elevator controller/traveling cable junction box.
2. Cables must comply strictly with ANSI/TIA-568-D and UNLV OIT Category 6A Standards (blue jacket color).
3. Max cable distance must not exceed 90 meters (295 feet) for permanent links.

B. Termination & Testing:

1. Terminate Category 6A runs on RJ-45 Category 6A modular jacks/patch panels as designated by UNLV OIT.

2. 100% of horizontal Cat 6A runs must be channel-tested and certified using a Fluke DSX-8000 (or equivalent) for 10GBASE-T compliance.

5. COORDINATION NOTE

A. Division 26 provides the 120V dedicated circuit; Division 27 provides the conduit runs, Category 6A cabling, and backboard space; Elevator Contractor lands connections into the traveling cable; Kings III installs cellular gear, cab devices, and provides active monitoring.

ELEVATOR COMMUNICATIONS AND EMERGENCY MONITORING SYSTEMS

– – – End of Section 27 15 23 – –

SECTION 27 53 19

DISTRIBUTED ANTENNA SYSTEM (DAS) INFRASTRUCTURE

1. POWER REQUIREMENTS (DAS HEADEND / REMOTE EQUIPMENT)

A. Dedicated Power Panel / Subpanel:

1. Provide a dedicated 100A, 120/208V, 3-phase (or 120/240V single-phase, per electrical drawings) electrical subpanel dedicated exclusively to DAS Headend Unit (HEU) and Remote Unit (RU) power distribution equipment.
2. Emergency / Generator Backup: The subpanel must be connected to the facility's Emergency Power Supply System (EPSS) / generator circuit and equipped with a dedicated Uninterruptible Power Supply (UPS) feed to maintain continuous RF coverage during power outages.
3. All circuits feeding DAS equipment chassis, battery backup trays, and remote units must be clearly labeled with panel and breaker designations per the most recent UNLV Campus Wiring Design Guideline (CWDG) Division 27 standards.

2. EQUIPMENT SPACE & WALL MOUNTING

A. Backboard Space:

1. Provide a minimum 4 ft x 4 ft (48" x 48") dedicated backboard space lined with 3/4" AC-grade, void-free, fire-retardant plywood (mounted smooth side out, painted with two coats of white fire-retardant paint with the fire stamp left exposed).

B. Depth & Clearances:

1. Maintain a minimum operational depth clearance of 12 inches for wall-mounted DAS Remote Units (RUs), fiber distribution boxes, and coaxial directional couplers/splitters.
2. Maintain a minimum 36 inches of clear working aisle space in front of all wall-mounted enclosures and rack-mounted DAS equipment in accordance with NFPA 70 / NEC guidelines.

3. PATHWAYS & CONDUIT (PER THE MOST RECENT UNLV CAMPUS WIRING DESIGN GUIDE [CWDG])

A. Conduit Specification:

1. All DAS riser, backbone, and horizontal distribution pathways must utilize Electrical Metallic Tubing (EMT).
2. Pathways supporting DAS fiber-optic backbones or ½" coaxial riser cables must comply strictly with ANSI/TIA-569 and the most recent UNLV Campus Wiring Design Guide [CWDG])

B. Installation & Bend Radius:

1. Sweep Bends: Conduit runs containing coaxial or fiber-optic cables must not contain more than two (2) 90-degree bends (180 degrees total) without a pull box.
2. Minimum Bend Radius: Conduit bend radius must be sized to accommodate RF coaxial cable and fiber minimum bend requirements (minimum 10 to 15 times the outside diameter of the pathway/cable).
3. Penetrations: Floor sleeves and wall stub-ups must extend a minimum of 3 inches Above Finished Floor (AFF), equipped with insulated grounding bushings and plastic end-cap grommets.
4. Provide continuous pull tapes (nylon/polypropylene, 200 lb. minimum tensile strength) in all empty DAS pathway conduits.

4. GROUNDING AND BONDING (RF / DAS INTEGRATION)

A. Equipment Grounding:

1. Provide a dedicated connection from the main Telecommunications Grounding Busbar (TGB) to all DAS headend chassis, remote nodes, coax surge protectors (lightning arrestors), and metal cable trays/enclosures per ANSI/TIA-607-D, NEC 250, and the most recent UNLV Campus Wiring Design Guide [CWDG]) Section 27 05 26.

5. COORDINATION NOTE:

A. Electrical (Division 26) must provide the 100A subpanel, generator backup tie-in, and final connections to the DAS UPS/power supplies. Division 27/DAS Contractor must be responsible for low-voltage signal distribution, RF cabling, coaxial pathways, and antenna placement.

DISTRIBUTED ANTENNA SYSTEM (DAS) INFRASTRUCTURE

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SECTION 27 53 19

SMALL CELL & DISTRIBUTED COMMUNICATIONS SYSTEM

1. GENERAL REQUIREMENTS & SYSTEM ARCHITECTURE

A. Scope of System:

1. Infrastructure must support an outdoor/indoor Small Cell Wireless Node Deployment utilizing a centralized VoltServer Digital Electricity™ (DE) Line Powering System (Class 4 / Fault Managed Power per NEC Article 722).
2. Centralized VoltServer Transmitter units located in the IDF/MDF must convert AC utility power into Digital Electricity packets and transmit remote DC power and data over hybrid copper/fiber cabling to remote Small Cell Node locations.

2. POWER INFRASTRUCTURE & ELECTRICAL COORDINATION

A. Primary Utility Power Feed (Division 26 Coordination):

1. Main Supply: Provide a dedicated 120/208V, 3-Phase, 4-wire, 200-Amp electrical subpanel dedicated to the VoltServer Digital Electricity Transmitter headend chassis.
2. *Note on Sizing:* Subpanel main breaker size and branch circuit counts are subject to final RF engineering designs and total small cell sector/antenna counts.
3. Emergency Backup: Electrical subpanel must be tied to the facility Generator / Emergency Power Supply System (EPSS) where available.

B. Remote Receiver Power Conversion (Division 27):

1. Remote small cell nodes must incorporate a local VoltServer DE Receiver (e.g., RX500 series) to convert incoming Class 4 Digital Electricity back to 48VDC / 120VAC for local radio head equipment.

3. EQUIPMENT MOUNTING & SPATIAL REQUIREMENTS

A. IDF/MDF Headend Space (Transmitter Location):

1. Open Bay Rack: Provide a standard 2-Post, 19-inch equipment rack (sized to 8U footprint minimum) with a minimum frame width of 26 inches and clearance depth of 20 inches to house VoltServer Digital Electricity Transmitters, fiber patch panels, and DC distribution chassis.

2. Wall Space Clearance: Provide a dedicated 2 ft x 4 ft (24" x 48") backboard wall space with a minimum clear depth of 24 inches for wall-mounted DE Junction Boxes, Primary Surge Protection (OVP), and fiber transition enclosures.
3. The wall backboard must be 3/4" AC-grade fire-retardant plywood painted white with two coats of fire-retardant paint (fire stamp visible).
4. Clearances: Maintain a minimum of 36 inches clear working aisle space in front of all racks and wall enclosures per NEC Article 110.

4. PATHWAYS AND CONDUIT (PER THE MOST RECENT UNLV CAMPUS WIRING DESIGN GUIDE [CWDG])

A. Pathway Construction:

1. All pathways must be constructed of 2-inch (2") Electrical Metallic Tubing (EMT) (or Schedule 80 PVC / Rigid Metal Conduit where exposed to weather/grade) to route hybrid fiber/copper cables and coaxial lines between the IDF equipment room and the small cell antenna locations.
2. Sizing permits two (2) multi-conductor hybrid or coaxial cables per 2" conduit run at a maximum 40% conduit fill ratio.

B. Execution Rules:

1. Conduit runs must not exceed 100 feet or contain more than 180 degrees total in bends (two 90-degree bends) without a NEMA-rated pull box.
2. Conduit sweep bend radius must be a minimum of 10 to 15 times the outside diameter of the conduit to protect hybrid/RF cable minimum bend radiuses.
3. Outdoor wall penetrations and roof penetrations must utilize weather-tight pitch pockets, Roxtec cable seals, or threaded weather-heads.
4. Pull line (200 lb. minimum tensile strength nylon) must be left in all installed conduits.

5. SMALL CELL ANTENNA MOUNTING TYPES

A. Installation Option A: Wall-Mount Deployment

1. Antenna and Remote Radio Units (RRUs) mounted directly to the building exterior facade utilizing heavy-duty galvanized/stainless steel wall mounts.

2. Requires structural engineering review to verify wind-load capacity and anchor attachment points on exterior masonry/curtain walls.

B. Installation Option B: Base-Mount / Non-Penetrating Roof Mount (NPRM)

1. Antenna and RRU assemblies mounted on a ballast-weighted base frame (NPRM) or direct-bolted curb/pedestal on roof decks or ground pads.
2. Requires protective rubber pads underneath ballast frames to prevent membrane damage, plus a dedicated ground tie-in.

6. GROUNDING AND BONDING

A. Grounding Connection:

1. Bond all metallic small cell equipment mounts, 2-post equipment racks, cable trays, and outdoor surge protection units (OVP) directly to the Telecommunications Grounding Busbar (TGB) using #6 AWG green insulated copper grounding wire in compliance with NEC 250, ANSI/TIA-607-D, and the most recent UNLV Campus Wiring Design Guide (CWDG) Section 27 05 26.

7. DIVISION COORDINATION SUMMARY:

A. Division 26 (Electrical): Provides the 3-Phase, 200A subpanel and main feeds to the VoltServer Transmitters.

B. Division 27 (Low-Voltage): Installs 2" conduits, 2-post rack/wall space, VoltServer DE equipment, hybrid cabling, and antenna mounting hardware.

C. Structural/Roofing: Reviews wind load calculations and signs off on wall anchorages or ballasted roof mounts.

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SECTION 27 80 00

VIDEO SURVEILLANCE SYSTEM (VSS)

PART 1: GENERAL

1.1 Summary

A. This Section is specific to Video Surveillance Systems and equipment. It describes the minimum requirements for Part 1 (General), Part 2 (Products), and Part 3 (Execution) General Requirements for Video Surveillance Systems and equipment specifications in new or retrofit construction.
B. The General Contractor and their Subcontractors must provide all labor, materials, and equipment required for the complete and proper installation of Video Surveillance 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).

1.2 Administrative & Planning Requirements

A. Consultation & Planning: A comprehensive recommendation plan for the installation of surveillance equipment must be developed in consultation with University Police Department, UNLV Planning and Construction (UNLV P&C), and the requesting unit where appropriate.
B. Cost Allocation: The requesting unit must be responsible for costs of new equipment, associated infrastructure, ongoing maintenance, repairs, replacements, and future upgrades.
C. Vendor Serviceability: All equipment must be non-proprietary or serviceable from multiple vendors who serve the Las Vegas valley.
D. Landscape Integration: Landscape architecture must consider the 10-year growth canopies of bushes and trees to ensure the surveillance cameras have an unobstructed view.

1.3 Submittals & As-Builts

A. As-Built Drawings: Contractors must provide as-built drawings to the UNLV OIT Network Development and Engineering department at least fifteen (15) business days prior to the physical installation of surveillance cameras.

1. As-built drawings must indicate exact camera locations, panel terminations, and cable routes.
2. Contractors must provide the make, model, serial number, and physical MAC address for all surveillance cameras and equipment.

B. IP Address Assignment: The UNLV OIT Network Development and Engineering department must provide the contractor with IP addresses for all surveillance cameras prior to physical installation.

1.4 Quality Assurance & Certifications

A. Contractor Certification: At the time of bid, all bidders must have a current Milestone Certification allowing the sale of Advanced Products.
B. Milestone Support Coordination: To ensure compliance with Care and Care Premium requirements, applicable integrators are encouraged to contact Milestone directly for assistance with pricing at salesus@milestone.us or (503) 350-1152.

1.5 Cybersecurity & Network Requirements

A. IT & Security Standards: Surveillance cameras and video management systems must meet security standards set by the UNLV Office of Information Technology (UNLV OIT).
B. Updates & Patching: All surveillance cameras and video management systems must be patched with the latest firmware/software and security updates.
C. Network Isolation: Public Internet access to surveillance cameras and video management systems is prohibited. All surveillance cameras and video management systems must be placed on a secure private VLAN and behind appropriate firewalls as prescribed by the UNLV OIT Network Development and Engineering department.

1.6 Maintenance & Warranty

A. Annual Maintenance: An annual maintenance contract is required to ensure surveillance cameras and their related equipment are in good working order with clean and properly focused lenses. B. Warranty Terms:
    1. Equipment Warranty: Five (5) years for all equipment.
    2. Labor Warranty: One (1) year labor warranty for all equipment.

PART 2 - PRODUCTS

2.1 IP Surveillance Cameras

A. Image Performance Requirements: For both day and night, recorded images must be of sufficient quality to enable University Police Department to clearly identify persons of interest (clear image of face, physical and clothing characteristics, items carried, vehicle make and model) and the capture of events.
B. Software Certification: Must be certified to support the current Milestone XProtect VMS release.
C. Pre-Approved Manufacturer: Axis Communications. Pre-approved Models: P3277-LV, P3277-LVE, Q6325-LE, P3737-PLE, P3747-PLVE, P4707-PLVE, P1487-LE.
D. Technical Specifications:
    1. Resolution & Frame Rate: Must support at least 5MP, 1080p @ 15fps.
    2. Compression & Streaming: Must support H.265 compression and multicast.
    3. Power: Must meet Power over Ethernet (PoE) compliance with the IEEE 802.3af standard.
    4. Environmental & Impact Ratings:
        a. Outdoor Cameras: Must be rated for IP66 and IK10.
        b. Indoor Cameras: Must be rated for IK10.

2.2 Recording & Storage Equipment (Network Video Recorders)

A. Centralized Data Storage: Surveillance camera recordings must be stored on existing equipment located in the UNLV OIT Data Center.
B. Storage Expansion: In the event new equipment must be purchased to expand storage space, the new equipment must adhere to guidelines established by the UNLV Purchasing and Contracts department and the UNLV OIT Server and Engineering department.
C. Bandwidth Contingencies: In the event bandwidth limitations make it impracticable to transmit surveillance camera recordings to the UNLV OIT Data Center, University Police Department will work with the applicable parties to determine the appropriate equipment and licensing to purchase.

2.3 Video Management System (VMS) Licensing

A. License Type: Unless otherwise specified, all bids or installations must include XProtect Corporate Device Licenses.
B. Software Maintenance Agreement: Each added device license must be accompanied by a Milestone Corporate device license with one (1) year of Milestone Care Plus & one (1) year of Care Premium.

2.4 Cabling & Conductors

A. Media Type: Wiring must consist of two (2) Category 6A Ethernet cables.
B. Standards Compliance: Cables must be installed, tested, and certified in adherence to the UNLV OIT wiring standards (refer to UNLV OIT Campus Wiring Design Guide).

PART 3: EXECUTION

3.1 Wiring & Network Integration

A. Cable Installation: Run two (2) Category 6A Ethernet cables per camera location in strict accordance with UNLV OIT Network Development and Engineering standards.
B. IP Configuration: Program and apply assigned IP addresses provided by UNLV OIT prior to physical deployment.

APPENDIX A

Codes, Standards, and Regulations

Link to Appendix A will be here when published.

Division 27 Appendix A

– – – 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)

Abbreviation / Acronym	Description / Second Description
AXT	Alien Crosstalk
b	One Bit
B	One Byte (eight [8] bits)
BAS	Building Automation System
BASE	Baseband (IEEE square wave signal)
BBC	Backbone Bonding Conductor
BC	Bonding Conductor
BCT	Bonding Conductor for Telecommunications (PBB>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; four (4)-pair balanced one hundred (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

Abbreviation / Acronym	Description / Second Description
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

Abbreviation / Acronym	Description / Second Description
(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

Abbreviation / Acronym	Description / Second Description
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

Abbreviation / Acronym	Description / Second Description
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)

Abbreviation / Acronym	Description / Second Description
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	Keypad
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.)

Abbreviation / Acronym	Description / Second Description
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	Not applicable

Abbreviation / Acronym	Description / Second Description
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 Association (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	Nevada 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)

Abbreviation / Acronym	Description / Second Description
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 Bonding Busbar (PBB)
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

Abbreviation / Acronym	Description / Second Description
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 (RCDD)
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

Abbreviation / Acronym	Description / Second Description
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 (SBB)
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 one hundred (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

Abbreviation / Acronym	Description / Second Description
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
TO	Telecommunications Outlet
TP	Transition Point
TR	Telecommunications Rooms (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
µm	Micron
UMC	Uniform Mechanical Code (IAPMO)
UNLV	University of Nevada, Las Vegas
UPC	Ultra-Physical Contact ferrule (LC connector dark blue - "Ultra-Polish Connector")

Abbreviation / Acronym	Description / Second Description
UPS	Uninterruptible Power Supply
UTP	Unshielded (one hundred [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
Wi-Fi	Wireless Fidelity (WAP & AP)
WLAN	Wireless LAN
W/O	Without
WP	Weatherproof
WSP	Wireless Service Provider
(X)	Scheduled for demolition/demo work
X	Times (e.g., eight by (8x) radius = eight (8) times the radius)
ZDA	Zone Distribution Area
1M	1,01,000 ft. (Manufactured) length of spooled cable fifteen percent (15%)
4-11	4 11/16" square electrical box, two and one-half inches (2-1/2") deep
5-square	Five foot (5'-0”) square electrical box, two and one-half inches (2-1/2") deep
8P8C	Eight (8) position x eight (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

Item	Division 27 Section	Definition
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**	**Telecommunications 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**

Item	Division 27 Section	Definition
M	**27 11 20**	**Communications Optical Fiber Enclosures**
N	**27 13 23 .01**	**Intrabuilding Optical Fiber Backbone Cabling**
O	**27 13 23 .02**	**Intrabuilding 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**

– – – End of APPENDIX C – – –

Approved Telecommunications Manufacturers and Part Numbers

APPENDIX D

Rack Elevation and Room Sizing Drawings

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Rack Elevation and Room Sizing Drawings