COMMUNICATIONS PROGRAM (CP)
CABLE PLANT STRUCTURED CABLING SYSTEM DESIGN AND INSTALLATION MANUAL

Version 2.0
November 2020

Document Revision Log

Revision	Date	Purpose	Author
1.0	01/21/2020	Baseline Document	C. Miller
1.0	02/12/2018	NICS CAB Approval	T. Dean
2.0	09/24/2020	Annual Update – NICS CAB Approval	C. Miller
2.0	11/02/2020	CAWG Approval	T. Dean
2.0	11/18/2020	CPB Version 2.0 Approved	T. Dean

Approval Authority:

JOSEPH SOLOMON

Digitally signed by JOSEPH SOLOMON
Date: 2021.01.04 07:45:13 -06'00'

Joseph B. Solomon — Date

NASA Communications Program

Program Manager

HAIG ARAKELIAN

Digitally signed by HAIG ARAKELIAN
Date: 2020.12.08 09:02:08 -08'00'

Haig Arakelian — Date

NASA Communications Program

Cable Plant Service Element Manager

CAROL Stephens

Digitally signed by CAROL Stephens
Date: 2020.12.31 16:39:18 -06'00'

Carol Stephens — Date

NASA Communications Program

Enterprise Architect

Concurrence:

Eric Latta (affiliate) Digitally signed by Eric Latta (affiliate)
Date: 2020.12.08 10:34:09 -06'00'

Eric Latta — Date

NASA Integrated Communications Service (NICS)

Enterprise Architect

Thomas Dean (affiliate) Digitally signed by Thomas Dean (affiliate)
Date: 2020.12.08 11:00:44 -05'00'

Thomas (Ted) Dean — Date

NASA Integrated Communications Service (NICS)

Cable Plant Service Manager

Table of Contents

List of Tables

List of Figures

1. Introduction

1.1 Purpose

A. The specifications and standards outlined in this document are intended to provide Architects, Engineers, Consultants, and Contractors with a comprehensive set of architectural, electrical, mechanical, and installation requirements for telecommunications rooms, associated support infrastructure, and the physical cabling within NASA facilities.

B. Furthermore, this standard is intended to meet the following objectives:

C. Establish a uniform agency standard by which all new building construction, renovation, and repair projects are governed as it relates to Cable Plant

D. Ensure that the Telecommunications rooms and cable pathways meet the current and future requirements of NASA

E. Facilitate the use of best practices related to cabling installation to provide longevity, risk reduction, and reliability in the cable plant infrastructure

F. Provide a reliable and secure cable plant infrastructure that meets or exceeds industry standards, federal, state, and local codes and regulations at NASA sites

G. Physical cabling infrastructure lays the foundation for a fast, highly reliable, and maintainable data network. Physical layer connectivity requires planning and proper installation to provide the means of transporting the information required for the successful mission of NASA.

1.2 Scope

A. At NASA, telecommunications and network technologies are critical elements in the design and commissioning of all new buildings and renovation projects. In turn, a properly designed and implemented structured cabling plant is fundamental to enabling these technologies. This document provides detailed Specifications and Drawings for the construction and implementation of equipment rooms, telecommunications rooms, pathways, and voice & data cabling for new building construction, building renovation, and repair projects.

B. The standards and Specifications detailed in this document are adapted from relevant industry standards and practices including the IEEE, NEC, NFPA, ANSI, TIA, and BICSI. As industry standards and best practices continue to change and evolve as new technologies are brought to market, this document will also change as needed to encompass new technologies and business directions.

C. Part numbers as well as technical specifications are subject to change by the manufacturer without notice. SAIC|NICS has endeavored to ensure the accuracy of all information within these standards. Contractors shall be responsible to verify the accuracy of all part numbers and specifications with the respective manufacturers.

D. Only products and manufacturers listed as approved per the SAIC|NICS Cable Plant Approved Product List (APL) document shall be utilized. Substitutions shall not be allowed. Loss of certification by Contractor, or unavailability of product to a Contractor that is not of a market wide nature, shall not be construed as an unavoidable circumstance.

E. The design intent is to provide a manufacturer specific, end-to-end solution for the voice and data cabling system. Contractors shall bid the cabling as an end-to-end solution in accordance with the design intent. The Cable Plant APL identifies approved hardware, components, connectivity, and cable for use at NASA facilities. Mixing or substituting of different manufacturers' products shall not be permitted.

F. Cables and terminations shall be provided and located as shown and in the quantities indicated on the drawings.

1.2.1 NASA Site Specifics

A. The category of cabling systems utilized is dependent upon the type of work being completed:

1. New construction or major renovation of existing buildings
    a. Category 6A rated cabling systems
2. Minor renovations and MAC work in existing buildings
    a. Match cabling to the type currently installed

B. SAIC|NICS has standardized on manufacturers product lines for end-to-end solutions. See Appendix C for directions to obtain the Cable Plant APL for all approved products.

C. All designs and work must adhere to the Cable Plant Target Architecture, Cable Plant Administration and Labeling Guide, and Cable Plant Approved Products List.

D. Any deviation from this document or any other referenced documents must obtain the proper approvals and waivers prior to design completion.

E. Refer to Appendix D for NASA site-specific references

1.3 Authority

The authority of this document shall be under the NASA Communications Program (CP).

1.4 Document Organization

1.5 References

All infrastructure design and construction shall conform to current industry standards, federal, state, and local codes. The following documents form a part of, and are applicable

to these Specifications. Where an effective date is not shown for any given document or publication, the issue in effect on the effective date a project is awarded shall apply. Any express conflict in documents shall be resolved by the NASA representative.

1. **NFPA 70**, National Electrical Code (NEC) (2017)
2. **NFPA 75**, Standard for the Fire Protection of Information Technology Equipment (2017)
3. **NFPA 780**, Standard for the Installation of Lightning Protection Systems (2017)
4. **NESC**, National Electrical Safety Code (NESC) 2017
5. **RUS PE-89**, Specifications for outside plant cable
6. **ANSI/SCTE 77-2007**, National Performance Standard for Underground enclosures
7. **TIA-568.0-D**, Generic Telecommunications Cabling for Customer Premises (September 2015)
8. **TIA-568.1-D**, Commercial Building Telecommunications Cabling Standard (September 2015)
9. **TIA-568.2-D**, Balanced Twisted-Pair Telecommunications Cabling and Components Standards (September 2018)
10. **TIA-568.2-D-1**, Addendum 1: Balun Requirements for Category 8 (April 2019)
11. **TIA-568.3-D**, Optical Fiber Cabling Components Standard (October 2016)
12. **TIA-568.4-D**, Broadband Coaxial Cabling and Components Standard (June 2017)
13. **TIA-569-D**, Telecommunications Pathways and Spaces (April 2015)
14. **TIA-569-D-1**, Addendum 1 - Revised Temperature and Humidity Requirements for Telecommunications Spaces (October 2016)
15. **TIA-606-C**, Administration Standard for Telecommunications Infrastructure (July 2017)
16. **TIA-607-C**, Telecommunications Bonding and Grounding (Earthing) for Customer Premises (November 2015)
17. **TIA-607-C-1**, Addendum 1 - Bonding in Multi-Tenant Buildings (January 2017)
18. **TIA-758-B**, Customer Owned Outside Plant Telecommunications Infrastructure Standard (March 2012)
19. **TIA-942-B**, Telecommunications Infrastructure for Data Centers (July 2017)
20. **ASTM A 123**, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
21. **ASTM C 913**, Standard Specification for Precast Concrete Water and Wastewater Structures

22. **ASTM E 184**, Standard Practice for Effects of High-Energy Neutron Radiation on the Mechanical Properties of Metallic Materials
23. **ASTM F 512**, Standard Specification for Smooth-Wall Poly Vinyl Chloride(PVC) Conduit and Fittings for Underground Installation
24. **ASTM B187-C11000**, Standard Specification for Copper, Bus Bar, Rod and Shapes and General Purpose Rod, Bar, and Shapes
25. **BICSI**, Telecommunications Distribution Methods Manual (TDMM) 13th Edition (2014)
26. **BICSI**, Outside Plant Design Reference Manual (OSPDRM) 6th Edition (2018)
27. **NCS**, National CAD Standards v6
28. **NEMA TC-2**, Electrical Polyvinyl Chloride (PVC) Conduit (2013)
29. **NEMA TC-6 and TC-8**, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations (2013)
30. **NEMA VE-1**, Metal Cable Tray Systems
31. **NASA NPR 8715.3D**, NASA General Safety Program Requirements
32. **NASA-STD-8719.11**, Safety Standard for Fire Protection (Revision A)
33. **PDS CNSS,** standard for Protective Distribution Systems by the Committee of National Security Systems
34. **CNSSAM,** Committee of National Security Systems Advisory Memorandum

2. Contractors

2.1 Contractor Qualifications

The term “contractor” includes any subcontractor or second tier subcontractors that are providing labor services and/or materials for the scope of the work.

Contractor shall be fully qualified to perform installations as described on the drawings and within these specifications and standards. The following qualifications apply to all work unless otherwise noted. SAIC|NICS reserves the right to waive any or all of these requirements.

A. All contractors working at NASA facilities shall be U.S. Citizens.

B. Contractor shall have been active in bidding, being awarded, and performing work consistent with that indicated on the drawings and in the specifications for a period not less than five (5) years.

C. Contractor shall possess current training and certifications by the specified manufacturers for the installation and maintenance of the voice and data cabling

systems, including firestop systems. Furthermore, the contractor must possess all respective certifications prior to bidding any project.

D. Contractor shall possess training and certification in the operation and use of all fusion splicing and test equipment.

E. Contractor shall possess current BICSI certifications (Technician, Installer 1, and Installer 2 Copper and Fiber) for the installation and maintenance of all voice and data cabling and associated equipment.

F. Contractor shall maintain an installation staff whose sole function is the installation of low voltage voice and data cabling and equipment and shall not utilize additional personnel obtained by means of a temporary placement or staffing agency.

G. Contractor shall not utilize apprentice or trainee personnel for the pulling or termination of voice and data cabling. The primary laborer for the pulling of voice and data cabling must be a certified installer.

H. All installation personnel assigned to the task of pulling or terminating cabling shall possess a current certification by BICSI, Trade equivalent, and/or the manufacturer for the specified cabling and connectivity products.

I. Contractor shall have a dedicated Registered Communications Distribution Designer (RCDD) assigned to the project, as Project Manager, who shall be the sole point of contact to SAIC|NICS or its representative. The RCDD/Project Manager shall provide regular project updates to the NASA representative as to percentage of job completed detailed by category of work, for example: horizontal cabling, backbone copper, backbone fiber, etc., the status of any unforeseen circumstances, and/or changes to the project design necessitated by field conditions.

J. Contractor is responsible for maintaining a drug-free environment, as NASA and SAIC|NICS are a Drug-Free Workplace.

K. Government Holidays and Mission Freeze dates will be observed unless otherwise approved.

2.2 Workmanship

A. All materials shall be installed in compliance with the recommendations of the respective manufacturer, current industry standards, these standards, the National Electrical Code, all applicable state and local building and fire codes, and best practices.

B. All work shall conform to the requirements of the Specifications. The installation, construction, cable terminations, and splicing shall be performed by workers trained and skilled in this type of work.

C. Contractor shall meet all OSHA and SAIC|NICS requirements related to safety and equipment operation. Work shall be performed during normal, day shift working hours, except where SAIC|NICS has elected second or third shift option.

D. Contractor shall be responsible for repairing all building and outside cable plant faults due to Contractor's installation defects, poor workmanship, and/or negligence, at no additional cost to SAIC|NICS prior to acceptance of the Work. SAIC|NICS personnel and/or agents shall have free access to the work at all times.

E. Contractor shall be responsible for repairing any customer assets in areas of work due to Contractor's installation defects, poor workmanship, and/or negligence, at no additional cost to SAIC|NICS prior to acceptance of the Work. SAIC|NICS personnel and/or agents shall have free access to the work at all times.

F. Work shall be installed in accordance with all applicable provisions of the National Electrical Code, as interpreted by the local authority having jurisdiction, as well as any further modifications or regulations published by local or state authorities.

2.3 Verification of Details

A. Contractor shall become familiar with details of work in the field and shall advise the SAIC|NICS designated Project Cable Plant Engineer in writing of any discrepancy in the design prior to commencement of Work.

B. Contractor shall acknowledge that it has investigated and satisfied itself as to all of the conditions affecting the Work. Any failure by the contractor to become acquainted with the available information shall not relieve contractor from responsibility for estimating properly the difficulty or cost of successfully performing the requested Work. SAIC|NICS shall assume no responsibility for any erroneous conclusions or misinterpretations made by contractors based on information made available by SAIC|NICS.

C. Specifications or Drawings errors and/or omissions detailing the tasks necessary to perform the Work and carry out the intent of the design or that are customarily performed shall not relieve Subcontractor from performing such omitted details.

D. Contractor shall be responsible to verify quantities for all equipment, cabling, components, and materials prior to submitting a bid. Subcontractor shall accept full responsibility for accurately estimating the Work and Materials based on the Specifications and Drawings.

2.4 Permits and Fees

A. Contractor shall secure and pay for any permits and inspections required for completion of the Work as required.

B. Contractor shall provide proper notice as required by law relative to the Work in their charge. Contractor agrees to comply with all applicable laws, including the applicable provisions of any federal, state, or local law or ordinance and all orders, rules and regulations issued thereunder.

2.5 Labor and Materials

A. Contractor shall provide and pay for labor, materials (per Statement of Work), equipment, tools, test equipment, construction equipment and machinery, transportation, and other services necessary for the proper execution and completion of the Work, unless otherwise noted.

B. Contractor shall enforce strict discipline and order among contractor's employees and subcontractors in performance of the Work.

C. Contractor retains title to all materials until fully installed and accepted by SAIC|NICS, unless otherwise noted.

D. Contractor has reviewed the qualifications of the individuals hereunder and certifies that all individuals meet the minimum qualification requirements for the specific work to be performed.

2.6 Safety

A. Contractor shall adhere to the latest edition of the American National Standards Institute (ANSI) National Electrical Safety Code (NESC), National Electrical Code (NEC), Local NASA Safety, Health & Environmental (SHE) Standards, OHSA Standards, and all local fire and safety regulations.

B. Contractor shall adhere to the NASA Confined Space Program. All employees working on identified confined space projects shall be NASA Confined Space trained or authorized by NASA Safety personnel prior to the commencement of work.

C. Contractor must follow all asbestos regulations for working in an asbestos environment including training, certification levels, respirator fit testing, physicals, and competent person per NASA center requirements. This is to include all OSHA standards, EPA regulations and standards, and NASA Procedural Requirement (NPR) 8715.1, NASA Occupational Safety and Health Programs. Contractors certified in asbestos abatement are to perform work only at the level for which they are certified.

D. Contractor shall be required to perform a Job Hazards Analysis (JHA) and provide a Health and Safety Plan (HASP) that shall be approved by NASA and or SAIC|NICS prior to the commencement of work. Contractor(s) shall comply with OSHA "General Industry" Standards of 29 CFR Parts 1900 to 1910, and "Construction" Standards Part 1926 as applicable. All employees are required to sign the JHA and HASP indicating they have read, understand, and will follow the safety procedures outlined in the JHA and HASP.

E. SAIC|NICS reserves the right to inspect contractor's work at any time to ensure compliance with the aforementioned documents and specific safety procedures stated herein.

F. Contractor shall be responsible to follow all safety requirements, conditions, and procedures e.g., confined space, asbestos, etc. as set forth by NASA.

G. Should the contractor violate any safety procedures or requirements, SAIC|NICS reserves the right to issue a stop work order. The stop work order shall remain in effect until contractor has resolved the violation. Responsibility for the stop work order shall rest solely with contractor with no cost or schedule impact to SAIC|NICS.

2.7 Protection of Persons and Property

A. Where applicable, the use of Personal Protective Equipment (PPE) is mandatory on all cable plant work at NASA Centers per OSHA and NASA Safety procedures. At a minimum, this PPE includes steel toe shoes, class 2 safety vest, hardhat, and safety glasses.

B. Contractor shall be responsible to provide all safety equipment and for the enforcement of all safety requirements including, but not limited to, use of hard hats, safety glasses, hearing protection, safety belts, tool tethers while working overhead, safety cones, and preventing personnel from working overhead while others are working underneath.

C. Contractor shall provide protection of persons and property throughout the progress of the Work. Contractor shall provide the necessary safety equipment, barricades, and signs to protect personnel and property of their own, their employees, subcontractor’s employees, and other trades working on the Site.

D. Contractor agrees to exercise reasonable care to avoid damage to NASA facilities and property of others. Contractor shall assume full responsibility for all damages to such facilities arising out of or caused by the conduct or property of contractor’s negligence. Contractor shall make an immediate report to SAIC|NICS of the occurrence of any such damage and hereby agrees to repair or replace at contractor's expense, or to reimburse NASA and or SAIC|NICS, or such other parties for expenses incurred by them in making necessary repairs and replacements.

2.8 Cleaning

A. In performance of the work, contractor shall make every reasonable effort to protect floors, carpets, ceiling tiles, walls, and other property from damage, and shall restore all such property, subject to the Work, to conditions substantially the same as when Work began.

B. Contractor shall be responsible for daily cleanup and removal (within contractor's work areas) of all non-salvageable materials and debris resulting from the execution of Work. Contractor shall be responsible for removal of materials and debris from Site. Oil waste, rags, or flammable materials must be removed from the building immediately after use.

C. Contractor shall ensure that all work in finished areas of the building are cleaned and restored to the same conditions as before the work. All salvageable materials not used or not yet installed shall be properly stored and secured.

D. Contractor shall clean equipment room racks, cabinets and wall field equipment at conclusion of installation to remove all dust, debris, and garbage from the work site.

E. Contractor shall properly firestop all rated penetrations in accordance with NASA's Health and Environmental Safety Standards.

F. Contractor shall ensure that all ceiling tiles are replaced and properly seated.

2.9 Storage Space

A. Storage space is limited and/or not secure. Storage of Materials shall be the responsibility of contractor. Outside space for placement of a construction trailer or storage container must be coordinated through SAIC|NICS or the Construction Manager. All costs associated with a construction trailer and/or storage container shall be included in contractor's bid proposal.

B. Contractor shall furnish and pay for all utilities, insurance, and security for any construction trailer and/or storage container placed on Site. Contractor shall be responsible for all connections to utility sources, including any required hardware and/or equipment required for making the connections.

C. Contractor shall remove all construction trailers and/or storage containers placed on the Site by the contractor or their subcontractors within ten (10) calendar days of notice from SAIC|NICS or ten (10) calendar days from Project completion date.

D. Contractor shall restore the site of the construction trailer and/or storage containers to its original condition. Contractor shall be responsible for all removal and restoration costs.

2.10 Badges, Driving, and Parking

A. Contractor agrees to abide by each of the NASA Centers' published policies on parking, driving, and badging rules.

B. Contractors are to follow all traffic laws and regulations while operating a motor vehicle at NASA facilities. Parking and traffic violation will not be tolerated.

C. Contractor shall submit a list of personnel to SAIC|NICS prior to commencement of Work. NASA and or SAIC|NICS shall provide the necessary access privileges as needed for the project.

D. As part of the badging process, all contractor personnel may be subject to finger printing and criminal background checks.

E. Contractor shall be permitted to park in designated areas as determined by NASA. NASA nor SAIC|NICS shall not be responsible for lost, stolen, or damaged contractor vehicles or property while parked on NASA's premises.

2.11 Responsibility for Tools and Equipment

Contractor shall be responsible to supply, maintain, and secure all tools, ladders, test equipment, lift equipment, and safety equipment. SAIC|NICS shall not accept any responsibility for the loss, theft, disappearance, or damage to equipment, tools, materials, or supplies of contractor, its employees, agents, or subcontractors.

2.12 Change Orders

A. All change orders shall be approved in writing by SAIC|NICS Contractual Representative. Under no circumstances shall verbal statement(s) be considered binding.

B. Justification for changes requiring cost increases or schedule delays shall be required in writing. Action on the change or Work affected by the change shall not be performed until Subcontractor receives written approval from SAIC|NICS Contractual Representative.

C. Any work performed by Contractor on a change order without following SAIC|NICS procedures shall be at the risk and expense of Subcontractor, and at no cost to SAIC|NICS.

D. As requested by SAIC|NICS, Contractor shall perform all necessary appraisals and field surveys to provide an estimate of the cost and schedule impact of the change request.

E. Based on the information provided in the change request, field notes, and surveys, Contractor shall provide SAIC|NICS with a written proposal with detailed unit prices for all labor and materials. Where applicable, all materials and labor shall be priced in accordance with the Unit Prices in the Contractor's base bid proposal. Contractor shall ensure that all information and pricing submitted with the proposal are complete and shall meet the intent of the change request.

F. Change order pricing shall remain effective for a period of 90 days from date of receipt by SAIC|NICS. SAIC|NICS will evaluate the change request in light of the cost and/or schedule impact on the Project and either approve or disapprove followed by notification to Contractor.

G. Upon receipt of written approval, Contractor shall assign a change order number to the change request. Approved changes shall be invoiced upon completion and acceptance. Change orders shall be separately itemized on all invoices.

2.13 Warranty

A. Contractor shall warrant that the Work shall be free of defects in material and workmanship for a period of one (1) year from the date of acceptance. Contractor shall promptly and at its own expense correct Work that is rejected by SAIC|NICS or Work that fails to conform to the requirements of the Specifications. In addition, the services provided shall be performed in accordance with the Specifications and with

that degree of skill and judgment exercised by recognized professional firms performing services of a similar nature and consistent with best practices in industry.

B. Contractor must provide a minimum 25-year manufacturer's warranty for all structured cabling installations.

C. Contractor shall assign to SAIC|NICS all manufacturers' warranties relating to any of the equipment and materials, specifically the respective manufacturers' extended warranties. Contractor shall deliver to SAIC|NICS copies of all such warranties.

D. Contractor shall warrant that it has obtained all applicable licenses for SAIC|NICS to use the materials and has paid all required royalties for use of the system for its expected useful life.

E. Contractor warrants that it has absolute title to and full right to sell said materials to SAIC|NICS as components of the system, and there are no liens, claims, or encumbrances of any kind whatsoever against said materials. Materials shall remain as so warranted at the time of delivery and final installation.

F. Contractor's warranty excludes remedy for damage or defect caused by abuse, modifications not executed by contractor, improper or insufficient maintenance, improper operation, normal wear and tear, and normal usage.

G. No inspection, acceptance of, or payment for the Work by SAIC|NICS shall constitute waiver of any warranties.

2.14 Submittals

A. Prepare shop drawings and product data sheets for telecommunications equipment with adequate details and scales as necessary to clearly show construction.

B. Indicate operating characteristics for each required item and design conditions. Submit the actual cable test data as generated by the manufacturer for the stock to be utilized for construction. Contractor shall review each submittal prior to submission and check for compliance with Contract Documents.

C. Shop drawings and product data shall include but are not limited to:

1. Copper Cabling
2. Fiber Cabling
3. Coaxial Cabling
4. Low Voltage Protection Devices
5. Outside Plant Splice Cases
6. Fiber Termination Housings
7. Fiber Connectors
8. Coupler Panels

9. Faceplates
10. Jacks/Inserts
11. Modular Patch Panels
12. 110 Wiring Blocks
13. Fiber Connector Housings
14. Racks & components
15. Cable Tray & components
16. Cable Ladder & components
17. Firestop material & assemblies
18. Cable and Component Mounting Hardware
19. CATV/Broadband Distribution System Cable, Components and Connectors
20. Telecommunications Grounding hardware and cabling

D. The submittals shall be reviewed for general compliance and not for dimensions, quantities, etc. The submittals that are returned shall be used for procurement. The responsibility of correct procurement remains solely with contractor. The submittal review shall not relieve contractor of responsibility for errors or omissions and deviations from the Contract requirements. Equipment substitutions are prohibited. If the submittal shows variations from the requirements of the Contract Documents for any reason, contractor shall provide written detail of each variation in the letter of transmittal.

E. Submittals shall be submitted in an electronic format. The file format shall be Adobe portable data file (.pdf).

F. Contractor shall note in red on the submittal any change in design or dimension on the items submitted including changes made by the manufacturer that may differ from catalog information.

G. Contractor agrees that shop drawing submittals, processed by the Architect, Telecommunications Engineer, or SAIC|NICS are not change orders or a means for equipment substitution. Contractor further agrees that the purpose of shop drawing submittals is to demonstrate contractor understands of the design intent. This understanding is demonstrated by articulating which equipment and material is required and by what methods of fabrication and installation shall be utilized.

H. Contractor agrees that if deviations, discrepancies or conflicts between shop drawing submittals and Contract Documents are discovered prior to or after shop drawing submittals are processed, Contract Drawings and Specifications shall take precedence and be followed.

2.15 Project Completion and Close Out

A. Project completion shall be defined at a minimum by the following requirements:

1. Contractor shall submit to SAIC|NICS a Manufacturer's Certification of Warranty for all installed cabling systems.
2. Contractor shall submit all applicable as-built documentation to SAIC|NICS for review and written acceptance as required elsewhere in these Specifications.
3. For work where Contractor is under Contract to a Construction Manager or General Contractor, Contractor shall submit a duplicate copy of all documentation to SAIC|NICS at the same time documentation is submitted to Construction Manager or General Contractor.
4. At the discretion of SAIC|NICS, Contractor shall provide demonstration of system performance by use of Acceptance Testing. Upon successful completion of each system demonstration, SAIC|NICS shall provide a written acceptance of each system.
5. Contractor shall submit all test results ensuring a passing performance (* PASS is not acceptable), record drawings, and all other documents necessary to commence the warranty periods for all equipment and devices as provided under the scope of the Project. Contractor shall provide proof of these submissions to SAIC|NICS.

   Contractor shall provide SAIC|NICS with electronic submittals as to the results of the installation testing within five (5) business days of completing the tests.
6. SAIC|NICS shall provide a final punch list to the contractor for completion within a set timeframe.
7. All punch list items shall be complete by the time of the Project closeout. If the contractor does not rectify all items on this list by the Project closeout date or at the discretion of SAIC|NICS, the Contractor shall provide a credit back to SAIC|NICS based on unit pricing garnered at the time of the bid. If no such unit pricing is available, a mutually agreed upon price, based on current recognized market value, shall be utilized.

B. Contractor shall complete all requirements of these Specifications. Any additional effort required at the time of the final walk-through due to the lack of submittals during the construction process shall cause forfeiture of final retainer either in part or in whole based on the degree of additional effort required. The exact nature of the magnitude of this forfeiture is at the discretion of SAIC|NICS.

3. Project Management

3.1 Project Manager

A. Contractor shall provide a Project Manager to manage and coordinate the Labor and Materials supplied by the Contractor for the Work as described in the site-specific requirements documents. Contractor's Project Manager shall be a single point of contact to SAIC|NICS. Contractor's Project Manager shall be responsible for fulfilling all project submittals and communications as stated herein and in the Contract Documents.

B. Contractor's Project Manager shall plan, direct, and control all portions of the Work as described on the Drawings and in the Specifications. Contractor shall conduct all phases of Work relevant to the project and any Change Orders in such a manner as to assure minimum interference to any SAIC|NICS related or other building construction related activities in the area(s) of work.

C. Contractor's Project Manager shall attend regularly scheduled meetings with SAIC|NICS. The purpose of these meetings shall be to discuss work progress, scheduling, identify problem areas, as well as opportunities to improve efficiency by recommending alternative procedures. Contractor's Project Manager shall contact SAIC|NICS after contract award, but prior to installation start-up, to determine the date of the Project Kickoff Meeting. At the Kickoff Meeting the frequency, day, and time of the project meetings will be jointly established.

D. Upon completion of the project, including submission of all as-built drawings and documentation, Contractor's Project Manager and SAIC|NICS shall hold a Project Closeout Meeting. The purpose of this meeting shall be to discuss remaining contractual issues, warranty start date, Subcontractor's warranty call procedures, and review all final as-built documentation for completeness and accuracy.

3.2 Project Schedule

A. Contractor shall be required to adhere to the project milestone and implementation schedule contained in the Contract Documents and agreed to as part of Contractor's proposal. Upon award of Contract, Contractor shall submit a detailed implementation schedule to SAIC|NICS. Contractor's Project Manager shall provide weekly updates as to the progress of performance compared to the project schedule. Any changes to the schedule shall be reviewed and approved in writing by SAIC|NICS. Revisions to approved schedule changes shall be reflected in the project schedule presented at the next project meeting.

B. Contractor shall be responsible to meet project schedule milestones and completion timeframes. Delays shall not be permitted unless approved in writing by SAIC|NICS. Contractor shall be responsible to make up for all schedule changes resulting in lost time that are caused by Contractor's inability to plan or properly coordinate work effort in accordance with the Project Schedule.

C. Telecommunications Rooms shall have project milestones included in any construction project, ensuring the early completion of architectural, mechanical, and electrical systems within the data rooms. This allows time for communications cabling to be installed according to project schedules.

3.3 Quality Control

A. Contractor shall provide quality control throughout the duration of the Project. Contractor's Project Manager shall conduct regular weekly inspections of all Work under Contractor's control. Contractor shall warrant the installation against all product defects, and shall warrant that all approved cabling components meet or exceed the requirements of the ANSI/TIA-568 standards and addendum.

B. Contractor shall ensure that all Work is performed in accordance with the Drawings and Specifications.

C. Contractor shall generate punch lists noting all deficiencies in the construction and installation of the system. A copy of these punch lists shall be provided to Contractor's installation personnel. Punch lists shall be accompanied with action-required statements.

D. SAIC|NICS reserves the right to conduct progress inspections of Subcontractor's Work in order to ensure quality and workmanship standards are being met. After each inspection and as necessary, SAIC|NICS shall generate a punch list of all areas where deficiencies in the Work are noted. The Contractor shall immediately correct all deficiencies noted on SAIC|NICS punch list at no additional cost to SAIC|NICS.

E. Contractor shall be responsible to identify and notify SAIC|NICS immediately of any issues causing the cabling and/or equipment to be installed in such a way as to cause that part of the installation to be in violation of the accepted standards and practices governing these types of installations. Failure to do so shall place the burden of the necessary repairs on Contractor.

F. Upon completion of all Work, including testing and labeling, Contractor shall conduct a final inspection and punch list with SAIC|NICS Project Manager. Prior to SAIC|NICS final Acceptance of any portion of the Materials and/or Work, Contractor shall ensure that all deficiencies are corrected.

3.4 Materials Management

A. If requested, the Contractor shall provide Materials management for all equipment, tools, materials, and hardware supplied by Contractor.

B. Contractor shall order the required Materials, track the orders through delivery, confirm receipt of Materials, store Materials, and distribute Materials to the Site as required.

C. Contractor shall be responsible to ensure that the Materials are properly stored and secured and conform to SAIC|NICS requirements as described in this Specification.

D. Contractor, at no cost to SAIC|NICS, shall replace all Materials believed and/or found to be defective, damaged, stolen, or missing.

E. Material orders and acknowledged ship dates shall be included in updates to the project schedule.

3.5 Subcontracts Management

A. Contractor may hire, as necessary, qualified Subcontractors for the installation of all or any portion of the network in accordance with the provisions and requirements in these Specifications, unless otherwise noted.

B. Contractor shall include in their proposals the names of all Subcontractors that are proposed or planned to participate in the work. SAIC|NICS reserves the right to reject any proposed Subcontractor(s) in whole or in part, unless otherwise noted. All personnel of said Subcontractor(s) shall be U.S. citizens and all employees shall meet the skill qualifications (education, employment experience, licensing and professional certifications) for performance on the resulting subcontract.

C. Any Contractor used to perform backbone or horizontal cabling Work shall be fully certified by the specified manufacturers. Subcontractor shall also meet all other qualifications as required of the Contractor listed elsewhere in these Specifications.

D. Contractor shall have sole responsibility for managing, coordinating, quality control, and evaluating the efforts of the Contractor's subcontracted labor, including pre-installation walkthrough, supervision, project communications, project meetings, material storage, security, phone service, and change order notification and preparation.

4. Outside Plant & Entrance Facilities

4.1 Maintenance Holes (MH)

A. General

1. MH shall be constructed of pre-cast (minimum 3500psi compressive) concrete materials with a minimum wall thickness of 6”. The manhole must conform to ASTM C913.

2. All materials used in a maintenance hole shall be resistant to corrosion. All steel shall be galvanized or zinc coated.

3. MH shall not to be used to house fiber optic splice cases. All splicing and terminating of cables shall be within designated equipment rooms within a building. Exceptions to be authorized by SAIC|NICS representative.

B. Exterior

1. Telecommunications MH shall not be adjacent to or share any walls with electrical MH. In addition, electrical power cables are not to be placed within telecommunications MH.
2. A conduit exiting a MH shall be aligned opposite the wall and at the same elevation where it entered the MH.
3. All conduits entering a MH will be sealed with a rubber boot from the outside of the MH prior to backfilling.
4. All joints in MH are required to be watertight with gaskets
5. The ductile iron cover shall be a minimum of 30” in diameter and shall be cast with the word "COMMUNICATIONS" in 2” letters.
6. Security of MH shall meet local center policy.
7. Unless otherwise noted, all MH shall be placed on 6” of compacted #57 limestone (determine requirements per local policy and procedures)
8. All MH shall have a unique identifier/label assigned to them, based off of current center’s procedure, for identification.

C. Interior

1. Minimum interior dimensions shall be 6'W x 6’L x 7’H. The maximum depth of all MH shall be ten (10) feet from the bottom to surface grade.
2. Racking equipment and cable supports are mandatory for all MH. A minimum of two (2) grounded cable racks, per side, shall be provided. All racks in MH shall be galvanized or zinc coated. MH shall have pulling rings cast into the wall opposite to each conduit entrance.
3. All MH shall have a grounded, galvanized ladder for climbing in and out.
4. MH shall be equipped with an approved ground and bonding ribbon.
5. All MH shall have a minimum 8” diameter sump for drainage near the ladder to allow for easy pumping access.

4.2 Hand Holes (HH)

A. General

1. HH shall only be used in pathways where duct-banks do not exceed three conduits (not more than a total of six conduits, three in and three out).
2. HH shall not be used as an intersection of two independent pathways, but can be used to form a radial branch of a single pathway (e.g. three in one side, one out of three sides, etc.). SAIC|NICS may waive the conduit count specifications in special circumstances where a maintenance hole cannot be installed.
3. Pathways shall be designed to ensure that the hand-hole is not exposed to vehicular traffic. HH shall be placed in the tree lawn whenever possible and

may be placed within sidewalks and other walkways or areas otherwise restricted to occasional traffic by light vehicles.

4. HH shall not be used to house splice cases. All splicing and terminating of cables shall be within designated equipment rooms within a building. Exceptions to be authorized by SAIC|NICS.
5. The maximum enterable HH size shall be 4'L x 4'W x 4'H.
6. Horizontal penetrations of the box shall be made using designated knockout locations, when available. Sidewalls of the hand hole shall not be penetrated in other locations without pre-approval from SAIC|NICS. Conduits may "stub-up" into the hand hole. Conduits that stub-up shall be within 2" of the HH sidewall.
7. Conduits entering a HH shall be aligned on opposite walls at the same elevation.
8. Unless otherwise noted, HH without bottoms shall be installed with at least a 4" layer of #57 limestone in the bottom to prevent mud from intruding into the HH.
9. Security of HH shall meet local center policy.

B. Materials

1. HH enclosures shall be designed and installed to withstand all loads likely to be imposed and shall meet the requirements in ANSI/SCTE 77-2002.
2. All HH shall be UL-listed and shall meet or exceed Tier 15 loading requirements.
3. HH covers shall be rated for heavy-duty applications and rated for extra heavy-duty applications where vehicular traffic will occur.
4. HH covers shall be lockable and labeled "Communications."
5. HH shall be available in various size configurations and be equipped with pulling eyes, cable racks and hooks and knockouts for conduit.
6. Unless otherwise noted, HH boxes and covers shall be standard gray.

C. Installation

1. HH shall be installed in accordance with the manufacturer's specifications and the local codes and ordinances.
2. HH with a depth greater than 24" shall be equipped with pulling eyes installed on the shorter sides of the box (or opposite sides of a square box), and galvanized steel cable racking.
3. Unless otherwise noted, HH shall rest on a bed of compacted #57 limestone measuring six or more inches deep and extending six or more inches beyond the sides of the box.

4.3 Underground Conduits/Duct-Banks

A. Clearances

1. The underground conduit/duct-bank shall be designed so that telecommunications cables do not share conduits, maintenance holes, hand holes vaults, pull boxes, or tunnels with any part of the electrical power distribution system.
2. The OSP pathways shall maintain the minimum separation distance from the electrical power distribution system as required by the National Electrical Code. Table 1 summarizes typical underground clearances. The Communications and Civil Manager may approve deviation from the provided information below.

Table 2: Typical Underground Clearances

Adjacent Structure	Minimum Separation
Power or Other Foreign Conduit:	3” of concrete, or 4” of masonry, or 12” of well tamped earth
Pipes (Gas, Oil, Water, etc.)	6” when crossing 12” when parallel
Railroad Tracks	50” below top of the rail
Street Railways	36” below the top of the rail

B. Conduits

1. The maximum distance between pulling points in a duct bank shall be less than 600’.
2. A minimum of eight (8), trade size 4” conduits are required between maintenance holes and/or buildings.
3. Either Schedule 40 and/or Schedule 80 are required for all OSP pathways depending on the route.
4. All conduits shall have a factory formed bell on one end for interconnecting segments.
5. All conduits and ducts shall be terminated with bell ends at the maintenance hole, building, or other termination point.

6. A nylon pull cord shall be installed and tied off in each conduit. The nylon pull cord shall have a minimum tensile strength of 200 pounds.
7. The installation of innerduct, including MaxCell or micro-duct for air blown fiber, is permitted.

C. Concrete Encasement

1. The minimum depth for the top of the duct bank shall be 32” below ground surface. Where local conditions require a lower depth, the local conditions shall apply.
2. High impact spacers shall be used along the entire pathway in all multi-duct systems. Spacers shall conform to NEMA TC-2, TC-6, TC-8, and ASTM F 512 dimensions. Duct spacers shall be installed at or near joints and no more than 5’ apart to provide adequate support and keep ducts uniformly separated.
3. All duct banks shall be concrete encased, shall be rebar reinforced with #4 rebar, and possess a minimum load strength of 3500psi. A minimum of four (4) steel reinforcing rebar rods shall be installed parallel to the conduit. In addition, these rebar rods shall be reinforced every 6’ with perpendicular rebar rods centered in between the spacers. Where conduits enter a building or a manhole, the rebar must be doweled into the structure to prevent shearing of the conduits in case of settlement. All duct banks shall use PVC conduit spacers (chairs) spaced at 8’ intervals. Duct banks shall be placed on 2” concrete mud mat prior to duct bank placement.
4. Each duct-bank run shall be installed with a continuous concrete pour. Construction joints between manholes are not permitted without written exception from SAIC|NICS.

D. Bends

1. All bends shall be manufactured sweeping bends. However if a manufactured bend cannot suffice for the installation, long radius bends (over 30’) shall be used whenever possible to make changes in direction. Long radius bends must not decrease the inner diameter of the conduit.
2. When necessary to place a 90° bend in the conduit run, a factory-made sweep with a minimum 48” radius shall be used.
3. Cold-formed trench bends shall have a minimum radius of 40” and shall pass mandrel integrity.
4. The bend radius criteria for conduits 2” or less shall be 6-times the inside diameter of the conduit and, for any conduit larger than 2”, 10-times the inside diameter of the conduit.
5. The maximum equivalent of two 90° bends is allowed between pulling points, including offsets and kicks.

6. Any single bend shall not exceed 90°.

E. Drainage of Duct-banks

1. Duct banks shall be pitched to drain toward manholes. All conduit, tubing, raceways, ducts, and duct banks shall be installed in such manner to insure against collection of trapped condensation. Raceway runs shall be arranged to be void of traps.
2. When conduits pass through exterior concrete walls of any facility, the entrance shall be watertight.
3. Wall sleeves at entrance points must be sized to provide a minimum of 1/2” clearance around the conduit to allow for proper sealing of the penetration.
4. All conduits shall have watertight connections and be sloped to drain away from the building entrance. All empty conduits are to be plugged and sealed with the proper materials to prevent water drainage into the building.

F. Tracer Wire

1. All new non-metallic duct banks shall be installed with tracer wire. Duct banks constructed of metallic conduits do not require a tracer wire unless the metallic conduit is not continuous along the entire route of the duct bank. Tracer wire shall be installed to enable the detection of plastic pipes and fiber optic cables.
2. The tracer wire shall be designed specifically for detecting buried utilities. Tracer wire shall be 12AWG copper wire coated with a 30-mil polyethylene jacket designed specifically for buried use.
3. The tracer wire shall be installed continuously along the entire pathway. Splices in the tracer wire shall only be permitted in maintenance holes, hand holes or vaults.
4. Splices in the tracer wire shall be connected by means of a split bolt or compression type connector to ensure continuity. Wire nuts shall not be used. Splices shall be sealed/waterproofed in shrink tubing rated for underground applications.

G. Warning Tape

1. Place warning tape a minimum of 18” above the duct-bank.
2. Warning tape shall contain metallic tracings to make it detectable.
3. Warning tape shall be a minimum of 3” wide, orange in color, and possess a non-degradable imprint that reads: “CAUTION COMMUNICATIONS CABLE BURIED BELOW.”

H. Photographic Records

1. Contractor shall photograph each segment of the conduit duct bank prior to and after concrete encasement.
2. All photographs shall be provided in digital JPEG format and labeled by segment in sequential order and submitted with the Contractor's as-built documentation.

4.4 Excavation, Trenching, and Backfill

A. All design requirements for excavation, trenching, and backfill shall be per NASA Facilities.

B. All construction shall follow NASA Facilities requirements.

4.5 Underground Cable Plant Installation

A. Test duct lines with a mandrel and swab out to remove foreign material before the pulling of cables. Avoid damage to cables in the setting up of pulling apparatus or in placing tools or hardware.

B. Do not step on cables when entering or leaving a manhole or hand hole.

C. Do not place cables in ducts other than those shown without prior written approval from SAIC|NICS.

D. Utilize appropriate cable pulleys and flanges to ensure cable does not exceed the minimum bend radius.

E. Roll cable reels in the direction shown on the cable flanges.

F. Under no circumstances shall the cable be fed from the bottom of a reel.

G. Utilize only cable lubricants recommended by the cable manufacturer.

H. Do not exceed the maximum allowable pulling tension during installation of the cable.

I. Contractor, at no additional cost to SAIC|NICS, shall replace cables that are damaged because of Contractor's installation procedures.

J. Cables shall not utilize the shortest route in manholes and hand holes. Route cables along walls providing the longest route and the maximum spare cable length. Do not interfere with cable duct entrances and support cables at a maximum span of 4'.

K. All fiber shall have a minimum of 50' of slack stored in key manholes. Slack shall be stored on an appropriate storage ring.

4.6 Aerial Cable Plant

A. General

1. Utility poles shall have limited use at NASA. New utility poles shall not be installed without SAIC|NICS's approval.

2. Aerial pathways shall only be used when existing poles are in place and available.
3. Contractor shall obtain permits, lease agreements, and any other required documentation for SAIC|NICS use of non-NASA owned poles. All documentation shall be in the name of NASA and shall be submitted to SAIC|NICS prior to installation.
4. Contractor shall adhere to requirements of the utility pole owner when using non-owned poles.
5. Contractor shall be responsible to survey the proposed pole line route and provide a detailed summary of all make ready requirements. Contractor shall perform all make ready work on NASA owned poles. For non-NASA owned poles, Contractor shall coordinate make ready requirements with the pole owner.
6. Contractor shall provide all necessary tools and equipment for safely working on utility poles.
7. Contractor shall comply with all local, state, and federal codes and regulations regarding pole line work. Personal protective equipment is required and shall be the responsibility of the Contractor.

B. Clearances

1. Clearances above streets, sidewalks, railroad and trolley tracks, alleys, etc. shall conform to the latest version of the National Electrical Safety Code, local codes, and ordinances.
2. Clearances between cables, conductors and/or electrical devices at each pole and the mid-spans must meet the National Electrical Safety Code, local codes and ordinances.

C. Installation

1. Cables shall be handled carefully to reduce unwanted bending.
2. The strand used to support aluminum-sheathed cables must be galvanized or aluminum coated 0.25” extra heavy steel (EHS). The lashing wire shall be stainless steel. Cable support straps will be either stainless steel or UV rated PVC.
3. Cable reel flanges shall be carefully inspected to insure that the surface is smooth and free from nails or other imperfections that will damage the cable while unreeling.
4. Prior to pulling the cable, ensure that all safety equipment and barricades are in place along the route to be pulled.

5. Cable blocks (rollers) will be placed on the strand along the entire length of the cable run at a maximum of 25’ intervals. A guide chute will be used at the first pole location for safe cable reel payout.
6. Bends of 45° and 90° will require the use of corner blocks for pulling the cable runs.
7. Contractor shall use a pulling eye and break away swivel when installing aerial cable. The pulling eye and break away should have pull tensions that are rated less than the pulling tension of the cable.
8. When using a winch or other mechanical pulling device, a dynamometer must be utilized when installing all cable along the strand to ensure the pulling tension of the cable is not exceeded.
9. All aerial cable(s) will be double lashed using .038" stainless steel lashing wire. When lashing the cable, the lasher should always be pulled in the same direction as the messenger strand was installed.
10. Cable/reel trailers must have tension brakes to ensure a steady pull and proper placement of the cable. Before pulling the cable onto the strand, the reel brakes should be applied. The amount of tension needed on the brake should be enough to turn the reel by using the strength of one hand. When the hand method of turning the reel is stopped, the reel should stop immediately.
11. Personnel shall be stationed at the cable reel at all times during cable pulling to ensure the cable pays-off the reel correctly.

D. Pole Guys

1. Contractor shall be responsible to install any additional pole back-guys in all locations where new pole mounting hardware is installed and the cable does not run through the pole at 180°. All pole guys will be installed in accordance with the latest release of the National Electrical Safety Code, and/or local, state, and federal codes and regulations.
2. All appreciable horizontal loads imposed by the new aerial cabling on non-self-supporting structures (e.g., poles) should be guyed.
3. Whenever possible, guys shall be attached at the same elevation as the messenger, preferably to the same bolt or attachment band.
4. Guy leads should be of a length to create an angle of 35° - 40° between the guy and the pole.
5. Whenever a short guy lead is unavoidable, especially on a substantial load, Contractor shall perform all calculations necessary to determine adequate guy strand and anchor size requirements.

6. Guy strand shall not be subjected to tensions above 60% of its ultimate rating during maximum loading conditions. (Refer to the National Electrical Safety Code for overload factors for specific situations.)
7. All anchors shall be properly sized and installed for the maximum expected messenger tension to ensure minimum “creepage.”

4.7 Building Entry Points

A. Underground

1. The duct systems shall be sloped to permit penetrating water to drain towards the manhole(s). The highest point of the duct array will be at the center of each run or at the building entry point.
2. Conduits shall be plugged with inserts to ensure that foreign matter does not enter the building.
3. Rigid (RGS) metal conduit shall extend from 5 feet beyond the exterior of the building foundation to the Telecommunications Room.

B. Above Ground

1. Rigid hot-dipped galvanized steel, 4” conduits shall be used as part of the duct system where conduits are exposed, cross open ditches, are attached to bridges or similar structure, etc.
2. All exposed pull boxes, junction boxes, etc., shall be NEMA-4 enclosures constructed of rigid hot dipped galvanized steel or approved equal.

C. Building Entry

1. OSP cables shall be enclosed in rigid metal conduit from 5 feet outside the point of building entry to the Telecommunications Room.
2. EMT or rigid metal conduit shall be extended from the building entry point into the equipment room. Appropriate sized pull boxes shall be designed into the pathway for all conduit runs that exceed 100’ and/or have more than the equivalent of two 90° bends.
3. All conduits must be grounded at both the building entry and Equipment Room to an approved ground with a minimum #6 conductor.

4.8 Dual Entrance Pathways

A. All new buildings should be equipped with dual entrance facilities, originating from separate and diverse pathways and manholes.

B. All standards that apply to the primary pathway and entrance facility shall apply to the redundant facilities.

C. Redundant OSP pathways must maintain a minimum 25’ separation up to the building entry. Once inside the building, diverse pathways shall be maintained until entering the Equipment Room.

5. Telecommunications Spaces (TS)

5.1 General

A. For the purpose of this document, telecommunication spaces (TS) shall represent any area or location that houses telecommunications equipment, hardware, and cabling.

Note: A true TS only, for instance as space within a hallway or corridor may not follow the full requirements in this section for buildout. In these circumstances, only the requirements necessary for the particular space shall be required.

B. TS’s shall have project milestones included in any construction project that ensures the early completion of architectural, mechanical, and electrical systems within the data rooms. This allows time for communications cabling to be installed according to project schedules.

C. TS’s shall be located above any threat of flooding and shall avoid locations that are below or adjacent to areas of potential water and steam hazards (e.g., kitchens, restrooms, laboratories, water fountains, steam pipes, etc.).

D. TS’s located below the water level shall have preventative measures in place against water infiltration.

E. A minimum of one TS per building will be dedicated to serve as the Main Distribution Frame (MDF). This room should be located in the lowest level of the building (minus the basement if possible). Alternate locations must be approved by SAIC|NICS.

Note - The size of the MDF can increase in size dependent upon the equipment to be housed in the room.

F. The quantity and placement of TSs is dependent on building size.

1. TRs shall be sized to accommodate the equipment planned for the room. At a minimum, the room should have 0.75 sf. of telecommunications room space for every 100 sf. of occupiable space.
2. A minimum of one TS per floor shall be placed in buildings.
3. The horizontal distribution distance to the work area shall not exceed 295’; this includes the horizontal and vertical component of the cabling.

G. Minimum room dimensions (dimensions shall be maintained): See Table 2 below.

Table 3: Room Dimensions

Telecommunications Space Dimensions	
Area Served by Closet (sq. ft.)	**Minimum closet size**
Up to 10,000 sf.	10'x 11'
8,000 to 15,000 sf.	10'x 15'
Greater than 15,000 sf.	10'x 20'+
Typical MDF Size	20’ x 20’

H. The preferred location for the TS is in the center of the floor space or area it is serving to minimize horizontal cable lengths.

I. In buildings with multiple floors, TSs shall be vertically aligned (stacked).

J. Each TS must be accessible from a main hallway or other common area.

K. Equipment not related to the support of the telecommunications space (e.g., plumbing piping, HVAC ductwork, pneumatic tubing, etc.) shall not be installed in, pass through, or enter that room.

L. Floor

1. Floor loading (dynamic and static) capacity in the space shall be sufficient to bear both the distributed and concentrated load of the installed equipment.
2. Floors shall be treated minimize dust.
3. Floors finishes shall be light in color to enhance room lighting.
4. Floors shall be treated with an anti-static vinyl tile or an anti-static epoxy.
5. All preparation of the sub-floor and finish shall be in accordance with the tile manufacturer’s requirements and recommendations.

M. Raised access floor (Optional)

1. The raised access floor system shall be tested and certified in accordance with Ceilings & Interior Systems Construction Association (CISCA) and shall be installed in compliance with manufacturer’s specifications and instructions.
2. Sub-floor surfaces shall be prepared in accordance with the manufacturer’s specifications. When constructed of concrete, the sub-flooring shall be sealed to prevent dust.
3. Pedestal assemblies shall be corrosive resistant, all steel welded construction, and shall provide an adjustment range of +/- 1”. Zinc electroplating shall be

prohibited on all pedestal components, including head plate, threaded rod, adjustment nut, pedestal tube, base plate, and all fasteners.

4. Steel stringers shall have conductive galvannealed coating. Zinc electroplating shall be prohibited on stringers and stringer fasteners. Stringers shall be individually and rigidly fastened to the pedestal with one machine screw for each foot of stringer length. Bolts shall provide positive electrical contact between the stringers and pedestals. Connections depending on gravity or spring action are unacceptable.
5. Panels shall consist of a top steel sheet welded to a formed steel bottom pan filled internally with a lightweight cementitious material. Mechanical or adhesive methods for attachment of the steel top and bottom sheets are unacceptable. Floor panels shall be protected from corrosion by electro-deposited epoxy paint. The use of zinc electroplating shall be prohibited. Coordinate floor panel color and additional covering with SAIC|NICS.
6. Floor panels shall possess a high pressure laminate anti-static covering.
7. Raised access floor system shall be fully grounded in accordance to section 7 of this document.

N. Ceiling

1. Suspended or false ceilings are not required or desired.
2. The minimum deck height shall be 10’.
3. Minimum height clearance in the room shall be 8’ 6” without obstructions.
4. Structural decking shall be treated to minimize dust.
5. Ceiling/decking shall be painted to match walls.

O. Walls

1. Walls shall be finished with drywall (completely taped, sanded, and painted) prior to attaching plywood backboards.
2. All walls within the telecommunications room shall extend from the floor to the structural deck above and be sealed.
3. Paint shall be light in color to enhance room lighting.
4. All finished walls shall be lined, unless indicated differently on the detailed engineering drawings and documents, with A/C PLUGGED-INT-APA void-free plywood sheets 48"W x 96"H x 3/4" thickness in size; Grade “C” surface towards the wall.
5. Unless noted otherwise, plywood sheets shall be installed flush on the finished drywall, block or concrete wall, securely anchored to the building structure so that the bottom edge is 6” AFF and the top edge is 8’ 6” AFF with plywood aligned in a vertical orientation. All data/communication cable conduits shall

stub either onto the backboards or onto cable trays and ladder systems within the space.

6. All plywood shall be painted with two (2) coatings of fire retardant paint. Color to be white, unless otherwise noted.
7. All equipment that is to be wall mounted must be mounted to the plywood backboard.
8. Minimum fire rating shall be a 1-hour rating per NFPA 75. The design team shall be responsible to determine a more stringent fire rating of the wall based on the requirements of the AHJ and shall amend the Construction Documents accordingly.

P. Door

1. Minimum Size:
    a. MDF = 48” W x 80” H (a double door configuration may be substituted without a center post)
    b. TS = 36” W x 80” H
2. The door shall be of steel or solid wood construction, removable, and should open outward fully opening 180°.
3. In corridor or adjacent space, provide 6’ of clearance in front of door.
4. Provide door sweep for the purposes of noise reduction and contamination control.
5. Fire rating, per NFPA 75, for door shall be:
    a. If walls are a 1-hour rating, then door rating shall be 3/4-hour
    b. If walls are a 2-hour rating, then door shall be 1 3/4-hour rating

Q. Security

1. Provide an Access Control System for all TS’s.

R. Power

1. AC outlets shall be provided to power telecommunications equipment interfaces, servers, and other telecommunications equipment. Coordinate exact power requirements with SAIC|NICS.
2. Each outlet will be fed by a dedicated branch circuit from dedicated breaker panels located in each respective room unless otherwise noted.
3. All electrical circuits serving telecommunications equipment shall be backed-up by a centralized UPS system and generator if available.
4. Convenience outlets (Quad NEMA 5-20R receptacles/double duplex) shall be installed on each wall of the TS.

5. Convenience outlets shall not be placed on emergency power.
6. Wall outlets shall be installed 15” on center AFF and must be flush when cut through plywood.
7. All room circuits are to be labeled and identified at the breaker panel and on the faceplate of the outlet.

S. Lighting

1. Provide minimum equivalent of 500 lux (50 foot-candles) as measured 3’ AFF at each point of cable and equipment termination.
2. Provide standard 1’ x 4’ (2) lamp lighting fixtures.
3. Locate light fixtures a minimum of 8’ 6” above finished floor.
4. Light fixtures are to be positioned parallel to rack rows and wall fields and located between rack rows.
5. Coordinate lighting layout with the equipment and cable tray layout to ensure light is not obstructed.
6. Locate light switches at the entrance of each room.
7. Provide emergency lighting.

T. Grounding and Bonding

All grounding shall be in compliance to the Specifications detailed under Section 7 (Telecommunications Bonding and Grounding System)

U. Pathways

1. Cable runway (Ladder) shall be installed to support cabling above the wall field and racks, and to support cabling as it enters the room.
2. Conduits (Electrical outlets and other electrical service) must be contained within the wall structure. Electrical conduit should not be placed where it might be crossed by a communications cable or where it disrupts backboard utilization.
3. All floor and wall penetrations (Floor Cores and Wall Sleeves) shall be fire-stopped per code.
4. Utilize the layout indicated in Appendix F when installing open relay racks in data rooms

V. Environmental

1. TS’s shall be environmentally controlled to maintain a room temperature range of 64°F to 81°F (18°C to 24°C) with relative humidity levels between 55% to 60% non-condensing.
2. Maintain positive pressure with a minimum of four (4) air changes per hour.

3. Provide continuous and dedicated environmental control (24 hours per day, 365 days per year). Air handling equipment must dissipate heat generated by active devices and satisfy building codes.
4. Provide dedicated thermostat within each room.
5. If emergency generator power is available, provide backup power to the A/C system.
6. To protect equipment from any leakage, drainage troughs and associated plumbing shall be installed underneath ceiling mounted units (specifically the condensate pump and supply and return piping). Drainage troughs shall be properly sloped and routed to the nearest drain. All drains shall be fully sealed.
7. Provide condensate pump where gravity drain is not available.
8. Provide electric reheat for dehumidification control.
9. Provide electrical disconnect switch to evaporator unit.
10. Architect/MEP Engineer shall determine nominal tonnage and system configuration (Air Cooled Split, Glycol Loop, or Chilled Water).

W. Fire Protection

1. Smoke detectors shall be provided.
2. Provide fire protection for rooms as required by code. When there is no Architect/Engineer, the Architect, Engineer, or Contractor shall verify requirements with the AHJ.
3. Consideration should be given to the installation of pre-action sprinklers or other “dry” fire-suppression systems.
4. For wet pipe systems:
    a. Drainage troughs should be installed to protect equipment from any leakage.
    b. If sprinkler heads are used, they shall be high temperature and have wire cages installed over the heads to prevent accidental operation.
5. Fire/smoke ratings of all architectural structures and assemblies, including but not limited to walls, plywood and paint, shall be verified and approved prior to construction with the AHJ.

5.2 Gateway (GW) & Point of Presence (PoP)

A. GW and PoPs are identified as locations where carrier circuits are located and where the NASA demarcation resides.

B. GW and PoPs shall be designed utilizing a structured cabling solution (SCS) allowing for a “plug-n-play” environment to mitigate outage risks.

C. The use of pre-terminated cabling products is the preferred method of application for these type environments.

6. Building Pathways

6.1 General

A. Construct all telecommunications building pathways in compliance with applicable local, state, and federal codes and regulations.

1. Per NEC 300.11 (C), conduits shall not be permitted as a means of copper cabling support.
2. Per NEC 770.133 (C), conduits shall not be permitted as a means of optical fiber cabling support.

B. Contractor shall verify the proper installation and sizing of the pathway system prior to installation of the cabling to ensure that all pathways meet Specifications.

C. Building pathways shall be designed and sized based on the following cabling types:

1. New construction or major renovation of existing buildings: Category 6A rated cabling systems
2. Minor renovations and MAC work in existing buildings: Match cabling to the type currently installed

D. For new construction in open environment buildings, special pathway design considerations, i.e. consolidation or zoning points, shall be provided to ensure future support.

E. Grounding and bonding of pathways shall comply with applicable codes and regulations, in addition to any requirements indicated in these Specifications.

F. Pathways shall not have exposed sharp edges or other surfaces that could cause damage or otherwise cause substandard installation.

G. The number of cables placed in any type of pathway shall not exceed 40% fill. The design of the pathway system shall allow for a 60% growth factor.

H. The preferred method of cable installation to an outlet location in existing construction is via fishing the wall. The use of surface mounted conduit or raceway shall be utilized only if the wall cannot be fished. New construction shall utilize conduit from an accessible ceiling to the work area outlet.

I. Pathway loading shall not exceed manufacturer’s specifications.

J. Elevator shafts shall not be used as pathways.

K. Bridle rings shall not be permitted.

L. All pathways shall have an appropriately sized pull string or rope installed. Each end of the string or rope shall be fastened in such a fashion to assure its availability in the future. Tag as required.

M. Cable trays, cable runways, and other communications pathways are for the exclusive use of the backbone and horizontal voice/data/coax cabling. Other low voltage cabling systems such as audio/visual, security, electrical power, etc. shall be installed in separate pathway systems unless otherwise approved by SAIC|NICS.

N. Contractor is responsible to repair any damage to the lay-in ceilings, floor tiles, and spray-on fireproofing caused by the installation of the support infrastructure or cabling.

O. Follow the Protective Distribution Systems (PDS) Committee on National Security Systems (CNSS) and the Committee on National Security Systems Advisory Memorandum (CNSSAM) standards documents when a PDS system is required.

6.2 Products

A. Refer to the SAIC|NICS Cable Plant Approved Products List for all approved manufacturers and solutions.

B. Cable Tray – Wire Mesh (Preferred Method)

1. Wire mesh cable tray shall have minimum actual loading depth of 4” and shall have an Underwriter’s Laboratories (UL) Classification.
2. Cable tray will consist of continuous, rigid and welded steel wire mesh cable management system to allow continuous ventilation of cables and maximum dissipation of heat.
3. Provide UL listed splice plates, supports, and other fittings of a single manufacturer’s source necessary for a complete, continuously bonded system in accordance with manufacturer’s specifications, industry standards, and code requirements.
4. Wire mesh cable tray systems shall be bonded in accordance with the National Electrical Code, TIA-607, Telecommunications Bonding and Grounding (Earthing) for Customer Premises. Discontinuous joints in cable tray systems shall be bonded through the use of approved connections or the use of bonding jumpers of a gauge no higher than #6 AWG.
5. Wire mesh cable tray fittings shall be factory produced or field-fabricated from straight tray sections in accordance with manufacturer’s instructions.
6. Connecting hardware, including splice connectors and support components, shall be furnished by the manufacturer.
7. Standard section length shall be 10’. Width shall typically be 6”, 9”, 12", 18" or 24" depending on the number of cables to be supported by the pathway.

8. The finish for the carbon steel wire shall be applied after welding and bending of mesh and shall be composed of hot-dip galvanizing as specified in ASTM A123.
9. All hardware is required to maintain a continuous ground along the entire length of the tray and shall be supplied by the manufacturer and installed by the Contractor.
10. Tray support system shall be per the manufacturer's specifications.
11. Separate conduit sleeves or segments must be provided as a pathway through any wall or over any obstruction or obstacle to access, such as a fire-rated hallway or fixed ceiling. Quantity dependent on cable tray size.
12. Contractor shall be trained and certified in the installation of wire mesh cable tray systems.

C. Cable Tray – Trough Type

1. Cable tray systems shall be "trough" type with a minimum actual loading depth of 4". Cable trays shall be of louvered ventilated construction with louvered openings a minimum of 3" wide.
2. Straight sections shall be one-piece construction. Top flanges shall be rolled outward and downward for safety of cables and personnel. Cable bearing surface shall be 3" wide. Openings shall be on 6" centers with metal drawn downward so cables can drop out at any location along the tray without cutting or gasketing the openings. Standard length shall be 12'. Width shall be 12", 18" or 24" depending on the number of cables to be supported by the pathway.
3. Fittings shall be 3-piece welded construction. Fittings shall have a 3" tangent for easy fit-up in field. Splice plates shall be made of .125" thick aluminum with a four-bolt design with slotted holes. All elevation transitions shall use at a maximum 45° bend fittings.
4. Radius drop cross members shall be provided for transition of cabling to rack or cabinet.
5. Cable tray systems shall be built and tested to NEMA VE-1 standards and shall have a UL classification for cable trays.
6. Hardware shall be 3/8" x 3/4" 302 stainless steel serrated round head bolts. SS hex nuts shall have an integral lock washer.
7. Cable tray systems shall be bonded in accordance with the National Electric Code and TIA-607, Telecommunications Bonding and Grounding (Earthing) for Customer Premises. Discontinuous joints in cable tray systems shall be bonded with approved connections or the use of bonding jumpers no smaller than #6 AWG.

8. Above ceilings, a minimum 8” clearance above the tray must be maintained at all times. All bends and tees must be fully accessible from above the tray.
9. Any change in mounting level height shall incorporate a continuous transition.
10. Tray support system shall be a trapeze type system constructed of Unistrut with ½’ threaded rods on each side of the tray. Center hung support systems shall not be permitted. Separate conduit sleeves or segments must be provided as a pathway through any wall or over any obstruction or obstacle to access, such as a fire-rated hallway or fixed ceiling.

D. Cable Runways (Ladder)

1. Unless otherwise specified, provide metal cable runways of types, classes, and sizes indicated with splice connectors, bolts, nuts, and washers for connecting units.
2. Cable runway shall be ladder type, constructed of rectangular steel tubing with a minimum stringer height of 1½”. The rungs shall be 3/8” x 1½” steel welded to the stringers at 12” intervals. Color shall be black.
3. Use the manufacturer specified connecting pieces (e.g., 45° and 90° horizontals, inside and outside bends, tees, crosses, etc.) when designing and constructing the cable tray/ladder system.
4. Cable runway shall be capable of carrying a uniformly distributed maximum load of 135 lbs. /ft. when supported every 5’.
5. Standard length shall be 9’ 11½”. Width shall be 12", 18” and/or 24" as indicated on the Drawings.
6. All fittings, supports, splices, etc. for the runway system shall be installed to provide a complete assembly including fasteners, hardware, and other items required to complete the installation as indicated on the drawings. Use heavy-duty splices in all areas where cable runway will support > 100 UTP cables.
7. Cable runways shall have a UL classification for cable trays. Cable runway systems shall be bonded in accordance with the National Electrical Code, TIA-607, Telecommunications Bonding and Grounding (Earthing) for Customer Premises. Discontinuous joints in cable runway systems shall be bonded with approved connections or the use of bonding jumpers no smaller than #6 AWG.
8. Radius drops shall be used when transitioning cables from the cable runway to a rack, wall field or other cable management device. Radius drop shall securely fasten to the rung or stringer and shall be the same width as the cable runway.
9. Radius bends shall be used when transitioning from one cable tray elevation to another. Radius bends shall be the same width of the cable runway. A transition shall not exceed the length of the radius bend.

10. Wall angle support brackets shall be installed when attaching the cable runway to a wall. The brackets shall be securely fastened to the wall in such a fashion that it will not break away under heavy loading conditions. The cable runway shall be attached to the bracket using J-bolts.
11. Threaded rod (1/2”) and ceiling kits shall be used to support the cable runway to the decking or structural steel. Ceiling supports shall be placed every 5’ along the cable runway. In heavy loading environments or in stacked environments, ceiling supports shall be placed every 3’. All threaded rods that may come in contact with cable shall be covered with threaded rod covers.
12. End Closings shall be installed at the end of open sections of cable runway that do not terminate at a wall.
13. In some equipment rooms, it may be necessary to tier cable runways in order to support a high density of cables. Under these circumstances, the cable runway shall be vertically tiered 12” apart. No more than two levels of cable runway will be permitted without written approval from SAIC|NICS.

E. Conduit and Backboxes

1. All conduit shall be a minimum of 1” regardless of the media type to be installed.
2. All conduits shall be EMT, IMC, or GRC depending on the environment, application, and code requirements. Rigid conduit shall be used in outdoors, underground, or in areas subject to severe physical damage.
3. The minimum bend radius of a conduit is equal to 10-times the conduit’s diameter.
4. The total number of bends along a conduit path shall not exceed 180° without a pull box.
5. No section of conduit shall be longer than 100’ between pull boxes.
6. All conduits shall be fitted with the proper sized fittings and bushings.
7. Provide dedicated conduits for backbone cabling.
8. Conduit capacity planning should ensure that no conduit exceeds a 40% fill at the time of the initial installation. When calculating conduit fill, use a fill deration factor of 15% for each 180° of bends.
9. Conduit sleeves (minimum of 2”; 4” for main cable pathways) must be installed through any wall along the pathway.
10. In retrofit installations, provide flex metal conduit for all in-wall cable installations. Flex conduit shall be sized one trade size larger than the standard requirements for rigid or EMT conduit.
11. Minimal 1” conduit stubs with device boxes shall be installed in all areas for the purposes of routing the horizontal cabling to the Telecommunications

Outlet. These conduits will stub directly into the nearest lay-in ceiling. Protective bushings shall be included and installed at the stub end.

12. All conduits shall be installed complete with pull-strings.
13. Backboxes shall be minimum 4 11/16” x 4 11/16” x 2 1/8” D with a single gang reducer plate.
14. Blank cover plates shall be provided for all unused outlet boxes.
15. For shallow wall construction, where the standard 2-1/8" deep backbox cannot be used, it will be acceptable to use a shallower backbox along with angled mini-com jack caps with angled faceplates.

F. Pull Boxes

1. Pull boxes shall be placed in conduit runs that exceed 100’ and/or 180° in bends.
2. Pull boxes must be located to provide easy access.
3. Pull boxes shall never be used for a right angle bend and must be installed to allow cable to pass through from one conduit to another in a direct line.
4. Pull boxes shall be sized according to conduit size and bend radius of the cable. Pull boxes must have a length at least eight (8) times the trade-size diameter of the largest conduit.

G. Innerduct

1. Corrugated innerduct shall be sized to provide an adequate pathway for the fiber optic cable (minimum 1.25” inner diameter).
2. All innerduct shall be plenum rated and shall have a pre-installed pull tape or pull rope.
3. The flame ratings shall meet or exceed UL-910 for Plenum and UL 1581-0 for General Purpose as outlined in the current National Electrical Code, Article 770.
4. Sections of innerduct shall be connected using couplers and connectors designed specifically for connecting innerduct.
5. Innerduct shall be orange in color unless a center has adopted a color code scheme. See Appendix D.

H. Micro-Duct for air blown Fiber

1. Air blown micro-duct shall be sized to provide an adequate pathway for the selected fiber product.
2. All micro-duct shall be plenum rated.

3. The flame ratings shall meet or exceed UL-910 for Plenum and UL 1581-0 for General Purpose as outlined in the current National Electrical Code, Article 770.
4. All couplers and connectors for micro-ducts must be of the same manufacturer as the micro-duct being used for the project.
5. Micro-duct can be color coded for specific applications.

I. Floor-Boxes

1. Floor-boxes must have separate entry points for power and communications cabling.
2. The floor-box manufacturer shall provide a complete line of adapter plates to facilitate mounting of UTP and coaxial cables.
3. The unit will contain accommodations for a minimum of four connectors for UTP, coaxial, audio, and/or video connections. All inserts shall be nonmetallic.
4. The minimum depth of the floor-box shall be 4” with a preferred depth of 5”. The floor-box wiring chamber shall provide two separate compartments to accommodate power wiring on one side of the box and communication wiring on the other side. The chamber shall also provide complete access to the communication wiring plate, which will allow for removal of the wiring plate without the need to disconnect the wiring of any communication device outlets.
5. The lid of the floor-box shall provide a removable cable guard for egress of power and communication workstation cables. The cable guard, when in use, should extend above the surface of the lid for the purpose of added protection of the workstation cables.

J. Poke-thru

1. Poke-thru devices must have separate entry points for power and communications cabling.
2. Poke-thru device manufacturer shall provide a complete line of adapter plates to facilitate mounting of UTP and coaxial cables. The unit will contain accommodations for a minimum of four connectors for UTP, coaxial, audio, and/or video connections. All communication inserts shall be nonmetallic.
3. Work Area Outlets (WAO) in the poke-thru device shall be capable of being installed either flush or recessed. The poke-thru device shall provide slide-type dust covers for protection of the WAOs.
4. The poke-thru device shall accept discrete, keystone type devices from various manufacturers including Hubbell.

5. The poke-thru device shall accommodate a mechanism to permit protection of communication cabling. This mechanism shall be zinc die-cast with two openings to accept both flexible and rigid conduit.

K. Surface Mount Raceway

1. This Specification addresses only the surface raceway requirements for vertically routing of the cables from the ceiling to a single WAO when routing or concealing the cables within the wall via wall fish or conduit is not possible.
2. All nonmetallic surface mount raceway systems shall consist of raceway and the appropriate fittings and device boxes to complete installation per the Drawings.
3. Surface nonmetallic raceway shall be utilized in dry interior locations only as covered in Article 352 Part B of the National Electrical Code, as adopted by the National Fire Protection Association (NFPA) and as approved by ANSI and Section 12-16000 of Canadian Electrical Code (CEC).
4. The raceway and all system components shall be UL listed and exhibit nonflammable self-extinguishing characteristics, tested to comparable specifications of UL94V-0.
5. The raceway shall have a minimum inside area of 1.25 square inches unless approved in writing by SAIC|NICS.
6. A full complement of fittings must be available including but not limited to flat, inside and outside corner fittings, tees, drop ceiling entrance fittings, cover clips, and end caps. The fittings shall overlap the cover and base to hide uneven cuts. All fittings shall be supplied with a base where applicable to eliminate mitering. A transition fitting shall be available to adapt to other series raceways. All fittings shall be of the same manufacturer and model or series as the raceway.
7. Device boxes shall be available for mounting standard WAO faceplates. A device box shall be available in single gang, two gang and three gang configurations and have a minimum depth of 2.75” [70mm] for extra deep devices. All device boxes shall be of the same manufacturer as the raceway and be fully attachable to the raceway.
8. The raceway, device boxes and all fittings shall comply with detailed manufacturer’s instruction sheets, which accompany system components as well as system instruction sheets. Raceway shall be securely supported in accordance to manufacturer’s installation sheets.

L. Low-voltage mounting bracket / Box eliminators

1. A low-voltage mounting bracket, similar to a plaster ring, may be used in place of an outlet box where permitted by code.

2. It is preferred that all outlet locations in a Category 6A installation shall use box low voltage mounting brackets and the wall cavity for the pathway. Provide an acceptable entry point to the wall above the ceiling

6.3 Execution

A. Vertical (Riser) Interconnecting Pathways

1. In multi-floor buildings, Telecommunications Spaces (TS) shall be vertically aligned and connected with a series of sleeves.
2. A minimum of (6) 4" trade size, conduit sleeves should be planned between TRs. The actual size of the pathway (number of sleeves) is dependent upon the number and size of interconnecting cables and the number of TSs in the riser.
3. Provide vertical sections of cable runway in each TS to support riser cables between rooms and from floor sleeve to equipment rack.

B. Horizontal Distribution Pathways

1. Ceiling Pathways
    a. Horizontal distribution pathways in accessible ceilings shall be constructed of a cable tray support system.
    b. In all cases, cable tray shall be the means of main pathway cable support. Open architecture pathways shall only be used to support cabling from the tray to the drop location.
    c. Cable pathways must follow the natural lines of the building. All cabling support devices must be attached to structural steel, structural ceilings/decking, or walls with the appropriate mounting hardware.
    d. Cable pathways shall be installed parallel or perpendicular to building structure.
    e. Designers, Engineers, and cable tray installation contractors must coordinate with all other trades/services to ensure the cable tray is the lowest utility in the ceiling space and located above common spaces. Also, must ensure that all cable trays are free and clear from any obstructions that could be caused by other trades/services within the ceiling space.
    f. Under no circumstances shall cables be mounted, attached, or supported on ceiling panels, support channels (T-bars) and/or vertical ceiling support wires.
    g. Install appropriately sized conduit where the path travels over inaccessible ceilings or in areas where cable tray or open architecture access parameters cannot be met.

h. In modular furniture areas, cables will route to the furniture via in-floor boxes or poke through devices from the ceiling below. Modular furniture installed adjacent to a hard wall shall be fed from the wall using grommeted faceplates and spiral wrap or flexible conduits to support cabling.

i. The use of powerpoles is an acceptable pathway where modular furniture is utilized. However, special capacity and electrical requirements do apply.

j. In hard-wall office environments, cables shall route from the ceiling to the faceplate via conduit stubs or wall-fish.

k. In overhead or ceiling pathways, open architecture and cable tray systems must maintain a 5” clearance from any light fixture, and a 12” clearance from any electrical ballast.

2. Access Floor Pathways

a. Horizontal cable distribution pathways under access floors shall be primarily constructed of a cable tray system.

b. For the use of a horizontal cable distribution pathway, there must be a minimum of 8” of clearance from the highest point of the finished floor to the underside of the stringers or floor panels.

c. There should be a minimum of 2” of free space between the top of the tray side rails and the underside of the stringers or floor panels.

d. Typical tray depth shall be 4”.

e. Install cable tray designed for use under raised floors using manufacturer’s mounting hardware.

f. Cable tray pathways must follow main public hallways and furniture aisles. Never route tray under offices, conference rooms, training rooms etc., or directly under modular furniture.

g. Cable tray systems shall be installed before the installation of access floor stringers or floor panels.

h. When a TS is included in the design, use threaded conduit sleeves to connect the TS with the access floor area. Do not penetrate walls with cable tray. Firestop all sleeves as required.

3. Open Architecture - Non-continuous support (J-Hooks)

a. Non-continuous supports shall be located at intervals not to exceed 4’ - nominal.

b. Steel, masonry, independent rods, independent support wires, or other structural parts of the building shall be used for cable support

attachment points up to the total weight for which the fastener is approved.

c. Rods or wires that are currently employed for other functions (e.g. suspended ceiling grid support) shall not be utilized as attachment points for non-continuous supports.

d. Contractor shall adhere to TIA 569 (including most recent additions and addendum), BICSI General Guidelines for Ceiling Systems, and the following Specifications:

1. Contractor shall provide proper support for cables in all situations requiring open architecture installation. Under no circumstances shall Contractor mount, attach, or support cabling on ceiling panels, support channels (T-bars) and/or vertical ceiling support wires.
2. Cabling shall be attached to structural steel, structural ceilings/decking, or walls with the appropriate mounting hardware.
3. Contractor shall provide and install J-hooks in all areas requiring open architecture support.
4. The use of bridle rings shall not be permitted.
5. Cable pathways shall follow the natural contours of the building. J-hooks shall be securely attached to structural walls, steel or decking.
6. Open architecture pathways shall have adequate support to withstand the pulling of cables through the supports. Once installed, the cables shall be secured to each support using listed Velcro cable ties.

4. Equipment Rooms and Telecommunications Rooms

a. Cable runway (ladder) shall be installed in each TS to support cabling from the room entry point(s) to the wall field and/or equipment racks and to support the cable service loop.

b. Cable runway (ladder) shall be installed in accordance with the manufacturer’s specifications.

c. Cable runway (ladder) shall be installed nominally at 8’ AFF unless otherwise noted.

d. Cable Runway Radius Dropouts (Waterfalls) shall be utilized to transition between horizontal components and vertical components of cable ladder. Utilize cable runway movable cross members as needed to provide dropouts at the correct location.

e. Cable ladder shall be utilized behind the open equipment racks for support of the data cabling. (See Appendix F)

C. Conduits and Backboxes

1. All conduits shall be installed complete with pull-lines.
2. Provide conduit from each outlet to the nearest accessible corridor ceiling space, cable tray or other area as indicated on the drawings and provide an insulated bushing at each stub.
3. Contractor shall protect cabling from all sharp or rough edges or points.
4. Continuous conduit runs installed by Electrical Contractor shall not exceed 30.5 m (100 ft.) or contain more than two (2) 90° bends without utilizing NEC sized pull boxes, unless otherwise indicated in the specifications or on the drawings.
5. Maximum conduit pathway capacity shall not exceed a 40% fill with the exception of perimeter and furniture fill, which is limited to 60% fill for moves, adds, and changes, unless otherwise noted on drawings.

D. Innerduct

1. Innerduct shall be sized accordingly to both the application and requirements.
2. Between termination points (MDF-TS), fiber optic cables shall be installed within innerduct, regardless if installed in conduit.
3. Separate innerduct pathways shall be installed between the MDF and each TS. When possible, the backbone multimode and single mode fiber optic cables for each termination point shall be installed in the same respective innerduct as space allows.
4. All fiber optic cabling routed through hallways (open architecture and cable tray systems) and unsecured risers shall be installed in innerduct.
5. Innerduct shall continue to the termination rack/cabinet once the cabling enters a TS.
6. When utilizing conduit pathways for backbone cabling, innerduct shall be installed to support the fiber optic cables.
7. Between termination points, innerduct shall run continuous with no breaks. In cable tray or cable runway, the innerduct shall be secured every 5’ with tie-wraps. In open vertical risers, the innerduct shall be secured to the wall every 3’ using conduit straps.
8. In open architecture areas, the innerduct shall be secured every 5’, using J-hooks. The mid-span sag of the innerduct between attachments shall not exceed 2” at the time of installation completion.

9. All innerduct splice points shall be coupled using the specified couplings and/or terminal adapters as manufactured by the innerduct manufacturer. Innerduct couplings and adaptors shall be sized appropriately based on the size of the innerduct. The use of electrical tape, duct tape, or any other form of joining material or device, other than that specified by the manufacturer, shall be prohibited.

E. Micro-Duct for Air Blown Fiber

1. Between termination points (MDF-TS), fiber optic cables shall be installed within innerduct, regardless if installed in conduit.
2. Separate innerduct pathways shall be installed between the MDF and each TS. When possible, the backbone multimode and single mode fiber optic cables for each termination point shall be installed in the same respective innerduct as space allows.
3. All fiber optic cabling routed through hallways (open architecture and cable tray systems) and unsecured risers shall be installed in innerduct.
4. Innerduct shall continue to the termination rack/cabinet once the cabling enters a TS.
5. When utilizing conduit pathways for backbone cabling, innerduct shall be installed to support the fiber optic cables.
6. Between termination points, innerduct shall run continuous with no breaks. In cable tray or cable runway, the innerduct shall be secured every 5’ with tie-wraps. In open vertical risers, the innerduct shall be secured to the wall every 3’ using conduit straps.
7. In open architecture areas, the innerduct shall be secured every 5’, using J-hooks. The mid-span sag of the innerduct between attachments shall not exceed 2” at the time of installation completion.
8. All innerduct splice points shall be coupled using the specified couplings and/or terminal adapters as manufactured by the innerduct manufacturer. Innerduct couplings and adaptors shall be sized appropriately based on the size of the innerduct. The use of electrical tape, duct tape, or any other form of joining material or device, other than that specified by the manufacturer, shall be prohibited.

F. Cable Tray and Cable Runway

1. Install cable tray and cable runway level and plumb according to manufacturer's written instructions, coordination Drawings, original design, and referenced standards.
2. Provide straight sections, curved sections, hangers, support rods, clamps, related fittings, and mounting accessories as recommended by the system

supplier. Conflicts shall be brought to the attention of SAIC|NICS for resolution.

3. Standard support systems shall consist of wall mounting, trapeze mounting, and under floor mounting hardware as described on the Drawings. Trapeze systems must be supported from each side of the cable tray or runway. The preferred method of mounting shall be trapeze with strut using two 1/2" threaded rods with sections directly attached to the building structure. Center support systems shall not be permitted or approved.
4. The Drawings indicate intended routings. Contractor shall provide horizontal and vertical transitions as required to suit field conditions in order to meet routing requirements. Any deviation from the indicated route, due to either field conditions or coordination issues, must be brought to the attention of SAIC|NICS immediately, as these may affect the design of the pathway and the subsequent cable routing.
5. Any unapproved routing of cable tray and/or cable runway shall be corrected by Contractor at no cost to SAIC|NICS.
6. Provide a minimum of 8" clearance above all cable tray sections from the finished structure of any device or equipment installed or routed above the cable tray.
7. Contractor shall coordinate clearances and routing of the cable tray with all other trades prior to installation and shall monitor the installation of the other trades during the progress of the project. Contractor shall hold all other trades accountable to this coordination. Any deviation by other trades to this coordination effort shall be brought to the immediate attention of the Construction Manager for immediate resolution, when applicable.
8. Installation shall comply with NEC Article 392. Ground cable trays that support as required for conductor enclosures in NEC Article 250. Cable tray and runway shall be provided with bonding jumpers or UL listed splice plates sized in accordance with NEC Section 250.102 between sections, raceways, and equipment. Bonding shall be in accordance with NEC Section 250.96.
9. Contractor shall protect cabling from all sharp or rough edges or points.

G. Surface Mounted Raceways

1. Surface Mounted Raceways for telecommunications cabling shall be provided where shown on the Drawings. For other locations, permission must be obtained for the Architect as described elsewhere in the section. Conductor fill shall comply with the National Electrical Code, the latest published revisions of the TDMM and with the manufacturer's guidelines.
2. If possible, transitions from conduit shall occur above ceilings.

3. Raceways shall be mechanically fastened to the walls or ceilings. Adhesive mounting only is not permitted.
4. Cabling shall be properly supported in the raceways.
5. All Surface Mounted Raceways shall be installed in an orderly manner as directed by SAIC|NICS and/or Architect.
6. Contractor shall protect cabling from all sharp or rough edges or points.

H. Cable Ties – Velcro Wrap

1. All Velcro cable wraps shall be a minimum of ¾" in width and properly sized and designed to conform to the environment in which they are installed (i.e., plenum rated cable ties in plenum ceilings, etc.).
2. Within the TS, provide only Velcro type wraps.
3. Velcro shall be attached so as not to crimp or kink the cables.
4. Velcro shall be installed at each j-hook location and at a point equally spaced between j-hooks.
5. The use of plastic "cable ties" shall not be permitted at SAIC|NICS on category 6 and category 6A rated cabling systems.

I. Special Situations

1. Pathways in the following locations require special considerations.
    a. Clean Rooms: All cabling shall be routed in conduit
    b. Test Cells: All cabling shall be routed in rigid (RGS) conduit.
    c. Explosion Prone Areas: All pathway components shall meet the requirements for an explosion proof area as required.

7. Telecommunications Bonding & Grounding System

7.1 General

A. It is the responsibility of NASA Facilities, Building Contractor, or Electrical Contractor to provide and install a Telecommunications Bonding Infrastructure per NEC and TIA-607 from the main building ground to the Primary Bus Bar (PBB; formerly TMGB) and any Secondary Bus Bar (SBB; formerly TGB) with the appropriate sized conductor.

The Telecommunications Bonding Infrastructure required by NASA Facilities, Building Contractor, or Electrical Contractor is:

1. Telecommunications Bonding Conductor (TBC) installed between the main building ground and the PBB; properly sized per NEC

2. Telecommunications Bonding Backbone (TBB) between the PBB and SBB(s); properly sized per NEC

B. It is the responsibility of NASA Facilities, Building Contractor, or Electrical Contractor to ensure that the Telecommunications Bonding Infrastructure meets the maximum resistance of 25 ohms per NEC.

Note: Critical buildings (e.g., public safety facilities, data centers, central offices, etc…) shall be designed to have a resistance of 10 ohms or less, preferably 5 ohms or less.

C. It is the responsibility of the Cable Plant engineer to ensure that a project design has the proper Telecommunications Bonding Infrastructure from the PBB/SBB to all equipment, required by code, to be grounded or bonded. This includes the proper sizing of all PBB/SBB(s), rack mount bus bars, bonding conductors, 2-hole lugs, and H-Taps.

D. It is the responsibility of the Cable Plant engineer to ensure that the grounding and bonding of telecommunications equipment is properly installed.

E. Refer to the below figures for proper grounding and bonding examples:

Figure 1: Example – Multi-Story Large Building

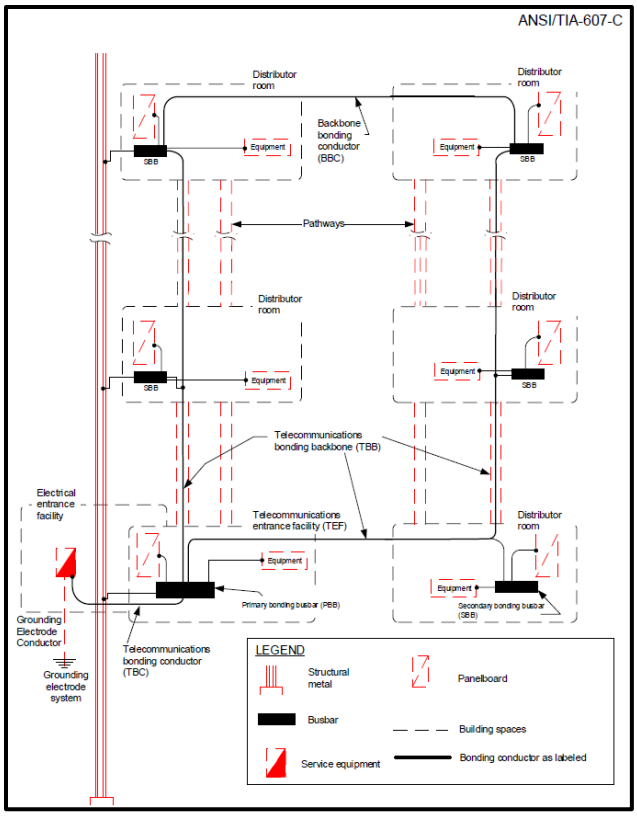
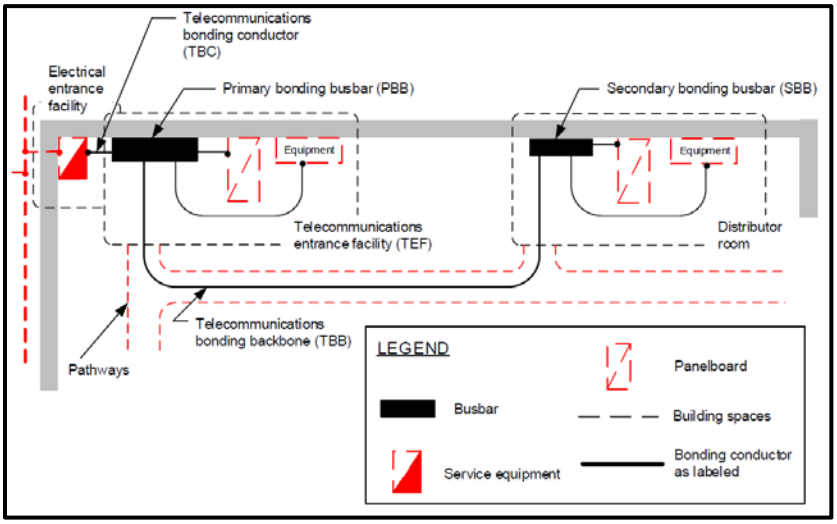


Figure 2: Example – Single-Story Large Building



F. Building contractor shall provide labeling and documentation regarding the Telecommunications Bonding Infrastructure in accordance with the Specifications and Drawings.

G. The Telecommunications Bonding Infrastructure shall be a supplemental grounding system and shall be bonded to the main electrical service ground.

H. The Telecommunications Bonding Infrastructure shall comply with the latest revisions of the NEC, NFPA, TIA-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, and IEEE 1100-2005 Powering and Grounding of Electronic Equipment.

I. Each building shall have one Primary Bonding Busbar (PBB) typically located in the building MDF. Each EF, ER/TR and cross connect area shall be equipped with a Secondary Bonding Busbar (SBB). The SBB's shall be bonded to the PBB through the Telecommunications Bonding Backbone (TBB). Both PBB and SBB shall meet the TIA-607 hole pattern. *NEMA style busbars shall not be used.*

Figure 3: Typical Primary Bonding Busbar

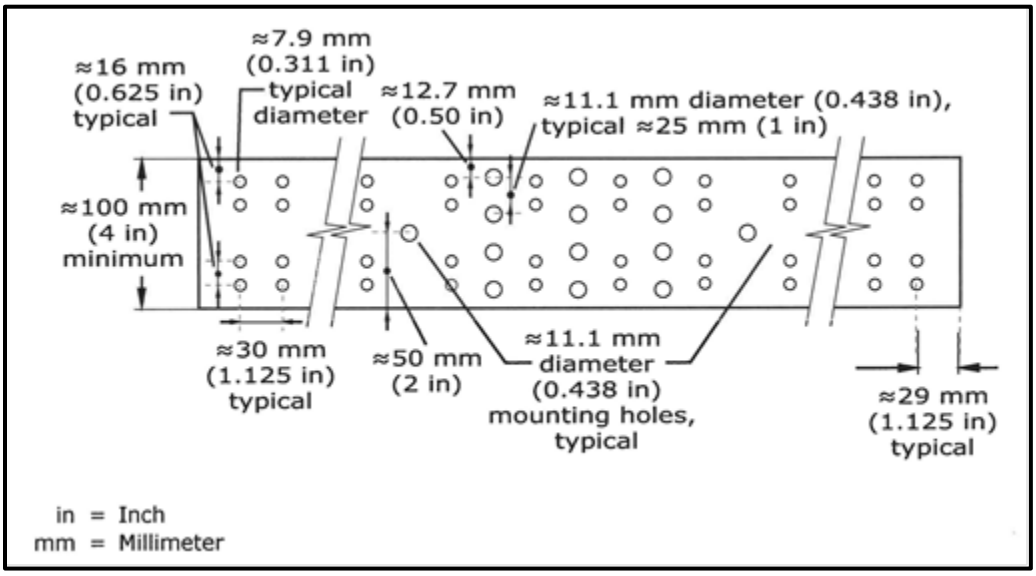
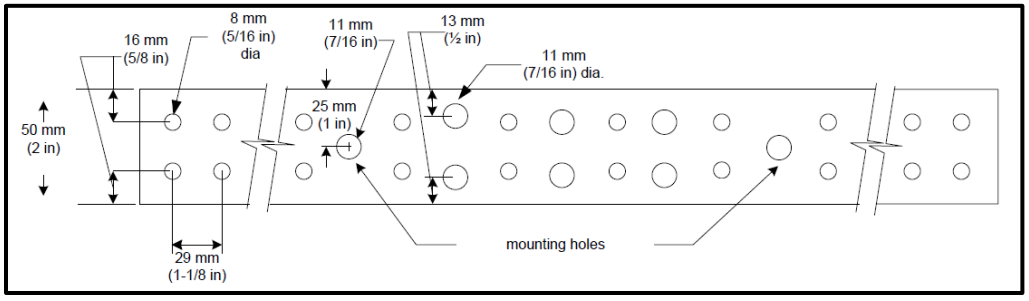


Figure 4: Typical Secondary Bonding Busbar



J. Sizing of the TBB shall be in accordance with Table 1 of the TIA-607.

Table 4: TBB Conductor Size vs. Length

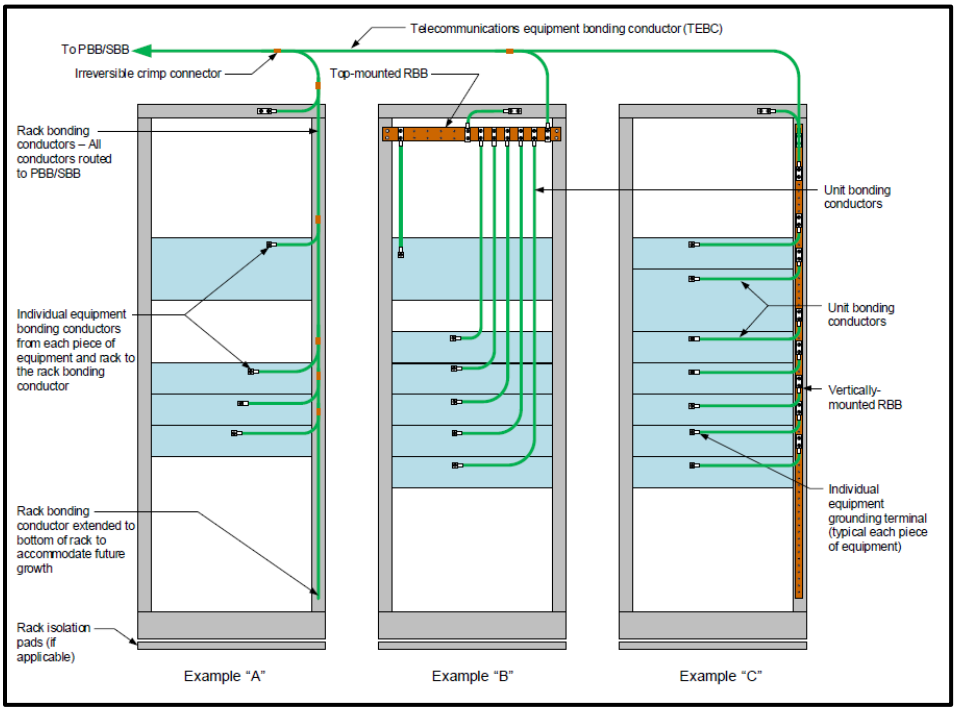
TBB/GE linear length m (ft.)	TBB/GE size (AWG)
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
20-26 (67-84)	3/0
26-32 (85-105)	4/0
32-38 (106-125)	250 kcmil
38-46 (126-150)	300 kcmil
46-53 (151-175)	350 kcmil
53-76 (176-250)	500 kcmil
76-91 (251-300)	600 kcmil
Greater than 91 (301)	750 kcmil

K. The Telecommunications Bonding Infrastructure shall be constructed to implement the design as indicated on the Drawings. If for any reason a conflict arises between the Specifications and the Drawings, the intent of the Drawings shall be the governing factor in the execution of the Telecommunications Bonding Infrastructure.

L. The Telecommunications Bonding Infrastructure shall not be connected in a way that creates pathways for circulating currents (Ground loop).

M. All racks, cabinets, and enclosures shall be bonded to the PBB/SBB either directly or via Telecommunications Equipment Bonding Conductor (TEBC). The following TIA-607 illustration is the preferred method for bonding racks, cabinets, and enclosures:

Figure 5: Example of three methods to bond equipment and racks



N. All voice, data, and video equipment shall be bonded to the local PBB/SBB or RBB if installed within the rack or cabinet.

O. Distribution of the Telecommunications Bonding Infrastructure shall be in accordance with the specifications and drawings.

P. The Telecommunications Bonding Infrastructure and PBB shall remain electrically connected through any transfer switches.

7.2 Products

A. Refer to the SAIC|NICS Cable Plant Approved Products List for all approved manufacturers and solutions.

B. Busbars

1. All busbars shall meet TIA-607 requirements. NEMA style shall not be utilized.
2. All busbars shall be 1/4" solid electro-tin plated copper.
3. All busbars shall be ASTM B187-C11000 compliant.
4. All busbars shall meet UL 467.
5. All PBB busbars shall be a minimum of 20"L x 4"H and have a minimum of 24 pairs of 5/16" holes and 6 pairs of 7/16" holes.

6. All SBB busbars shall be a minimum of 20”L x 2”H and shall have a minimum of six pairs of 5/16” holes and 3-pairs of 7/16” holes.
7. All RBB shall be 19” wide, 1 RU high, and have a minimum of 14 holes. Must be able to mount to rack or cabinet rails with #12-24 screws.
8. All insulators shall be manufactured from an environmentally friendly, halogen free nylon material reinforced with fiberglass.
9. All insulators shall be 2” tall.
10. All insulators shall meet UL 94 VO for self-extinguishing.
11. All brackets and fasteners shall be constructed of stainless steel.
12. All brackets shall be 1/8” thick.

C. Irreversible Compression Connections

1. All irreversible compression connections shall be two-hole lug type.
2. All irreversible compression connections shall have color-coded barrels that correspond to the correct crimp die, possess an inspection window for visual assurance of conductor insertion, and shall be tin-plated to inhibit corrosion.
3. All irreversible compression connections shall be UL Listed for use up to 35KV, temperature rated 90°C and CSA Certified to 600V when installed in compliance with the manufacturer’s specifications.

D. Cable

1. All TEBC shall be minimum #6 AWG in size.
2. All Unit Bonding Conductor UBC (for bonding conductors between the equipment and TEBC or RBB, shall be minimum #12 AWG in size.
3. All bonding cable shall be copper stranded and either bare-copper (plenum) or jacketed (non-plenum and riser rated) depending on the environment in which the cable is installed.
4. All bonding cable with a jacket shall be green or green with yellow stripe in color.

E. Ground Washers/Screws

Provide ground washers/screws as part of any grounding/bonding assembly. Bolts and nuts shall be stainless steel. Washers shall be beveled compression and stainless steel.

F. Equipment Rack Bonding Screws

All screws used to attach the ground bus to the equipment rack shall provide a bond to the rack by removing paint from the threaded holes without creating metal shavings. Screws shall be paint piercing, green in color, and constructed of electro zinc plated steel

7.3 Execution

A. Metallic enclosures, including telecommunications cabinets and racks, shall be bonded to the local PBB/SBB through a TEBC. Each enclosure shall have its own dedicated RBC connected to the TEBC using a listed irreversible crimp connection. The TEBC and RBC shall be sized not less than #6 AWG or the largest size equipment grounding conductor in the AC branch power circuits serving the rack cabinet lineup. The TEBC shall be a continuous copper conductor. TEBC shall be separated a minimum of 2" from conductors of other groups such as power or telecommunications cables.

B. Equipment containing metallic parts in metallic cabinets and racks shall be bonded to the Telecommunications Bonding Infrastructure in accordance with the manufacturer's instructions or through a unit bonding conductor (#12 AWG or larger) to the rack grounding busbar (RBB) in the rack/cabinet.

C. The TBB shall be installed in a continuous run (without splices) between the PBB and every SBB. Where the TBB is installed in a riser or multiple SBBs are connected to the same TBB cable, approved taps shall be used to connect the TBB to each PBB/SBB.

D. The bonding conductor used between the TBB and PBB/SBB shall be the same size as the TBB.

E. The bonding conductor used to bond the PBB to the main electrical service ground shall be at a minimum the same size as the TBB.

F. TEBC shall be installed for horizontal cable equipment shall be grounded in compliance with ANSI/NFPA 70 and local requirements of the AHJ. Horizontal equipment includes but is not limited to cross connect frames, patch panels and racks, cable runway, active telecommunications equipment, test apparatus, and equipment.

G. The TEBC used to bond the horizontal cable equipment to the PBB/SBB shall be a minimum of #6 AWG, stranded, jacketed, copper wire. The color of the jacket shall be green.

H. Paint piercing grounding screws and antioxidant shall be used when attaching ground lugs to equipment racks and enclosures.

I. Sharp bends in the TBB and the bonding conductors shall be avoided. The maximum sweep radius shall be less than or equal to 90°. All 90° bends shall be sweeping. All bends in the bonding conductors shall flow towards the PBB/SBB or the source of the TBB.

J. The TBB shall be supported by a separate and independent support system and shall not share electrical or telecommunications pathway support systems. When non-insulated (non-jacketed) copper cable is used, the bonding conductor shall be installed in innerduct and the support system shall be insulated and non-conductive.

Extreme care shall be taken to ensure the cable does not come into contact with structural steel, plumbing piping and fixtures, sprinkler system, electrical conduit, or other metallic device or apparatus.

K. The Telecommunications Bonding Infrastructure shall be an independent system from the building grounding electrode system with the exception of the bond to the main electrical service ground.

L. Contractor shall bond all non-current carrying equipment to the local PBB/SBB including, but not limited to cable trays and runways, equipment racks and cabinets and continuous point-to-point conduit and associated pull boxes.

M. Grounds shall be constructed using an insulated (green jacket), stranded copper bonding conductor (minimum #6 AWG), stranded, jacketed, copper wire), two-hole lug compression type connectors, and trilobular screws.

N. Bonding conductor size shall depend on the distance from the PBB/SBB to the racks using the distance chart specified in the TIA-607.

O. Contractor shall bond the PBB and each SBB to the building steel and the local power panel with a minimum #6 AWG, stranded, jacketed, copper wire.

P. Contractor shall remove paint/finish from equipment rack/cabinet and cable runway where a two-hole lug is installed.

Q. The PBB shall be connected to the building's Grounding Electrode System via the Telecommunications Bonding Conductor (TBC) through the Electrical Entrance Facility.

8. Firestop

8.1 General

A. Furnish and install fire stopping for fire rated construction in the following areas:

1. All openings in fire rated floors and wall assemblies accommodating penetrating items such as cables, conduits, raceways, cable trays, etc.
2. Empty openings in fire rated construction made by Contractor but not utilized for the aforementioned materials.

B. General

1. Seek qualified assistance in identifying rated barriers before starting work
2. DO NOTUSE other trades penetrations for communications cabling.
3. ALL penetrations to rated walls requires a U.L. Listed fire stopping assembly
4. All new fire stopping requires submittals & inspection by a qualified person

5. Firestopping materials shall conform to Flame (F) and Temperature (T) ratings required by local building code and as tested by nationally accepted test agencies per ASTM E-184 or UL 1479 fire tests in a configuration that is representative of field conditions. The F rating must be a minimum of one (1) hour but not less than the fire resistance of the assembly being penetrated. Fire
6. Owner shall rely on the judgment and decision of the manufacturer for non-standard applications of the product. Drawings for engineering judgments must indicate the UL tested system or systems upon which the judgment is based, in order to evaluate the engineering judgment against a known performance.
7. Firestopping material shall be non-halogenated, lead and asbestos free, and shall not incorporate nor require the use of hazardous solvents.
8. Firestop products that dissolve in water after curing are not acceptable.
9. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces.
10. Firestopping shall be performed by a Contractor trained or approved by the firestop manufacturer. (A manufacturer's willingness to sell its products to a contractor does not itself confer qualification on the buyer.)
10. Contractor shall be responsible for the correct replacement of firestop material in all existing wall and floor penetrations used as pathways for any cabling installed by Contractor.
11. Conform to the manufacturer's printed instructions for installation in accordance with a U.L rated system or engineering judgment of the manufacturer.
12. ALL floor penetrations require 2 hour rated firestopping assemblies.

C. Codes and Standards

1. NASA-STD-8719.11a
2. ASTM E 84
3. ASTM E 119
4. ASTM E 814
5. UL 263
6. NFPA 101 6-2.2.5 & 6-2.2.8
7. UL 1479
8. State and Local Building Code/Fire Code

8.2 Products

A. Refer to the SAIC|NICS Cable Plant Approved Products List for all approved manufacturers and solutions.

B. Deliver all materials in original unopened packages fully identified with the manufacturer's name, trade name, and UL label.

C. All firestopping materials shall be manufactured by one manufacturer. Any deviation from the specified manufacturer must be approved by SAIC|NICS.

D. Materials shall be stored off the ground and protected from environmental conditions as required by manufacturer.

E. All firestop materials shall be installed prior to expiration of shelf life.

8.3 Execution

A. General

1. Conform to the manufacturer's printed instructions for installation and documentation. Firestop assemblies are to be identified on As-Built drawings.
2. Coordinate this work as required with all other trades.
3. Firestopping shall precede finishing of gypsum board.
4. Where firestopping is installed at locations that shall remain exposed in the completed work, provide protection as necessary to prevent damage to adjacent surfaces and finishes, and protect as necessary against damage from other construction activities.
5. AHJ or SAIC|NICS Representative shall perform visual inspection of all installations.

B. Inspection

1. Examine all areas and conditions where firestop is to be installed and notify SAIC|NICS of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until Contractor, in a manner acceptable to SAIC|NICS, has corrected unsatisfactory conditions.
2. Verify that environmental conditions are safe and suitable for the installation of the firestop products.

C. Conditions Requiring Firestopping

1. Contractor shall be responsible to verify the fire rating of each wall and supply firestop materials that meet or exceed the rating.
2. Provide firestopping for conditions specified elsewhere whether or not fire stopping is indicated on construction drawings.

3. All firestopping shall be installed in accordance to the UL rated system designed for the application.
4. Grout, mortar, or gypsum based products shall not be installed in lieu of firestopping material specified.
5. All smoke walls (smoke barriers, smoke partitions, etc.), rated or non-rated, shall be firestopped with systems designed to maintain a minimum 1-hour rating or that which is equal to the rating of the wall.
6. Provide firestopping for penetrations including conduits, raceways, cables, cable trays or other equipment that pass through one or both surfaces of a fire rated floor or wall.
7. Except for floor on grade, provide firestopping for penetrations that occur through a structural floor or roof and a space that would otherwise remain open between the surfaces of the penetration and the edge of the adjoining structural floor or roof.
8. Where a penetration occurs through fire rated walls or partitions of hollow-type construction, provide firestopping to fill spaces around the penetration, on each side of the wall or partition.
9. The requirements for penetrations shall apply whether or not sleeves have been provided and whether or not penetrations are to be equipped with escutcheons or other trim. If penetrations are sleeved, firestop annular space, if any, between sleeve and wall opening.
10. Provide firestopping to fill miscellaneous voids and blank openings in fire rated construction where existing raceways, conduits, cables, cable trays, or other equipment have been removed.

D. Preparation

Surface to receive firestop shall be free of dirt, dust, grease, oil, oil from release agents, or other matter that would impair the bond of the firestop material to the substrate or penetrating items.

E. Installation

1. Do not penetrate a barrier of unknown construction.
2. Sleeves and core-drilled holes shall be sized at least 1” larger in diameter than penetrating items.
2. Installation and documentation of firestop shall be performed by applicators/installers qualified and trained by the manufacturer. Installation shall be performed in strict accordance with the manufacturer’s detailed installation procedures. Conform to the manufacturer’s printed instructions for installation and documentation. Firestop assemblies are to be identified on As-Built drawings.

3. Apply firestop in strict accordance with UL rated system designs and manufacturer's recommendations.
4. Coordinate with plumbing, mechanical, electrical, and other trades to assure that all conduits, raceways, cables, cable trays, and other equipment that penetrate fire rated construction have been permanently installed prior to installation of firestop. Schedule and sequence the work to assure that partitions and other construction that would conceal penetrations are not erected prior to the installation of firestop.
5. Sealants and putties shall be tooled into place to insure proper adhesion to penetrations and surrounding surfaces.
6. Install dams when required to contain firestopping materials within openings and as required to achieve required fire resistance rating.
7. Correct unacceptable firestopping and provide additional inspection to verify compliance with this Specification at no additional cost.
8. Finish surfaces of firestopping that is to remain exposed in the completed work to a uniform and level condition.
9. Label all completed fire stop assemblies as required by Code
10. AHJ or SAIC|NICS appointed designee shall perform visual inspection of all installations.

9. Equipment, Cabinets, Enclosures, & Cable Management

9.1 General

A. Each MDF or TR shall be equipped with equipment racks and/or cabinets for mounting SAIC|NICS provided equipment and contractor provided cable termination hardware.

B. Equipment racks shall be able to support and organize electronic equipment, cross connection, and/or termination hardware for fiber optic cabling, horizontal cabling, riser cabling, or building entrance cabling as required by the design.

C. Minimum 18" cable ladder (horizontally oriented) shall typically be installed in the MDF and TR's on all 4 walls to provide access and provide a cable path from any entry point into the room to the equipment racks.

D. Open equipment racks shall be used in secured TRs as directed by the SAIC|NICS Cable Plant Engineer only. In areas of co-location with multiple systems, the use of cabinets is preferred.

E. Seismic bracing shall be installed where required by local and state code.

F. Refer to Appendix E for typical equipment rack elevations

9.2 Products

A. Refer to the SAIC|NICS Cable Plant Approved Products List for all approved manufacturers and solutions.

B. Equipment Racks

1. All racks to be 2 or 4 post construction
2. All racks shall be UL Listed
3. All racks shall have a minimal 1,500 pound weight capacity rating
4. All racks shall have a minimal usable rack space of 45 RU's and a mounting width of 19".
5. All rack rails shall meet EIA-310-E and tapped #12-24 thread size for mounting equipment.
6. All rack components shall be black in color and made of lightweight 6061-T6, extruded aluminum.
7. Racks shall be self-supporting and self-squaring and equipped with 1/2" holes for securing multiple-rack-lineups.
8. All racks shall be provided with all necessary hardware to assemble the frame.
9. Racks shall be packed in cartons with suitable shipping inserts such that no damage occurs to the rack finish. Finishes shall not be scratched, chipped, or marred.
10. Racks shall be manufactured ensuring electrical continuity between all metallic components and with a dedicated grounding lugs or location.

C. Cabinets

1. All cabinets shall be minimum 30" wide, 36" deep, and 42 RU high
2. All cabinets shall be UL Listed
3. All cabinets shall have a minimal 2,500 pound static load rating on leveling feet.
4. All cabinets shall be manufactured ensuring electrical continuity between all metallic components and with a dedicated grounding lugs or location.
5. All cabinets shall be provided with all necessary hardware to assemble the enclosure.
6. Cabinets shall be packed in cartons with suitable shipping inserts such that no damage occurs to the cabinet finish. Finishes shall not be scratched, chipped, or marred.
7. Contractor shall provide all accessories and related hardware associated with equipment cabinets unless otherwise noted on the Drawings.

8. Cabinets are required as indicated on Drawings or as directed by SAIC|NICS. Cabinets are to be specified as follows:
9. All cabinets shall be provided with the following accessories:
    a. Frame with front and rear 19” rails
    b. One set of 4 adjustable levelers
    c. Removable vented top panel with (2) 4” knockouts
    d. Locking Plexiglas or mesh front door
    e. Locking perimeter vented steel rear door
    f. Solid Lift off side panels
    g. 16 position 20A power strip
    h. (4) Vertical Lacing Bar Kits

D. Wall Mounted Enclosures

1. Shall be UL Listed
2. Shall be manufactured ensuring electrical continuity between all metallic components and with a dedicated grounding lugs or location.
3. Shall be minimum 30” deep.
4. Low-Profile (Vertical) Wall Mounted Enclosures
5. Shall be UL Listed
6. Shall be manufactured ensuring electrical continuity between all metallic components and with a dedicated grounding lugs or location.

E. Cable Management

1. Provide 19” x 3.5” (2 RU) rack mountable horizontal cable management panels with black, polyester powder, paint finish.
2. Vertical sections of cable ladder shall be utilized to provide a pathway from any floor or ceiling sleeve to the horizontal cable ladder.
3. Provide minimum 7’H x 6”W, single sided (front) vertical cable managers between equipment racks and a minimum 7” H x 3” W on each end. Vertical Cable managers shall have a hinged door cover or brackets over the guide fingers on the front. Guide fingers shall be spaced at 1RU intervals for securing and routing patch cables.
4. All parts shall be black in color.
5. Vertical cable managers shall be of the same manufacturer as the equipment rack.

9.3 Execution

A. Contractor shall ensure that all racks specified for each room are positioned in accordance with the Drawings.

B. Racks shall be secured to the floor and to the overhead cable runway and/or an adjacent wall to ensure racks do not move.

C. Vertical cable managers shall be secured between equipment racks in accordance with manufacturer's instructions using manufacturer's mounting hardware.

D. Racks shall have a minimum 3' clearance in front of the rack base and 3' of clearance from the rear of the vertical cable ladder. Clearance of 4' is preferred.

E. Cabinets shall have a minimum 3' clearance on all sides not adjacent to a wall. Clearance of 4' is preferred.

F. Contractor shall supply and install cable runway (ladder) between the rack(s) and the wall field as required. All backbone fiber optic cables shall be routed and secured between the rack(s) and the mounting board via the cable runway.

G. Assemble racks with paint piercing grounding washers to ensure all rack-framing members are bonded together.

H. Nominal height of the horizontal cable ladder shall be 8'.

I. Equipment racks shall be grounded to the PBB/SBB in accordance with the NEC, ANSI/NFPA 780, TIA-607 (including most recent additions and addendum), and ANSI/IEEE Std.1100 standards.

J. Contractor shall remove paint/finish from equipment rack/cabinet and cable runway where a two-hole lug is installed.

K. Cable management behind the racks shall be constructed of vertical and horizontal sections of cable ladder. This combination of cable ladder shall be utilized to support cabling routed for termination on patch panels. See Appendix F for design details.

10. Backbone Fiber Optic Cabling

10.1 General

A. The backbone fiber optic cabling is comprised of OS2 single mode cables, LC connectors, LC coupler panels, LC modular cassettes (preferred method) and rack-mount housings.

B. The backbone fiber optic cabling shall be comprised of OS2 single mode fibers detailed in Table 4 unless otherwise noted on the Drawings.

Table 5: Minimal Fiber Strand Count

From	To	Minimum Single mode Count
POP/Gateway	Any Bldg	48
Core Bldg	Core Bldg	288
Core Bldg	Distribution Bldg	144
Distribution Bldg	Distribution Bldg	144
Distribution Bldg	Access Bldg	48
Access Bldg	Access Bldg	24
Any Bldg	Remote/Dead End Bldg	12

C. For internal building pathways, the backbone fiber optic cable shall be a tight-buffered (plenum rated) cable.

D. For OSP pathways, the backbone fiber shall be an indoor/outdoor rated or outdoor rated loose tube type cable rated for underground duct.

E. For aerial installation, loose tube fiber optic cable is required.

F. All fiber optic cables and connecting hardware shall meet TIA-568 standard.

G. Adapter plate couplers shall follow the color format in Table 5.

Table 6: Standard Fiber Coupler Color Code

Fiber Optic Adapter Plate Coupler Color Format	
Single Mode	Blue
50um Multimode	Aqua
62.5um Multimode	Orange
APC Single Mode	Green

10.2 Products

A. Refer to the SAIC|NICS Cable Plant Approved Products List for all approved manufacturers and solutions.

B. General

1. Fiber optic cabling shall be provided with the quantity of fibers indicated on the Drawings and/or Specifications.
2. All fiber optic cables shall be by the same manufacturer and shall be the same type, unless otherwise indicated on the Drawings. A mix of fibers from different manufacturers shall be prohibited.

3. Outdoor and indoor/outdoor rated cable shall be of loose tube construction and rated for underground duct installation depending on the pathway. Each buffer tube shall contain a maximum of 12 fibers and the fibers shall not adhere to the inside of the buffer tube.
4. Cables shall comply with TIA 492 specifications, NEC Article 770, OFNP (plenum), OFNR (riser) or OFN (non-plenum).
5. All fibers shall be color coded to facilitate individual fiber identification. Fibers shall utilize a coating to ensure color retention to minimize micro-bending losses and improve handling. The coating shall be mechanically strippable.
6. All fiber shall be terminated in a rack mount or wall mount housing that provides integral space for fusion splice trays.
7. All fiber shall be fusion spliced.
8. The use of hot melt connectors or mechanical splice connectors is not accepted.
9. All fiber housings shall be identified per TIA-607 standards and the SAIC|NICS Cable Plant Administration Labeling manual.

10.3 Execution

A. Fiber Optic Cable

1. Fiber optic cable shall be installed in a single continuous length between termination points. In order to address this requirement, utilize one of the three following options:
    a. Outdoor rated cable must terminate within 50’ of entering the building. (NEC 800.48 - 50’ Rule)
    b. Outdoor rated cable must transition into a rigid or IMC conduit within 50’ of entering a building. (NEC 800.48 - 50’ Rule)
    c. Use Outdoor/Indoor plenum rated cable for the entire installation. All cabling shall meet the restrictions of the environment in which it is installed.
2. Intermediate splicing of the backbone fiber optic cables can be permitted but by prior approval only.
3. Fiber optic cables shall not be placed in any raceway, compartments, outlet box, or junction box with electrical conductors.
4. Cables shall not be attached to or supported by conduits, raceways, fire sprinkler heads or delivery system, or any environmental sensor located in the ceiling space per NEC 300.11, 725.143, and 770.133 (C). Only exception is per NEC 2017 300.11 (C).

5. All fiber optic cable strands shall be tested on the reel after arriving onsite, prior to installation, and after termination per SAIC|NICS testing standards.
6. Fiber optic cable shall be fusion spliced at both ends to a factory terminated LC ultra-polished cable/connector assembly and properly installed, labeled, and secured. Cable assembly splice points shall be protected with splice protection sleeves and neatly organized into splice trays, which shall be loaded into a fiber termination housing. Cable assemblies shall be neatly routed from the splice tray, labeled, and mounted in connector panels.
7. A minimum 25’ service loop shall be provided at each termination point of the cable in the TR. A minimum of one 50’ service loop shall be provided in key MH/HH between the termination points. At the termination point (MDF and TR), the service loop shall be neatly coiled and stored on a fiber storage ring placed on the backboard or as directed by SAIC|NICS.
8. Fiber optic cables shall be installed in such a manner as to avoid kinks and other deformities. Extreme care shall be taken when handling, fishing, and pulling all fiber optic cables to avoid damage to fibers and jacketing/cladding. Avoid excessive and sharp bends.
9. The minimum bend radius of all fiber optic cables shall be carefully observed in accordance with the manufacturer’s specifications.
10. During the installation of the fiber optic cable, the manufacturer's maximum pulling tension shall be strictly followed.
11. Whenever possible, pull cables (including fiber optic cables) simultaneously where more than one is being installed in the same raceway. Avoid multiple pulls whenever possible.
12. Use pulling lubricant where necessary. The lubricant must be approved by the cable manufacturer. Use of soap or grease is not permitted as a pulling lubricant.
13. Use a pulling means that will not damage the cables or support infrastructure.

B. Fiber Termination Points

1. All multimode fibers shall be fusion spliced in the field to factory terminated, ultra PC polished cable/connector assemblies, and mounted into fiber splice housings or fiber termination housings. The fiber termination housings shall be populated with 50 µm multi-mode grade (unless otherwise noted), duplex, LC couplers and coupler panels or modular fusion splice cassettes (preferred method).
2. All single mode fibers shall be fusion spliced in the field to factory terminated, ultra PC polished cable/connector assemblies, and mounted into fiber splice housings or fiber termination housings. Fiber optic termination housings shall

be populated with single mode grade, duplex, LC couplers and coupler panels or modular fusion splice cassettes (preferred method).

3. As directed by the project requirements, select numbers of single mode fiber may be terminated in LC-APC connectors (green in color).
4. Fusion splices shall be stored and secured in splice trays within the fiber optic termination housing in accordance to the manufacturer's specifications.
5. In the MDF or TR, if horizontal fibers are utilized, they shall be installed in a dedicated fiber termination housing separate from the backbone fiber optic cables.
6. All loose-tube fiber optic cables shall be properly prepped and installed in fan-out assemblies in each respective fiber termination housing.
7. The slack from the multi-mode and single mode fiber strands shall be properly coiled and labeled within the fiber termination housings in accordance with the specifications. Proper strain relief shall be provided at the connection points to avoid damage to the fibers.
8. In the MDF or TR, Contractor shall install a rack-mount fiber termination housing that will contain both the multimode and single mode fibers. Unless otherwise indicated on the Drawings, the multimode and single mode fiber strands shall be placed in the same housing, but on separate coupler panels.
9. As indicated on the Drawings, Contractor shall install a wall mount fiber termination housing. Both the multimode and single mode fiber strands shall be placed in the same housing, but on separate coupler panels.
10. Contractor shall install wire management panels as shown on the Drawings.

11. Backbone Copper Cabling (High Pair Count)

11.1 General

A. The backbone copper cabling system is typically designed in a hierarchical star or a multiple hierarchical level topology similar to the backbone fiber cabling.

B. The voice grade cables shall be capable of supporting all standard voice and low-speed data applications and shall meet the required Specifications.

11.2 Products

A. Refer to the SAIC|NICS Cable Plant Approved Products List for all approved manufacturers and solutions.

B. Intra-building Unshielded High-pair Copper Cable

1. Unshielded high-pair copper cables shall be used as the intra-building backbone cables. The cable shall support voice and building service applications.
2. The high-pair copper cables shall be UL Listed Type CMP (plenum).
3. High-pair copper cables shall consist of 24-AWG solid copper conductors insulated with color-coded jacket.
4. Cables shall be available in pair counts of 25, 50, 100, 200, and 300, and shall be ETL certified to current revisions of TIA-568 for Category 3.
5. Cabling shall be UL Listed for Fire Safety.

C. Inter-building Shielded High-pair Copper Cable

1. Shielded high-pair copper cables shall be used as the inter-building backbone cables. The cable shall support voice, low-speed data and building service applications.
2. The cable shall meet RUS PE-89-AL standards.
3. The cable shall be rated accordingly, depending on the pathway and the space occupying.
4. Shielded high-pair copper cables shall consist of 22-AWG solid annealed copper conductors.
5. Conductors shall be dual insulated with an inner layer of foamed polyolefin covered by an outer layer of solid, colored polyolefin.
6. Individual conductors shall be twisted into pairs with varying lay lengths to minimize crosstalk.
7. The core assembly shall be filled with ETPR compound, completely filling the interstices between the pairs and under core tape.
8. The shield shall be constructed of a corrugated, copolymer coated, 8-mil aluminum tape applied longitudinally with an overlap.
9. Cables shall be available in pair counts from 25 to 1500 and shall be RUS listed.
10. The jacket shall be black and designed to withstand exposure to direct sunlight, atmospheric temperature changes, and stresses expected in standard installations. The jacket shall be marked with manufacturer, pair count, gauge, part number, and sequential footage.

D. Wiring Blocks

1. The 66 or 110 wiring blocks shall support up to Category 6 applications and facilitate cross connection and interconnection using either cross-connect wire or the appropriate patch cords.

2. The wiring blocks shall be fire retardant, molded plastic consisting of horizontal index strips for terminating 25 pairs of conductors each. These index strips shall be marked with five colors on the high teeth, separating the tip and ring of each pair, to establish pair location. A series of fanning strips shall be located on each side of the block for dressing the cable pairs terminated on the adjacent index strips.
3. The wiring block shall accommodate 22-AWG through 26-AWG conductors and shall be able to mount directly on wall surfaces with or without backboards or on a 24" freestanding frame.
4. Clear label holders with the appropriate colored designation strips shall be provided with the wiring blocks. The insert label shall contain vertical lines space based on circuit size (3, 4, or 5 pair) and shall not interfere with running, tracing or removing jumper wire/patch cords.
5. The wiring blocks shall be available in 100 and 300 pair sizes.
6. The wiring blocks shall be capable of mounting to a wall frame or equipment rack.
7. Wiring blocks shall be equipped with connecting blocks configured for 5-pairs for backbone cabling applications.
8. The wiring block shall be able to accommodate over 500 repeated insertions without incurring permanent deformation and it shall pass the reliability test of no more than one contact failure in 10,000 connections.

E. Building Entrance Terminals and Protection Modules

1. All copper circuits shall be provided with protection between each building or between areas with separate electrical service. Protection shall be provided with entrance cable protector panels at each end. All building-to-building circuits shall be routed through this protector.
2. Each protector shall be connected with a minimum 6-AWG, jacketed, copper bonding conductor between the protector ground lug and the local TGB unless otherwise noted on the Drawings.
3. Each protector panel shall be provided with plug-in protector modules for each pair terminated on the chassis.
4. Protector units shall have 66 or 110 type, 100-pair wiring blocks on both the input and output.
5. Surge protection modules
    a. Standard Voice Circuits - Shall be black 5-pin, 3-element gas tube protector module.
    b. Other – If necessary, use application specific modules to meet the requirements.

11.3 Execution

A. Contractor shall provide manufacturer trained and qualified installation personnel to install all high-pair count copper cables and termination hardware.

B. Contractor shall utilize proper tools and test equipment when installing, terminating and testing cables and wiring blocks.

C. Prior to installation, inspect cable reels or cartons for damage. Repair or replace defective cables at no cost to SAIC|NICS as required prior to installation.

D. High-pair count copper cables shall not share any pathway (inside or outside) with electrical service.

E. Cables shall be installed in such a manner as to avoid kinks and other deformities.

F. For high pair count backbone cables, the total number of failed pairs shall not exceed 1% (one percent) for each cable segment. Excessive failures shall require the replacement of the cable at no expense to SAIC|NICS.

G. The minimum-bending radius of all cables shall be carefully observed in compliance with the manufacturer’s specifications. The manufacturer's maximum pulling tension shall be strictly followed.

H. All outdoor rated inter-building cables shall transition to an indoor rated cable within 50’ of entering a building unless installed in conduit up to the termination point. All indoor rated cabling shall meet the requirements of the environment in which they are installed.

I. All cables shall be installed in a single, continuous length between termination points. Splicing of any cable shall not be permitted.

J. In open vertical risers, the cables shall be secured every 3’ using approved mounting method.

K. In open architecture areas, cables shall be secured every 3’ to 5’ using J-hooks.

L. In the MDF and TR, cables shall terminate on 300-pair 66 or 110 wiring blocks. The pairs shall be broken out and numbered in sequential order on the block, left to right, bottom to top (e.g., 1-100, 101-200, 201-300, etc., depending on the number of pairs). Pair assignments shall be provided by SAIC|NICS.

M. The 66 or 110 wiring blocks shall be placed in the wall field as indicated on the Drawings.

N. Contractor shall provide and install C5 clips for the 66 or 110 wiring blocks in order to populate the block.

O. Cross-connects shall be the responsibility of others unless otherwise noted.

P. Cables shall not be attached to or supported by conduits, raceways, fire sprinkler heads or delivery system, or any environmental sensor located in the ceiling space

per NEC 300.11, 725.143, and 770.133 (C). Only exception is per NEC 2017 300.11 (C).

12. Horizontal Cabling

12.1 General

A. Horizontal cabling shall be designed in a Star Configuration with cables originating in the TR and routing to the Work Area Outlet (WAO).

B. The use of zone distributions or zoned architecture for horizontal cabling is an acceptable design method.

C. All category cabling shall be UL Listed and ETL certified Type CMP (Plenum rated) cabling regardless of installation location.

D. The category of cabling systems utilized is dependent upon the type of work being completed:

   1. New construction or major renovations of existing buildings: Category 6A rated cabling systems

      a. A major renovation is defined as an entire floor, telecommunications room serving area, or an area where all or the majority of the existing horizontal cabling is being affected.

   2. Minor renovations and MAC (Moves, Adds, and Changes) work in existing buildings

      a. Match cabling to the type currently installed.

      b. If any other cabling is planned for cable installation, contact SAIC|NICS Cable Plant Service Management.

E. In the TR, all horizontal cables shall terminate to a patch panel.

F. At the WAO, all horizontal cables shall terminate to a modular connector/jack.

G. The installation of category 6 or 6A cabling requires the cables to be terminated at both ends with modular jacks or male terminatable plug. The use of 8P8C modular plug at the field end is not permitted.

12.2 Products

A. Refer to the SAIC|NICS Cable Plant Approved Products List for all approved manufacturers and solutions.

B. Category 6A UTP Cable

   1. Category 6A UTP horizontal cables shall consist of 4-pair, solid annealed copper, minimum 23-AWG, unshielded conductors, and shall terminate onto an 8-pin modular jack provided at each Telecommunications Outlet.

2. Cable shall be a round cable design with cross member to maintain the appropriate pair spacing relationship. Cable shall support all current and future applications designed to run on Category 6A cabling. Use of a bonded pair cable shall be prohibited.
3. All Category 6A cable shall be rated to no less than 500MHz.
4. All Category 6A cable shall meet 11° C temperature-rise over ambient in a 91 cable bundle tested with 0.7A/conductor powering scheme.
5. All Category 6A cable must be UL Listed CMP-LP (0.7A or higher) to mitigate NEC 2017 regulations.
6. All Category 6A cable must support up to 140 watts to POE devices.
7. Outside diameter shall not exceed .250" for indoor CMP rated cable construction.
8. All Category 6A cable channel performance (including Alien Crosstalk performance) shall be guaranteed for the worst-case six-around-one channel configuration, where the entire 90m permanent link length is in a structured bundle.
9. All Category 6A cable manufacturer(s) must provide a minimum 25-year warranty when installed by an approved certified installer.

C. Category 6A STP Cable

1. The use of category 6A STP (shielded) cabling is acceptable when a shielded solution is required to satisfy the requirements.

   Note: Shielded cabling requires an overall shielded solution. (I.e. cabling, patch panels, patch cords, and grounding and bonding.)

D. Category 6 UTP & STP Cable

1. Match existing cable type and manufacturer.

E. Category 5e UTP & STP Cable

2. Match existing cable type and manufacturer.

F. Patch Panels

1. Modular (Blank)
   a. The modular (blank) patch panel must be on the SAIC|NICS Cable Plant APL and accept the SAIC|NICS Cable Plant APL modular jack.
   b. The use of front loading angled patch panels is acceptable.
   c. Lacing bars or strain relief bars are required at the rear of the patch panels.
   d. 96-port patch panels shall not be permitted.

2. 110 Punchdown
    a. All modular patch panels shall be wired to TIA 568B.
    b. Modular patch panels shall utilize IDC type connections for terminating horizontal cables and be able to accommodate 23-AWG and/or 24-AWG cable conductors.
    c. Patch panels shall be capable of greater than 750 insertions and 200 terminations.
    d. Patch panels are limited to 24-port and/or 48-port configurations.
    e. Lacing bars or strain relief bars are required at the rear of the patch panels.
    f. 96-port patch panels shall not be permitted.
    g. The modular patch panel shall be UL listed and ETL certified.

G. Coaxial Drop Cable and Connectors
1. Coaxial drop cables shall be RG6 quad shielded (plenum).
2. Plenum rated cables shall be of quad shield construction; constructed of a foam FEP dielectric, bonded tape, 60% braid, non-bonded tape, 40% braid, and a plenum rated Kynar jacket.
3. Provide 75 Ohm, compression coaxial cable connectors installed per cable manufacturer's specification.

12.3 Execution

A. General
1. Contractor shall provide manufacturer trained and qualified installation personnel to install all horizontal cables and termination hardware.
2. Contractor shall utilize proper tools and test equipment when installing, terminating, and testing horizontal cables.
3. Prior to installation, inspect cable reels or cartons for damage. Repair or replace defective cables at no cost to SAIC|NICS as required prior to installation.
4. All horizontal cables, regardless of media type, shall not exceed 90 m (295') from the TOs in the work area to the horizontal cross connect. This is inclusive of all horizontal and vertical cable components.
5. The length of jumpers, patch cords, and equipment cables in the TR and the Work Area shall not exceed 10m (33') combined.
6. Contractor shall minimize the amount of UTP cable jacket (< ½") removed at each termination point.

7. All cabling shall be labeled with preprinted labels per Section 14 - Cabling System Administration.
8. No handwritten cable identification shall be allowed.
9. Contractor shall minimize the amount each cable pair is untwisted to a maximum of < ½" at each termination point.
10. Terminate cable per manufacturer's recommendations.

B. Cable Routing

1. Horizontal cables shall not be placed in any raceway, compartments, outlet box, or junction box with conductors of electric light and power circuits.
2. Horizontal cables shall be installed in a single continuous run between the TR and the WAO. Splicing of a cable shall not be permitted.
3. From the point of entry into the TR, the cables shall be separated by type and routed to their respective termination points.
4. Cables shall be properly protected from damage from any sharp edges when entering and exiting the cable tray.
5. Contractor shall ensure horizontal UTP cables are placed and terminated in such a manner as to avoid kinks and other deformities.
6. Conventional (non-UTP cable) A/V cables, Security System cables, and Building Automation/Control cables shall not be installed in cable tray systems designated for voice/data cabling. A/V cables, Security System cables and Building Automation/Control cables shall be installed in other approved pathway systems.
7. During installation, Contractor shall ensure the manufacturer's maximum pulling tension is never reached.
8. Contractor, at no additional cost to SAIC|NICS, shall replace cables that are damaged because of Contractor's installation procedures.
9. Where Contractor is required to install non-continuous pathways, Contractor shall keep hallway crossover to a minimum. Furthermore, non-continuous pathways shall be routed to follow logical paths parallel and perpendicular to the building structure.
10. Where duct, cable trays, or conduit are not available, the Contractor shall bundle (50 cables or less) horizontal cabling with Velcro. Bundles shall be snug but not deforming the cable geometry. Where cable bundles are to be supported by J-hooks, the J-hooks shall be attached to the building structure and framework per local codes and regulations between 3' – 5' intervals. It is important fluctuate the spacing between all adjacent J-hooks during installation.

11. The use of cable ties shall not be permitted at SAIC|NICS. Velcro is the only approved method of securing and bundling category rated cables.
12. Velcro and other methods of binding cabling shall not be installed in such a fashion as to bend, crimp, or deform the cabling in any way to alter the electrical or transmission characteristics of the cabling.
13. UTP cabling, which runs parallel with electric power or lighting cables or conduits, shall maintain the following separation distance:
    a. Less than 3 kVA: 50 mm (2 in) for pathways and 50 mm (2 in) for spaces
    b. For > 3 < 6 kVA: 1.5 m (5 ft.) for pathways and 3 m (10 ft.) for spaces
    c. For > 6 kVA: 3 m (10 ft.) for pathways and 6 m (20 ft.) for spaces
14. The Contractor shall provide all devices for routing the cabling as indicated on the Drawings and as required by the manufacturer to maintain the long-term health and operability of the cabling.
15. The number of horizontal cables placed in a cable support or pathway shall be limited to the manufacturer's stated capacity or TIA-569 cable fill guidelines.
16. Horizontal cables shall not be exposed in the Work Area or other locations with public access unless otherwise noted on Drawings.
17. Cables routed in a suspended ceiling shall not be draped across the ceiling tiles. Cable supports shall be mounted a minimum of 150 mm (6 inches) above the ceiling grid supporting the tiles.
18. Where cable tray is installed and usable, Contractor shall route the cable from the WA to the nearest available cable tray. From the conduit stub or "wall fish" to the tray, the Contractor shall install additional cable support apparatus as necessary to properly support the cables to the cable tray.
19. Cabling shall maintain clearance from Line Voltage cabling and devices at all times, and shall be spaced from these devices to comply with the TDMM, the NEC, and any other local codes or regulations.
20. When working around existing cabling, the Contractor will take extra precautions to ensure that existing services are not disrupted in any way.
21. Cables shall not be attached to or supported by conduits, raceways, fire sprinkler heads or delivery system, or any environmental sensor located in the ceiling space per NEC 300.11, 725.143, and 770.133 (C). Only exception is per NEC 2017 300.11 (C).
22. Prior to the point of entry into the TR, cables shall be separated by type and routed via the cable tray or runway to their respective termination point.

23. Cabling shall be installed per manufacturer's recommendations.

C. Pulling Tension

1. The maximum pulling tension for all cables shall not exceed the respective manufacturer's specifications.

D. Bending Radius

1. Horizontal pathways shall be installed such that the minimum bending radius of the horizontal cables is kept within manufacturer specifications both during and after installation.
2. The Contractor shall adhere to the manufacturer's requirements and as indicated in the TDMM for bend radius and pulling tension of all data and voice cables. Where the manufacturer's specifications differ from those cited in the TDMM, the Contractor shall abide by the greater bending radius and the lesser pulling tension.
3. The minimum bending radius for any cable shall not exceed the respective manufacturer's specifications.
4. In cable terminations spaces, the bending radius for all 4-pair cables shall not exceed four times (4x) the outside diameter of the cable and ten times (10x) the outside diameter for high pair count cables.
5. During installation, the bending radius of a 4-pair cable shall not exceed eight times (8x) the outside diameter of the cable and ten times (10x) the outside diameter for high pair count cables.

E. Slack

1. In the Work Area, a minimum of 1m (3') shall be left for UTP and fiber cables. The slack shall be coiled and secured in the ceiling above the faceplate.
2. In TRs, a minimum of 1.5m (5') of slack shall be left for all horizontal cables. This slack shall be neatly managed on cable trays, cable runways, or other approved means of support.

F. Special Requirements for Cable Routing and Installation

1. All cabling shall comply with the requirements as outlined in the National Electrical Code Articles 725, 760, 770, and 800 and the appropriate local codes. All cabling shall bear CMP (plenum rated) markings for all environments in which cabling is installed.
2. Cables shall terminate on the patch panels in sequential order based on SAIC|NICS Cable Plant Administration Labeling manual. There will be no gaps or open termination points on the patch panels, even if a gap exists in the room numbering system.
3. On the wall field, the cables shall be neatly bundled and held in place with D-rings attached to the plywood backboard. D-rings shall be installed every 9"

and cables shall be attached to the D-rings using Velcro cable ties. In addition, cables shall be tie-wrapped with Velcro ties between D-rings. Cables shall be neatly routed into their respective wiring block bay.

4. At each WAO location, pathways will be sized to accommodate a neatly coiled, 3’ loop of UTP cable above the ceiling at the top of the conduit stub, power pole, and/or “wall fish.” In raised floor and thru-floor environments, the cable loop shall be placed beneath floor near where the cable enters the modular furniture or floor box.

G. Shielded Cabling

1. Shielded cabling is only effective if implemented/installed in a total shielded solution. Proper patch panels, jacks, patch cords, and grounding and bonding is required for the solution to be fully effective. Improper installations will greatly affect performance.

H. Wireless Devices

1. Contractor shall furnish and install two category 6A horizontal cables to each faceplate designated as wireless on the Construction Drawings. Contractor shall coil 15’ of slack at each wireless WAO location.

13. Work Area

13.1 General

A. The Work Area consists of the WAO terminated on the end of the horizontal cable and provides modular connectivity.

B. Unless otherwise specified, a WAO requires a minimum of two horizontal cables. Cubical/Modular furniture that has a zone cabling architecture can reduce the minimum number of cables to the WAO, but will be specified on drawings.

C. Contractor shall provide all connecting hardware and install WAO’s as indicated on the Drawings.

D. Contractor shall install all wireless access points as shown on the Drawings and the site survey design Drawings. The wireless site survey shall be performed by others under a separate contract.

E. All cabling shall be labeled with preprinted labels per SAIC|NICS Cable Plant Administration and Labeling Guide.

F. No handwritten cable identification shall be allowed.

G. Modular jacks shall be compliant with TIA-568 standards including the most recent release, revisions, and addendum.

H. Work Areas Types are described in Table 6.

Table 7: Work Area Types

Work Area Type	Criteria	Minimum TO	Comments
Walled Offices	< 100 ft2	2	
Walled Offices	> 100 ft2	3	
Modular Offices	- -	1*	See note below
Laboratories	Every 16' – 20'	1	
Conference Room	Small	2	Contact SAIC|NICS Collaboration for Requirements
Conference Room	Medium	3	Contact SAIC|NICS Collaboration for Requirements
Conference Room	Large	4	Contact SAIC|NICS Collaboration for Requirements
Conference Room	All	1	IP TV Service
Storage Rooms	--	--	See Walled Offices
Break Rooms	--	1	Wall Phone
Break Rooms	--	1	IP TV Service

*** Requires two horizontal cables except for a zoned architecture, in such case one cable will suffice.**

13.2 Products

A. Refer to the SAIC|NICS Cable Plant Approved Products List for all approved manufacturers and solutions.

B. Faceplates

1. Contractor shall provide all faceplates, including blank cover plates.
2. All faceplates shall be available in single, duplex, triplex, quadplex, or simplex arrangements in a single gang configuration.
3. Blank inserts shall be used to fill empty jack openings on the faceplate.
4. Contractor shall coordinate faceplate type and color with SAIC|NICS.
5. Angled face plates shall be utilized for shallow wall construction.

C. Jacks

1. All modular outlet jacks shall meet or exceed Category 6A transmission requirements for connecting hardware (or category 6/5e requirements where specified), as specified in the most recent revisions of TIA-568, and related addenda.
2. All modular outlet jacks shall be capable of being installed flush in any modular faceplate, frame, or surface mounted box provided by the approved manufacturer.

3. Modular outlet jacks shall be capable of greater than 750 insertions and 200 terminations.
4. Modular outlet jacks shall be capable of terminating 22, 23, or 24 AWG UTP cable and shall be equipped with IDC type contacts.
5. Modular outlet jacks shall be designed with an integral locking mechanism, which upon insertion of a modular plug, provides maximum pull out strength at the plug/jack interface.
6. Modular outlet jacks shall be compliant with TIA-568 standards including the most recent release, revisions, and addendum.
7. Modular outlet jacks shall be individually serialized and tested at the manufacturer's facility.
8. All modular jacks shall be wired to the center's preferred wiring scheme. TIA-568A or TIA-568B.
9. For shallow wall construction, angled modular jacks or jack caps shall be utilized.

D. Coax Connectors/Couplers

1. All coax connectors shall be compression type.
2. All coax connectors must be approved for use by the coax cable manufacturer.
3. Coax cable must be prepared for use by utilizing proper tools as approved by the coax cable manufacturer.
4. Coax insert shall be of the pass-thru type and match the color of the faceplate.
5. Coax connectors shall be tightened snug onto the coax adapter to minimize RF radiation.

E. Wall Phone Faceplate

1. Faceplate shall be capable of accepting a terminated cat 5e, 6, or 6A jack.
2. Faceplate shall be equipped with mounting lugs for wall-mounted telephone sets and shall be UL certified.
3. Faceplate shall be constructed of a stainless steel plate that resists scratching, cleaning solutions, and corrosive atmospheres.

F. Patch Cables (Patch Panel)

1. Patch cables shall be RJ45-to-RJ45 type for all data connections.
2. Patch cables shall be of the same category rating as the cabling system being installed.
3. The Contractor shall furnish a quantity of patch cables equal to 100% of the horizontal cables terminated in each TR as part of the contract.

4. Patch cables shall be provided in quantities and lengths as determined by the SAIC|NICS Project Manager or representative.

G. Work Area Cables

1. Work area cables are not in the context of this contract.

13.3 Execution

A. General

1. Drawings detail the relative locations of each WAO. Contractor shall verify with Architect and/or SAIC|NICS the precise location of each WAO prior to installation. Contractor shall be required to re-verify that the UTP cable length of 90-meters (295 ft.) is not exceeded for each WAO location that changes by more than 2-meters from that location shown on the Drawings.
2. Contractor shall verify ADA requirements for each faceplate by location type.
3. For adjacent Work Area spaces separated by a full wall (does not include modular furniture or half walls), back-to-back faceplate installations shall be prohibited. Faceplates in adjacent Work Areas must be installed between separate wall-stud zones.

B. Wireless Access Points (WAP)

1. SAIC|NICS shall be responsible to perform a wireless site survey and design. The wireless site survey and design drawings shall determine the final placement of each WAP.
2. All WAPs shall be powered via the horizontal cabling (PoE). Separate 110vac power will not be required.
3. SAIC|NICS shall install all WAPs in accordance with the wireless site survey and design drawings.
4. Contractor shall furnish two (2) cat 6A work area cables for each WAP.
5. Contractor to terminate WAP cables per drawings.
6. SAIC|NICS shall provide on-site technical assistance during final testing of the WAPs.

14. Administration and Labeling

Reference the SAIC|NICS's Cable Plant Administration and Labeling Guide for cable plant administration and labeling directions.

15. Testing

15.1 General

A. Category copper testing instruments shall meet the most recent version of standard TIA-568 & TIA-1152.

B. All Balance Twisted Pair category copper is required to pass the respective "Permanent Link" test according to the most recent version of standard TIA-568.2. Individual tests performed independently of the other required tests will not be accepted.

C. All fiber optic cable strands are required to pass both Tier I and Tier II test requirements in both directions according to the most recent version of standard TIA-568.

D. All cable testing is required to meet the manufacturer's warranty criteria and SAIC|NICS's acceptance criteria. Contractor shall be responsible to repair or replace any cable that does not meet Specification at no additional cost to SAIC|NICS.

E. A test result marked with an asterisk ("*"), referred to as a "Star Pass," will not be accepted. SAIC|NICS reserves the right to mandate re-termination or other reasonable rework to improve the performance of any cable indicated as "fail or "marginal pass."

F. Contractor shall review every test report for accuracy, completeness, and conformance to the Specifications.

G. After delivery of materials to the Site and prior to installation, all cables, cable reels, and shipping cartons shall be visually inspected to detect possible damage incurred during shipping and transport. Visibly damaged goods should be immediately reported to the vendor and returned for replacement.

H. All test results are required to be documented and submitted in hard copy (summary only) and electronic (softcopy) format with the as-built documentation.

I. Contractor shall provide unaltered electronic test results submitted in the original software format of the respective test equipment manufacturer. Text files or files that have been imported into a word processor or other text editor application shall not be acceptable.

J. All test equipment shall be calibrated annually or per manufacturer's specification, with certification provided to SAIC|NICS upon request. Test equipment is to maintain calibration throughout the testing process of a project without the need to re-calibrate; otherwise, all cabling must be re-tested.

K. SAIC|NICS retains the right to be present at any or all testing. Contractor shall provide written notice 48 hours prior to the beginning of the testing process.

L. Independent third party system testing may be required, at the discretion of SAIC|NICS in the event of non-performance of the specified testing procedures,

submittals and/or installation procedures. The extent and logistics of the independent testing shall be arranged by SAIC|NICS. All costs associated with the testing shall be the responsibility of the Contractor.

M. All cables shall pass testing before SAIC|NICS's acceptance of the cables.

15.2 Fiber Optic Cable Tests

A. Pre-installation Test

1. Contractor shall be responsible for pre-installation testing of all fiber optic cables. Tests shall be performed while the cable is on the spool.
2. Contractor shall submit test plan that shall include procedure and acceptance criteria for meeting this requirement.
3. Contractor shall replace the entire cable spool should any strand fail to meet the acceptance criteria. Replacing the cable shall not relieve Contractor of meeting project deadlines and milestones.
4. Contractor shall provide SAIC|NICS with written notification as to the results of the pre-installation testing within five (5) business days of completing the tests.

B. All fiber testing is required to pass both TIA-568 Tier I and Tier II testing requirements in both directions.

C. The use of launch cords at both ends of the fiber under test shall be utilized.

D. Optical Power Test

1. Each strand of all fiber optic cable (backbone and horizontal) shall be tested to verify the optical loss performance.
2. Contractor shall perform optical power tests in both directions for all fiber optic cable.
3. Each multimode fiber strand shall be tested at 850nm and 1300nm.
4. Each single mode fiber strand shall be tested at 1310nm and 1550nm.
5. All optical power meter tests shall be performed using a stable light source.
6. Contractor shall use the test equipment manufacturer's standard form. Test data shall include the following information:
    a. Project
    b. Origination Bldg./TR
    c. Destination Bldg./TR
    d. Cable Manufacturer
    e. Cable Part Number

f. Cable Type (e.g., Multimode or Single mode)

g. Cable Construction (e.g., Tight Buffered, Loose Tube or Ribbon)

h. Jacket Rating (e.g., OFNR, OFNP, etc.)

i. Connector Type

j. Transmit Level

k. Wavelength

l. Origin Panel/Port Number

m. Destination Panel/Port Number

n Strand Color/Number

o. Receive Level

p. Link Loss

7. The total allowable link loss shall be based on the information shown below:

   a. For calculation purposes, a cable segment is based on an individual strand of multimode or single mode fiber terminated on each end with a fiber connector, excluding patch cables.

   b. These calculations shall be used as the Acceptance Criteria for the backbone cable.

E. OTDR

1. Contractor shall perform OTDR testing in both directions for all levels of the backbone fiber optic cable. The purpose of the OTDR tests shall verify the length of each strand and the optical integrity of each fiber (e.g., opens, terminations, loss/km, microbends, etc.).

2. Contractor shall ensure that the launch cable used during the OTDR tests conforms to the OTDR manufacturer's specifications.

3. The Contractor shall utilize launch cables at both the near end and also at the far end.

4. Contractor shall ensure that the refractive index parameter is set to equal that of the fiber manufacturer's specifications.

5. All results shall be documented and provided in Contractor's standard format.

F. Return Loss Test (Reflectance)

1. Contractor shall perform return loss (reflectance) tests on each single mode fiber strand in both directions for all fiber optic cable.

2. The minimum acceptable return loss (reflectance) shall be -45dB for UPC 1310 and 1550 with Event Loss at -0.2dB per event and -55dB for APC at 1310 and 1550 with Event Loss at -0.2dB per event.

3. Any cable/connector assembly failing to meet the acceptance criteria shall be repaired or replaced by the Contractor at no additional cost to SAIC|NICS.

15.3 Category Copper Cable Tests

A. Upon completion of category copper cable installation, Contractor shall perform a Permanent Link certification tests on every cable.

B. The Permanent Link test performed is required to match the installed product.

C. Testing shall be performed to published standards to the latest revisions of TIA-568.2 and all other applicable standards at the time of installation.

D. All tests shall be performed with a minimum certified Level IIIe UTP test device. Certified test equipment as manufactured by Fluke shall be acceptable. Contractor shall utilize the latest model/software revision for all testing. SAIC|NICS shall approve the use of alternate test equipment. All costs associated with calibrating test units shall be Contractor's responsibility.

E. All category copper field testers shall be factory calibrated per manufacturer's recommendation. The calibration certificate shall be provided to SAIC|NICS for review prior to the start of testing.

F. Test leads shall be validated and referenced prior to project certification testing and replaced according to manufacturer's recommendations.

G. For any given project, the Contractor must use the same test equipment (manufacturer and model) for all UTP cable tests. Mixing of different manufacturer's test equipment shall not be permitted.

H. All test equipment shall be operating under the latest version of firmware/software as provided by the manufacturer. Contractor shall be responsible for all costs associated with test equipment firmware/software upgrades.

I. Prior to testing, Contractor shall perform the following setup procedures on the test equipment.

   1. Enter all relevant project data into the test equipment, including technician/operator name, date of test, project name, building, floor, WAO number and jack position number, etc.

   2. Enter appropriate cable manufacturer, manufacturer's model number, and electrical parameters of the cable, including nominal velocity of propagation.

   3. Calibrate the scanner to the injector.

J. Contractor shall verify that the WAO number matches the number on the patch panel.

K. Contractor shall troubleshoot, correct, repair, or replace each cable that does not meet specification at no expense to SAIC|NICS.

L. A test result marked with an "*" (asterisk) will not be accepted.

M. A test summary and each individual cable test shall be included as part of Contractor's as-built documentation submittal. Only the Test Summary Sheet shall be printed and submitted in hardcopy format. The individual UTP cable tests shall be submitted in electronic format only. The Test Summary Sheet for each Telecommunications Room shall be signed and dated by Contractor's Project Manager. Contractor shall submit all cable test results in electronic form.

N. The electronic test results must be submitted in the original software format of the respective test equipment manufacturer.

O. Text files or files that have been imported into a word processor will not be accepted.

P. For cabling manufacturers and part numbers not approved on the SAIC|NICS Cable Plant APL, all Category 6A testing shall include 1% of cable lengths over 150' for alien crosstalk. Cables to be selected by SAIC|NICS.

15.4 Backbone Copper High Pair Count Cable Tests

A. Contractor shall test all high pair count copper cables in order to verify continuity and wire map of the cables.

B. Each cable pair shall be tested for shorts, opens, crosses, splits and reversed polarity. All testing shall be performed using an Owner approved tester.

C. For the backbone cable, the total number of failed pairs shall not exceed 1% (one percent) for each cable segment.

D. Contractor shall troubleshoot, correct, repair, or replace each cable that does not meet specification at no expense to SAIC|NICS.

15.5 Telecommunications Grounding System Performance and Test Requirements

A. Two-point ground/continuity testing

1. This testing procedure will help determine if there is an acceptable maximum level of resistance between any point in the telecommunications bonding and grounding system and the building's electrical grounding electrode system. The test is performed using an earth ground resistance tester that is configured for a continuity test, otherwise known as a two-point test or a "dead earth" test.

2. The earth ground resistance tester generates a specific alternating current (ac) test current. This current is less susceptible to the influences of stray currents in the grounding system. This makes the ground resistance test a more accurate testing device than a standard volt-ohm-millimeter.

3. Prior to two-point ground testing, a visual inspection shall be performed to verify that the bonding and grounding system is installed according to the

guidelines in this Standard. Due to the possibilities of ground faults traveling through the TGS, a voltage test should be performed prior to conducting the two-point continuity test and verified with the test equipment manufacturer's instructions. Consult with other contractors to ensure other electrical work does not interfere with this test.

4. The test is typically performed by connecting one meter lead to the nearest building's electrical grounding electrode and a specific point on the telecommunications bonding and grounding system such as the PBB. This same test can also verify continuity between any two points of the telecommunications bonding and grounding system such as between the PBB and a SBB.
5. It is recommended that this test be performed in the following areas:
    a. PBB/SBB to the electrical ground in Distributors
    b. PBB/SBB to the building steel (if present)
    c. PBB to SBB
    d. Building steel (if present) to the electrical ground.
6. In order for this test to be valid it must be done before the telecommunications equipment is installed otherwise parallel paths may invalidate test results.
7. The recommended maximum value for resistance between any point in the telecommunications bonding and grounding system and the building's electrical grounding electrode system is 100 milliohms. In the case of long TBB and GE conductor runs, the resistance of the conductor must be factored into the total resistance. For example, 1 km of a No. 3/0 conductor has a resistance of 0.2028 ohms. (0.06180 ohms per 1000 ft.).

16. Project Demolition – Abandoned Cabling

16.1 General

A. Abandoned Data/Voice Cables

1. For all projects, it shall be the responsibility of the Cable Plant Engineer to assess the scope of the work to determine if any cabling is to be abandoned during the project.
2. For any cabling determined to be abandoned, per NFPA 70® (National Electric Code®), identified cabling should be removed in its entirety.
3. For any cabling determined not to be abandoned but is to be reserved for future use, the cable must be tagged at both ends identifying the cable for future use [per NFPA 70® (National Electric Code®)].

4. It shall be a recommendation for good practices to periodically evaluate known legacy cables to determine their status for abandonment, especially for high pair count copper cabling.
5. Demolition of abandoned cables not only meets code requirements, it also frees up building pathway spaces and OSP ductbank space for future installations.

16.2 Execution

A. Abandoned Cabling

1. Any cables deemed abandoned shall be removed in its entirety as long as it can be removed without the risk of damaging adjacent cabling.
2. Any abandoned cables successfully removed shall be recycled per SAIC|NICS's recycling policies and procedures.
3. Any abandoned cables that cannot be removed due to the risk of damaging adjacent cabling should be clearly identified at both ends of the cable.

B. Unused Cabling – For Future Use

1. Any cables deemed not to be abandoned but needed for future use must be clearly identified per NFPA 70® (National Electric Code®) with "for future use" labels at each end.
2. This only applies to unterminated cables. Cables that are terminated at both ends are considered to be in use.

17. As-Built Documentation

17.1 General

A. Contractor shall submit to SAIC|NICS as a condition of final payment and acceptance all as-built documentation as required in these Specifications.

B. Copies of the Contractor's red-lined drawings showing handwritten changes and WAO numbers shall be submitted to SAIC|NICS immediately upon completion of testing.

C. All final documentation and record drawings shall be submitted prior to the cabling being placed into service.

D. All documentation shall be submitted in hard copy and/or soft copy format depending on the type of documentation. Soft copy shall be submitted electronically in PDF format.

E. Contractor is required to submit all as-built documentation in person and review it with SAIC|NICS during the Project Closeout Meeting.

F. SAIC|NICS shall record all new project documentation per local center's policy for data archiving.

17.2 Voice and Data Communications Cabling System Documentation

A. Documentation requirements for the Voice and Data Communications Cabling System shall include the following information. Contractor shall electronically organize the documentation into folders for each section as follows:

1. Electronic format shall be entitled "Voice and Data Communications Cabling System Documentation" and shall include the project name and date of submittal.
2. Backbone & Horizontal Fiber Test Results
    a. Backbone Fiber - Summary of testing and Power Meter Test Sheets
    b. Backbone Fiber – Summary of testing and OTDR Traces
    c. Horizontal Fiber – Summary of testing and Power Meter Test Sheet
    d. Horizontal Fiber – Summary of testing and OTDR Traces
3. UTP Horizontal Cable Tests
    a. Original test files
    b. Summary
    c. Individual Cable Detail Sheets
4. ID Charts
    a. Backbone Fiber Strand ID Charts
    b. Horizontal Fiber Strand ID Charts
    c. UTP Wiring Block ID Charts or Patch Panel Charts
5. Record Drawings
    a. Floor Plans showing WAO locations and their respective faceplate number
    b. All Telecommunications Room and Rack Layout Drawings
    c. All schematic detail drawings
6. Manufacturer's Specifications and Project Specific Warranties (hard copies are acceptable when furnished by manufacturer.)

17.3 Record Drawings

A. Contractor shall modify the design drawings to reflect all conditions of the low voltage cabling systems, including but not limited to backbone and horizontal

cabling, WAO numbers, cable tray locations, floor core locations, wall sleeve locations, equipment rack and wallboard layouts, etc.

B. Contractor shall provide soft copy of all as-built drawings in AutoCAD format (.dwg). Along with the soft copy, Contractor shall provide two hard copy sets of as-built drawings. Each hard copy set shall include (1) "E" size and (1) "D" size set of drawings.

C. Contractor shall add all revision information in the appropriate title block space. All drafting will be two-dimensional and scaled as appropriate and clearly perceptible.

D. Contractor shall be responsible to obtain all of the electronic AutoCAD files from the Architect and/or Engineer. Contractor shall be responsible for all costs associated with obtaining the files.

E. "X References" or XREF clipping will not be used. Match Lines will be provided detailing the adjacent drawing number as required. Details or other drawing entities will be provided as blocks rather than bound to the drawing file.

F. All text fonts will be the original typeface and sized for clarity (notes, dimensions, etc.) to help distinguish annotations for the drawing. Text sizing will be dependent on drawing scales, but will be consistent throughout the individual site.

17.4 Fiber Strand Charts

A. A separate fiber strand ID chart shall be generated for each backbone and horizontal fiber termination housing in the MDF and TR.

B. Contractor shall follow the same format as the strand ID charts provided in each fiber termination housing and as shown elsewhere in the Specifications.

C. Contractor shall provide a copy of these charts electronically in either MS Word or MS Excel format.

D. The following key corresponds to numbers on each chart.

1. **Unit ID:** Backbone Cabinet No. ## (e.g., MM-01, MM-02, MM-03, etc., numbered in sequential order by fiber type top of rack to bottom, left to right.
2. **Serving:** Telecommunications Room - Hub No. and Room No.
3. **Fed From:** Telecommunications Room - Hub No. and Room No.
4. **Strand ID:** Each block (e.g., A1, A2, etc.) represents a duplex connector; therefore, both strands must be listed. Strand numbering shall be in sequential order. For MIC cables numbering is 1, 2; 3, 4; 5, 6; etc. For loose tube cables, include tube color before strand number (e.g., Bl-1, Bl-2; Bl-3, Bl-4; etc.)
5. **Date:** Fiber Optic Cable Installed
6. **Installed By:** (company name)

7. **Link Length:** (as measured with the OTDR).

17.5 UTP – 110 Patch Block ID Chart

A. A separate UTP wiring block ID chart shall be generated for each TR 110 wiring block. The chart shall represent the physical layout of the 110 wiring blocks and shall identify the WAO number, cable length, and the cable's destination.

B. General data such as Project Name, Date of Installation, and Telecommunications Room Location/Designation shall be included on the chart. Unused ports on the chart shall be left blank for future use.

C. Contractor shall provide a copy of these charts electronically in either MS Word or MS Excel format.

17.6 UTP – Patch Panel ID Chart

A. A separate UTP patch panel ID chart shall be generated for each patch panel. The chart shall represent the physical layout of the patch panels and will identify the WAO number, cable length, and the cable's destination.

B. General data such as Project Name, Date of Installation, and Telecommunications Room Location/Designation shall be included on the chart. Unused ports on the chart shall be left blank for future use.

C. Contractor shall provide a copy of these charts electronically in either MS Word or MS Excel format.

17.7 Test Results

A. Contractor shall provide detailed test documentation on all of the required testing. Test results shall include the following:

1. All fiber optic cable test results
2. Horizontal UTP test results
3. Backbone high pair count copper cable test results
4. Broadband video system test results

B. Horizontal UTP cable test results shall be documented and shall include the following general information:

1. Contractor's Company Name
2. Owner's Name: NASA "Center Name"
3. Project Name
4. Date of Testing

5. Time
6. WAO & Cable Number
7. Test Technician or Operator
8. Test Equipment Model/Serial No.
9. Test Acceptance Criteria
10. Test Frequencies

C. Contractor shall provide a copy of the horizontal UTP test results electronically in the original software format of the respective test equipment manufacturer.

17.8 Manufacturer's Specifications

A. Contractor shall provide all cable and associated hardware manufacturer's specifications, operational manuals, and warranties as normally provided by the manufacturer.

Appendix A. Acronyms

Acronym	Description
ADA	Americans with Disabilities Act
AFF	Above Finished Floor
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
APL	Approved Products List
ASTM	American Society for Testing and Materials
BICSI	Building Industry Consulting Services International
CISCA	Ceilings & Interior Systems Construction Association
CSO	Communications Service Office (NASA)
EF	Entrance Facility
GE	Grounding Equalizer
GRC	Galvanized Rigid Conduit
IEEE	Institute of Electrical and Electronics Engineers
ISP	Inside Plant, refers to interior or intra-building cable and components
MDF	Main Distribution Frame
NCS	National CAD Standards V6
NEC	National Electric Code
NEMA	National Electrical Manufacturer Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NICS	NASA Integrated Communications Services
OSP	Outside Plant
OTDR	Optical Time Domain Reflectometer
PBB	Primary Busbar
RBC	Rack Bonding Conductor
RCDD	Registered Communications Distribution Designer
RFP	Request for Proposal
RUS	Rural Utilities Service
SBB	Secondary Busbar
SCTE	Society of Cable Telecommunications Engineers
SCS	Structured Cabling Solution
TBB	Telecommunications Bonding Backbone
TEBC	Telecommunications Equipment Bonding Connector
TGB	Telecommunications Grounding Busbar
TGS	Telecommunications Grounding System
TIA	Telecommunications Industry Association
TMGB	Telecommunications Main Grounding Busbar

Acronym	Description
TR	Telecommunication Room
UTP	Unshielded Twisted Pair
WAO	Work Area Outlet

Appendix B. Definitions

As used throughout this document, and any associated SAIC|NICS documents, including but not limited to Contract Documents, Construction Documents, RFP Documents and Attachments, the terms below shall have the following definitions.

Term	Definition
Acceptance	Shall be defined as SAIC|NICS's notification to the Contractor that the work, as defined herein, has been delivered and installed in accordance with a RFP and all associated Appendices, Amendments and Change Orders and that the Contractor has satisfactorily completed all system testing and documentation as specified herein.
Building	Shall refer to the Site where those portions of the work shall include the internal horizontal and/or vertical fiber, copper and/or coaxial cabling within a given physical structure.
Campus	Shall refer to the Site where those portions of the work shall include interconnecting or backbone cabling, comprised of either fiber, copper and/or coaxial(s) between two or more buildings.
Contract Agreement	Shall mean Contractor Company's Subcontract Agreement.
Contractor	Shall mean the successful bidder selected by SAIC|NICS to perform all or a portion of the installation work for the structured cabling project as described in these specifications.
Documentation	Shall mean all current product descriptions, technical manuals, supporting materials, warranties, test results and Contractor produced detailed technical drawings and illustrations, including copies thereof, which are to be provided by Contractor to SAIC|NICS pursuant to these specifications.
Drawings	Shall mean the graphic and pictorial portions of the Contract Documents showing the design location and dimensions of the services, generally including plans, elevations, sections, details, schedules, and diagrams.
Furnish	Shall mean to supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.
Install	Shall mean work that includes the actual unloading, unpacking, assembly, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
Materials	Shall mean the materials, products, supplies and components, which are to be provided by the Contractor for incorporation into, or in

Term	Definition
	connection with the installation of the structured cabling system, including those items listed in a RFP and Appendices.
Project	Shall mean the total construction of which the work performed under the Contract Documents may be the whole or a part and which may include construction by SAIC|NICS or by separate Contractors.
Project Manager	Shall mean and include the sole representative of either party, and such representative shall have full responsibility for coordination of the activities of his or her respective party.
Provide	Shall mean to furnish and install, complete and ready for the intended use.
Services	Shall mean those Contractor obligations including, but not limited to, materials, installation labor, testing, project management, and documentation that are to be provided by Contractor to SAIC|NICS pursuant to the specific Contract Documents and/or RFP.
Site	Shall be defined as the land, building, and environment provided by SAIC|NICS where work is to take place and services and materials are to be rendered as defined herein.
Specifications	Shall mean that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, installation standards and methods, and installation workmanship for the work, and performance of related Services.
Subcontractor	A person, entity or business concern who has a direct contract with Contractor to perform all or a portion of the work at the Site. The term Subcontractor does not include a separate Contractor or Subcontractors of a separate Contractor.
Work	Shall mean those Contractor obligations including, but not limited to materials, equipment, labor, testing, project management and documentation that are required by the Contract Documents, whether completed or partially completed. The work may constitute the whole or a part of the Project.

Appendix C. Reference Documents

I. *Cable Plant Approved Products List*
   a. *See the SAIC Cable Plant Service Manager for access to document.*

II. *Cable Plant Administration Labeling manual*
   a. *See the SAIC Cable Plant Service Manager for access to document.*

III. *Corporate Target Architecture*
   a. *See the SAIC Cable Plant Service Manager for access to document.*

Appendix D. NASA Site Specific References

AFRC

Waiver No.	Site	Comments
1	AFRC	The use of air blown fiber for a distribution method of fiber installation is permissible.
2	AFRC	Seismic bracing is governed by local policy.

ARC

Waiver No.	Site	Comments
1	ARC	The security of MH/HH is governed by local policy.
2	ARC	Seismic bracing is governed by local policy.

GSFC

Waiver No.	Site	Comments

GRC

Waiver No.	Site	Comments
1	GRC	See local policy: “PROTECTED DISTRIBUTION SYSTEM REQUIREMENTS FOR INSTITUTIONAL COMMUNICATIONS SYSTEMS IN GRC TESTING FACILITIES”

HQ

Waiver No.	Site	Comments

JSC

Waiver No.	Site	Comments

KSC

Waiver No.	Site	Comments
1	KSC	Utilizes their own color scheme for innerduct

LaRC

Waiver No.	Site	Comments

MSFC

Waiver No.	Site	Comments

MAF

Waiver No.	Site	Comments

NSSC

Waiver No.	Site	Comments

SSC

Waiver No.	Site	Comments

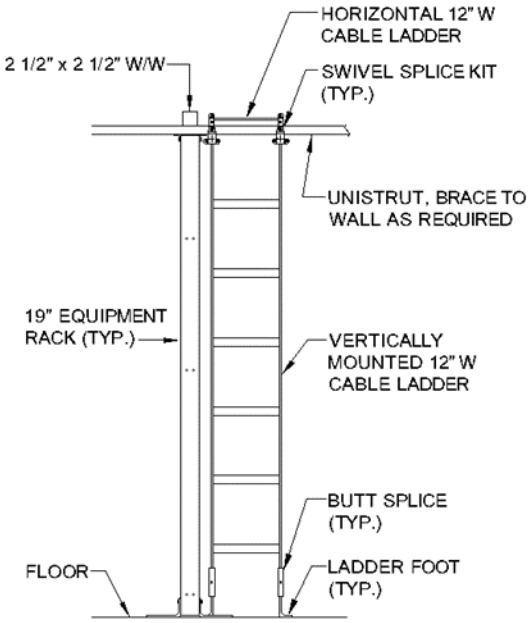
WFF

Waiver No.	Site	Comments

WSTF

Waiver No.	Site	Comments

Appendix E. Typical Equipment Rack Configuration

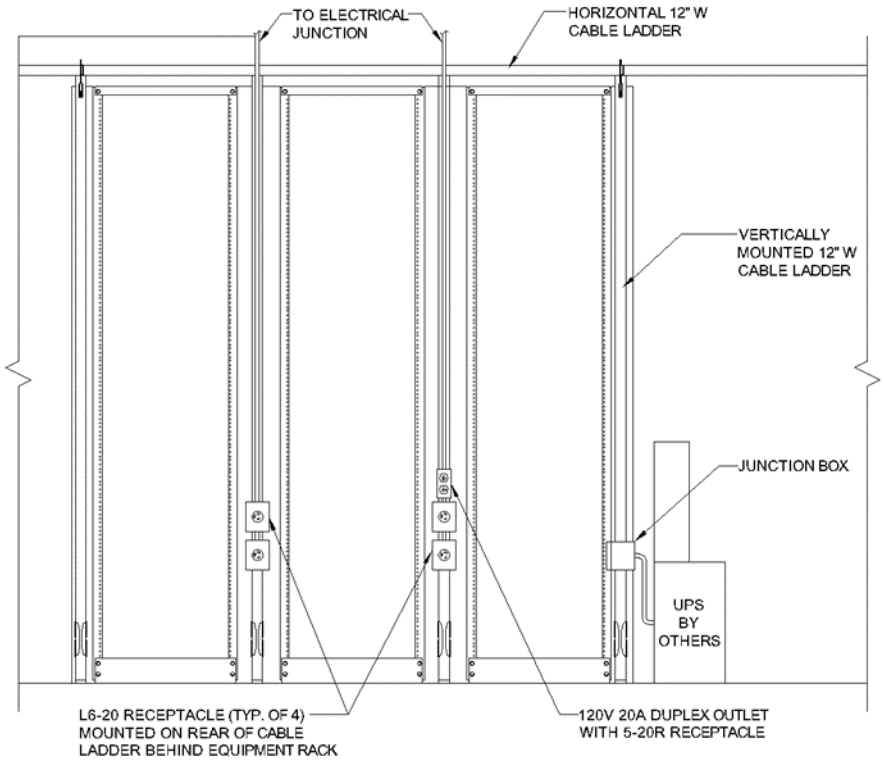


TYPICAL RACK DETAIL - SECTION

1/2" = 1'-0"

SAIC
FROM SCIENCE to SOLUTIONS

TYPICAL RACK CONFIGURATIONS			
DRAWING NUMBER			REVISION
SCALE	DATE 11-8-12	SHEET	DRAWING LOCATION



SAIC.
FROM SCIENCE to SOLUTIONS

TYPICAL REAR RACK ELEVATION

NO SCALE

TYPICAL REAR RACK ELEVATION			
DRAWING NUMBER		REVISION	
SCALE	DATE 7-9-12	SHEET	DRAWING LOCATION