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DEPARTMENT OF THE ARMY **AR-33 82 00.00 48 (April 2020)**
U.S. ARMY CORPS OF ENGINEERS **----------**
Preparing Activity: LRL USACE

ARMY RESERVE GUIDE SPECIFICATIONS
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SECTION 33 82 00.00 48

TELECOMMUNICATIONS OUTSIDE PLANT (OSP)
04/20

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Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted directed to the mailbox SpecsIntact@usace.army.mil.
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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
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The publications listed below form a part of this specification to the

extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318M	(2014; ERTA 2015) Building Code Requirements for Structural Concrete & Commentary

ARMY RESERVE NETWORK ENTERPRISE CENTER (ARNEC)

ARNEC	Army Reserve Network Enterprise CenterInfrastructure Technical Criteria

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C857	(2016) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C990	(2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM F512	(2019) Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative

	Dictionary of IEEE Standards Terms
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-87-640	(2016) Optical Fiber Outside Plant Communications Cable; 4th Edition
ICEA S-98-688	(2012) Broadband Twisted Pair Telecommunication Cable, Aircore, Polyolefin Insulated, Copper Conductors Technical Requirements
ICEA S-99-689	(2012) Broadband Twisted Pair Telecommunication Cable Filled, Polyolefin Insulated, Copper Conductors Technical Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 6 & 8	(2013) Standard for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
NEMA TC 9	(2004) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-46A	(1990) FOTP-46 Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers
TIA-455-78-B	(2002) FOTP-78 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation
TIA-455-107	(1999a) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Set

TIA-492CAAA	(1998; R 2002) Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers
TIA-526-7	(2015a) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
TIA-526-14	(2015c) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-568.0	Generic Telecommunications Cabling for Customer Premises
TIA-568.1	Commercial Building Telecommunications Cabling Standard
TIA-568.2	Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	Optical Fiber Cabling Components Standard
TIA-568.4	Broadband Coaxial Cabling and Components Standard
TIA-569	Commercial Building Standard for Telecommunications Pathways and Spaces
TIA-590	(1997a) Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant
TIA-598	Optical Fiber Cable Color Coding
TIA-606	Administration Standard for the Telecommunications Infrastructure
TIA-607	(2015c; Addendum 1 2017) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
TIA-758	Customer-Owned Outside Plant Telecommunications Infrastructure Standard
TIA/EIA-455	(1998b) Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

U.S. ARMY

I3A	Technical Criteria for the Installation Information Infrastructure Architecture

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 1755	Telecommunications Standards and

	Specifications for Materials, Equipment and Construction
RUS Bull 345-50	(1979) Trunk Carrier Systems (PE-60)
RUS Bull 345-65	(1985) Shield Bonding Connectors (PE-65)
RUS Bull 345-72	(1985) Filled Splice Closures (PE-74)
RUS Bull 1751F-630	(1996) Design of Aerial Plant
RUS Bull 1751F-640	(1995) Design of Buried Plant, Physical Considerations
RUS Bull 1751F-643	(2002) Underground Plant Design
RUS Bull 1751F-644	(2002) Underground Plant Construction
RUS Bull 1751F-815	(1979) Electrical Protection of Outside Plant
RUS Bull 1753F-201	(1997) Acceptance Tests of Telecommunications Plant (PC-4)
RUS Bull 1753F-401	(1995) Splicing Copper and Fiber Optic Cables (PC-2)

UNDERWRITERS LABORATORIES (UL)

UL 6	(2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 83	(2017) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 94	(2013; Reprint Sep 2017) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 351	UL Standard for Safety Rosettes
UL 467	(2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment
UL 497	(2001; Reprint Jul 2013) Protectors for Paired Conductor Communication Circuits
UL 510	(2017) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514B	(2012; Reprint Nov 2014) Conduit, Tubing and Cable Fittings
UL 651	(2011; Reprint Nov 2018) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

UL 1242	(2006; Reprint Mar 2014) Standard for Electrical Intermediate Metal Conduit -- Steel

1.2 GENERAL DESIGN REQUIREMENTS

Telecommunication products, product quality, and product execution must be in accordance with ARNEC and I3A. If a difference arises between these specifications or the drawings, or both, then adherence to these criteria documents will take precedence for such products.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification are as defined in TIA-568.0, TIA-568.1, TIA-568.2, TIA-568.3, TIA-569, TIA-606, and IEEE 100 and as specified.

1.3.1 Entrance Facility (EF)

An environmentally controlled telecommunications space that serves as an entrance to the building for both private and public network service cables (including wireless) including the entrance point at the building wall and continuing to the equipment room.

1.3.2 Telecommunications Equipment Room (TER) (Telecommunications)

An environmentally controlled centralized space for telecommunications equipment that serves the occupants of a building. The space will also house all backbone cable terminations that serve all other telecommunications spaces on an Army Reserve site. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity. The room is the recognized cross-connect between the backbone cable and the horizontal cabling for the area served..

1.3.3 Telecommunications Room (TR)

An environmentally controlled space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling for the area served.

1.3.4 Main Telecommunications Room (MTR)

An environmentally controlled space for housing telecommunications equipment, cable, terminations, and cross-connects. This room will be utilized when a new building or buildings with more than one TR within the new building(s) is being constructed on an existing site where the site already has an existing TER in an existing building. This room will serve as space where all backbone cable from other TRs within the new building will terminate. This will also be the room where new outside plant conduit will terminate. The room is the recognized cross-connect between the backbone cable and the horizontal cabling for the area served.

1.3.5 Telecommunications Enclosure(TE)

An environmentally controlled space for housing telecommunications equipment, cable, terminations, and cross-connects. This is a non-dedicated telecommunications space. This enclosure will only be utilized when there is no opportunity to build out a dedicated

telecommunications room. A lockable floor or wall mounted telecommunications cabinet will be required in the room and will house all of the telecommunications terminations and network equipment. The enclosure is the recognized cross-connect between the backbone cable and the horizontal cabling for the area served.

1.3.6 Pathway

A physical infrastructure used for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

The telecommunications outside plant to consist of cable, conduit, manholes, poles required to provide signal paths from the closest point of presence to the facility, including free standing frames or backboards, interconnecting hardware, terminating cables, lightning, and surge protection modules at the entrance facility. The work to consist of providing, testing and making operational cabling, interconnecting hardware and lightning, and surge protection necessary to form a complete outside plant telecommunications system for continuous use.

1.5 SUBMITTALS

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NOTE: Submittals must be limited to that necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space following the name of the item requiring the submittal by using "G" when the submittal requires Government approval. Submittals not classified as "G" will show on the submittal register as "Information Only".
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NOTE: USARC G-6 is to be provided submittals under this section to review. USARC G6 has no contractual authority over the contract, and this must be annotated in the Engineering Considerations and Instruction to Field Personnel (ECIFP). Adding them as a reviewer directly in the contract could potential create a condition where USARC G6 could obligate the Government.
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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00.00 06 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications Shop Drawings; G[, [_____]]

SD-03 Product Data

Telecommunications Entrance Facility; G[, [_____]]

Closures; G[, [_____]]

Cable Splices and Connectors; G[, [_____]]

Wire and Cable; G[, [_____]]

Inner-duct; G[, [_____]]

Maintenance Holes; G[, [_____]]

Hand Holes; G[, [_____]]

Building Protector Assemblies; G[, [_____]]

Protector Modules; G[, [_____]]

SD-06 Test Reports

Outside Plant Test Plan; G[, [_____]]

Pre-Installation Tests; G[, [_____]]

Acceptance Tests; G[, [_____]]

SD-07 Certificates

Telecommunications Contractor Qualifications; G[, [_____]]

SD-09 Manufacturer's Field Reports

Factory Reel Test Data; G[, [_____]]

SD-11 Closeout Submittals

Record Documentation; G[, [_____]]

1.6 QUALITY ASSURANCE

1.6.1 Telecommunications Shop Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that are to be shown to ensure a coordinated installation. Wiring diagrams to identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings to indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals to include the nameplate data, size, capacity, applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Outside Plant

Submit Outside Plant Design in accordance with ARNEC, I3A, TIA-758, and RUS Bull 1751F-630 for aerial system design, and RUS Bull 1751F-643 for

underground system design. Provide T0 shop drawings that show the physical and logical connections from the perspective of an entire campus, such as actual building locations, exterior pathways and campus backbone cabling on plan view drawings, major system nodes, and related connections on the logical system drawings in accordance with TIA-606. Drawings to include wiring and schematic diagrams for fiber optic and copper cabling and splices, copper conductor gauge and pair count, fiber pair count and type, pathway duct and inner-duct arrangement, associated construction materials, and any details required to demonstrate that cable system has been coordinated and will properly support the switching and transmission system identified as specified and indicated. Provide Registered Communications Distribution Designer (RCDD) approved drawings of the telecommunications outside plant. Update existing telecommunication Outside Plant T0 drawings to include information modified, deleted or added as a result of this installation in accordance with TIA-606. The telecommunications outside plant shop drawings to be included in the as-built drawings.

1.6.1.2 Telecommunications Entrance Facility

Submit T3 drawings for EF Telecommunications as specified in Section 27 10 00.00 48 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS, paragraph "Telecommunications Space." The telecommunications entrance facility shop drawings to be included in the as-built drawings.

1.6.2 Telecommunications Contractor Qualifications

Work to be performed by and the equipment provided by the approved telecommunications contractor. A minimum of 30 days prior to installation submit qualifications for: the telecommunications contractor, the telecommunications installer, the supervisor (if different from the installer), and the cable splicing and terminating personnel. Submit documentation of the experience of the telecommunications contractor and the key personnel.

1.6.2.1 Telecommunications Contractor

The telecommunications contractor to be from a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor to demonstrate experience in providing successful telecommunications systems that include outside plant and broadband cabling within the past 3 years. Submit documentation for a minimum of 3 and a maximum of 5 successful telecommunication system installations for the telecommunications contractor. Each of the key personnel to demonstrate experience in providing successful telecommunications systems in accordance with TIA-758 within the past 3 years.

1.6.2.2 Key Personnel Qualifications

All key personnel must be selected in accordance with the ARNEC requirements. Provide key personnel who are regularly and professionally engaged in the business of the application, installation, and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed depending upon how many of the key roles each has successfully provided. Each of the key personnel to demonstrate experience in providing successful telecommunications systems within the past 3 years.

Cable splicing and terminating personnel assigned to the installation of this system or any of its components to have training in the proper techniques and have a minimum of 3 years experience in splicing and terminating the specified cables. Perform modular splices by factory certified personnel or under direct supervision of factory trained personnel for products used.

Supervisors and installers assigned to the installation of this system or any of its components to have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products.

Submit documentation for a minimum of 3 and a maximum of 5 successful telecommunication system installations for each of the key personnel. Documentation for each key person to include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed. Include specific experience in installing and testing telecommunications outside plant systems, including broadband cabling, and provide the names and locations of at least 2 project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience to have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation.
Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work. All key persons to be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work by the date of Bid Opening.

Note that only the key personnel approved by the Contracting Officer in the successful proposal will do the work for the telecommunications system. Key personnel to function in the same roles, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from the Contracting Officer.

1.6.2.3 Minimum Manufacturer's Qualifications

Cabling, equipment, and hardware manufacturers to have a minimum of 3 years of experience in the manufacturing, assembly, and factory testing of components in accordance with TIA-568.0, TIA-568.1, TIA-568.2, and TIA-568.3. In addition, cabling manufacturers to have a minimum of 3 years of experience in the manufacturing and factory testing of cabling in accordance with ICEA S-87-640, ICEA S-98-688, and ICEA S-99-689.

1.6.3 Outside Plant Test Plan

Submit a complete and detailed test plan for field tests of the outside plant including a complete list of test equipment for the copper conductor

and optical fiber cables, components, and accessories at least 30 days prior to tests. Provide outside plant testing and performance measurement criteria in accordance with the ARNEC, I3A, TIA-568.1 and RUS Bull 1753F-201. Include procedures for certification, validation, and testing that includes fiber optic link performance criteria, and equipment calibration data and type.

1.6.4 Standard Products

Provide materials and equipment that are standard products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and the manufacturer's latest standard design that has been in satisfactory commercial or industrial use for at least 1 year prior to bid opening. The 1-year period to include applications of equipment and materials under similar circumstances and of similar size. The product to have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the
1-year period. Products supplied to be specifically designed and manufactured for use with outside plant telecommunications systems. Where 2 or more items of the same class of equipment are required, these items will be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless otherwise stated.

1.6.4.1 Alternative Qualifications

Products having less than a 1-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 3000 hours, exclusive of the manufacturers' factory or laboratory tests, is provided.

1.6.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site will not be used, unless specified otherwise.

1.6.5 Regulatory Requirements

Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated.

1.6.5.1 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate to state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.7 DELIVERY, STORAGE, AND HANDLING

Ship cable on reels in 500 or 1000 feet length with a minimum overage of 10 percent. Radius of the reel drum not to be smaller than the minimum bend radius of the cable. Wind cable on the reel so that unwinding can be completed without kinking the cable. Two meters of cable at both ends of

the cable to be accessible for testing. Attach permanent label on each reel showing length, cable identification number, cable size, cable type, and date of manufacture. Provide water resistant label and the indelible writing on the labels. Apply end seals to each end of the cables to prevent moisture from entering the cable. Reels with cable to be suitable for outside storage conditions when temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 100 percent. Equipment, other than cable, delivered and placed in storage to be stored with protection from weather, humidity, and temperature variation, dirt and dust, or other contaminants in accordance with manufacturer's requirements.

1.8 RECORD DOCUMENTATION

Provide the activity responsible for telecommunications system maintenance and administration a single complete and accurate set of record documentation for the entire telecommunications system.

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA-606. T5 drawings to include schedules to show information for cut-overs and cable plant management, patch panel layouts, cross-connect information and connecting terminal layout as a minimum. Provide T5 drawings in electric format in .pdf and CAD. Provide the following T5 drawing documentation as a minimum:

a. Cables - Provide a record of installed cable in accordance with TIA-606. The cable records to include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with ANSI/TIA-606. Include manufacture date of cable with submittal.

b. Termination Hardware - Provide a record of installed patch panels, cross-connect points, campus distributor and terminating block arrangements and type in accordance with TIA-606. Documentation to include the required data fields as a minimum in accordance with TIA-606.

Provide record documentation as specified in Section 27 10 00.00 48 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

1.9 WARRANTY

The equipment items to be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the Contract.

PART 2 PRODUCTS

2.1 TELECOMMUNICATIONS OSP TERMINATIONS

2.1.1 Building Protector Assemblies

Submit self-contained 5 pin unit supplied with a field cable stub factory connected to protector socket blocks to terminate and accept protector modules for all pairs of outside cable. Building protector assembly shall have interconnecting hardware for connection to interior cabling at full capacity. Submit manufacturer’s instructions for building protector assembly installation. Provide copper cable interconnecting hardware as

specified in Section 27 10 00.00 48 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.1.2 Protector Modules

Submit in accordance with UL 497 solid state type 5 pin rated for the application. Submit the number of surge protection modules equal to the number of pairs of exterior cable of the building protector assembly.

2.1.3 Fiber Optic Terminations

Provide fiber optic cable terminations as specified in section 27 10 00.00 48 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.2 CLOSURES

2.2.1 Copper Conductor Closures

2.2.1.1 Aerial Cable Closures

Provide cable closure assembly consisting of a frame with clamps, a lift-off polyethylene cover, cable nozzles, and drop wire rings. Closure to be suitable for use on Figure 8 cables. Closures to be free breathing and suitable for housing of the type indicated splices of non-pressurized communications cables and sized as indicated. Construct the closure with ultraviolet resistant PVC.

2.2.1.2 Copper Cable Closures

a. Aboveground: Provide aboveground closures constructed of not less than 14 gauge steel and acceptable for pole or stake mounting in accordance with RUS 1755. Closures to be sized and contain a marker as indicated. Secure covers to prevent unauthorized entry.

b. Direct Burial: Provide buried closure suitable for enclosing a straight, butt, and branch splice in a container into which can be poured an encapsulating compound. Closure to have adequate strength to protect the splice and maintain cable shield electrical continuity in the buried environment. Encapsulating compound to be re-enterable and not alter the chemical stability of the closure. Provide filled splice cases in accordance with RUS Bull 345-72.

c. In Vault or Manhole: Provide underground closure suitable to house a straight, butt, and branch splice in a protective housing into which can be poured an encapsulating compound. Closure to be of suitable thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Encapsulating compound to be re-enterable and not alter the chemical stability of the closure. Provide filled splice cases in accordance with RUS Bull 345-72.

2.2.2 Fiber Optic Closures

2.2.2.1 Aerial

Provide an aerial closure that is free breathing and suitable for housing splice organizer of non -pressurized cables. Construct the closure with ultraviolet resistant PVC.

2.2.2.2 Direct Burial

Provide buried closure suitable to house splice organizer in protective housing into which can be poured an encapsulating compound. Closure to have adequate strength to protect the splice and maintain cable shield electrical continuity, when metallic, in buried environment. Encapsulating compound to be re-enterable and not alter chemical stability of the closure.

2.2.2.3 In Vault or Manhole

Provide underground closure suitable to house splice organizer in a protective housing into which can be poured an encapsulating compound. Closure to be of thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Encapsulating compound to be re-enterable and not alter the chemical stability of the closure.

2.3 PAD MOUNTED CROSS-CONNECT TERMINAL CABINETS

Provide in accordance with RUS 1755 and the following:

a. Constructed of 14 gauge steel.

b. Equipped with a double set of hinged doors with closed-cell foam weatherstripping. Lock doors and contain a marker as indicated.

c. Equipped with spool spindle bracket, mounting frames, binding post log, jumpering instruction label, and load coil mounting provisions.

d. Complete with cross connect modules to terminate number of pairs as indicated.

e. Sized as indicated.

2.4 CABLE SPLICES AND CONNECTORS

2.4.1 Copper Cable Splices

Provide fold back splices of a moisture resistant, 2-wire insulation displacement connector held rigidly in place to assure maximum continuity in accordance with I3A, and RUS Bull 1753F-401. Splice cables greater than 25 pairs using multi-pair splicing connectors, which accommodate 25 pairs of conductors at a time. Provide correct connector size to accommodate the cable gauge of the supplied cable.

2.4.2 Copper Cable Splice Connector

Provide splice connectors with a polycarbonate body and cap and a tin-plated brass contact element. Connector to accommodate 22 to 26 AWG solid wire with a maximum insulation diameter of 0.065 inch. Fill connector with sealant grease to make a moisture resistant connection in accordance with I3A, and RUS Bull 1753F-401.

2.4.3 Fiber Optic Cable Splices

In addition to the requirements below, all fiber optic cable splices shall be in accordance with I3A, and TIA-758. Provide fiber optic cable splices

and splicing materials for fusion methods at locations shown. The splice insertion loss to be 0.3 dB maximum when measured in accordance with TIA-455-78-B using an Optical Time Domain Reflectometer (OTDR). Design splices for a return loss of 40.0 db max for single mode fiber when tested in accordance with TIA-455-107. Physically protect each fiber optic splice by a splice kit specially designed for the splice.

2.4.4 Fiber Optic Splice Organizer

In addition to the requirements below, all fiber optic cable splices shall be in accordance with I3A, and TIA-758. Provide splice organizer suitable for housing fiber optic splices in a neat and orderly fashion. Splice organizer to allow for a minimum of 3 feet of fiber for each fiber within the cable to be neatly stored without kinks or twists. Splice organizer to accommodate individual strain relief for each splice and allow for future maintenance or modification, without damage to the cable or splices. Provide splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors in a splice organizer kit.

2.4.5 Shield Connectors

Provide connectors with a stable, low-impedance electrical connection between the cable shield and the bonding conductor in accordance with RUS Bull 345-65.

2.5 CONDUIT, DUCTS, AND FITTINGS

2.5.1 Rigid Metal Conduit

UL 6

2.5.2 Rigid Metallic Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 400 volts per mil at 60 Hz, and tensile strength must be minimum 3500 psi.

2.5.3 Intermediate Metal Conduit, PVC Coated

UL 1242

2.5.4 Plastic Conduit for Direct Burial and Riser Applications

UL 651 and NEMA TC 2, EPC-40 or EPC-80 as indicated.

2.5.5 Plastic Conduit for Concrete Encasement

Provide Type EB-20 per UL 351, ASTM F512, and NEMA TC 6 & 8.

2.5.6 Inner-duct

Provide corrugated or solid wall polyethylene (PE) or PVC inner-ducts, or fabric-mesh inner-ducts, with pull wire. Size as indicated.

2.5.7 Duct Sealant

UL 94, Class HBF. Provide high-expansion urethane foam duct sealant that expands and hardens to form a closed, chemically and water resistant, rigid structure. Sealant must be compatible with common cable and wire

jackets and capable of adhering to metals, plastics and concrete. Sealant must be of curing in temperature ranges of 35 degrees F to 95 degrees F. Cured sealant mist withstand and temperature ranges of -20 degrees F to 200 degrees without loss of function.

2.5.8 Metal Conduit Fittings

UL 514B

2.5.9 PVC Conduit Fittings

UL 514B, UL 651.

2.5.10 PVC Duct Fittings

NEMA TC 9.

2.6 PLASTIC INSULATING TAPE

Provide in accordance with UL 510.

2.7 PULL ROPE

Plastic or flat pull line (bull line) having a minimum tensile strength of 200 pounds.

2.8 WIRE AND CABLE

2.8.1 Copper Conductor Cable

Provide solid copper conductors, covered with an extruded solid insulating compound. Twist insulated conductors into pairs which are then stranded or oscillated to form a cylindrical core. For special high frequency applications, separate the cable core into compartments. Complete cable by the application of a suitable core wrapping material, a corrugated copper or plastic coated aluminum shield, and an overall extruded jacket. Telecommunications contractor to verify distances between splice points prior to ordering cable in specific cut lengths. Gauge of conductor to determine the range of numbers of pairs specified; 19 gauge (6 to 400 pairs), 22 gauge (6 to 1200 pairs), 24 gauge (6 to 2100 pairs), and 26 gauge (6 to 3000 pairs).

2.8.1.1 Underground

Provide filled cable in accordance with ICEA S-99-689 and RUS 1755.

2.8.1.2 Aerial

Provide filled cable in accordance with RUS 1755 except that it shall be suitable for aerial installation and shall be Figure 8 distribution wire with 6,000 pound Class A galvanized steel or 6,000 pound aluminum-clad steel strand.

2.8.1.3 Screen

Provide screen-compartmental core filled cable in accordance with ICEA S-99-689 and RUS 1755.

2.8.1.4 Fiber Optic Cable

Provide single-mode fiber optic cable in accordance with TIA-492CAAA. Multimode fiber provided to match existing multimode fiber. Provide optical fibers as indicated. Design fiber optic cable with loose tube construction specifically for outside use. Provide fiber optic color code in accordance with TIA-598.

2.8.1.5 Strength Members

Provide central, non-metallic strength members with sufficient tensile strength for installation and residual rated loads in accordance with ICEA S-87-640. The strength member is included to serve as a cable core foundation to reduce strain on the fibers, and not to serve as a pulling strength member.

2.8.1.6 Performance Requirements

Provide fiber optic cable with optical and mechanical performance requirements in accordance with ICEA S-87-640.

2.8.2 Grounding and Bonding Conductors

Provide grounding and bonding conductors in accordance with RUS 1755, TIA-607, ARNEC, I3A, IEEE C2, and NFPA 70. Solid bare copper wire meeting the requirements of ASTM B1 for sizes No. 8 AWG and smaller and stranded bare copper wire in accordance with ASTM B8, for sizes No. 6 AWG and larger. Insulated conductors to have 600-volt, Type TW insulation in accordance with UL 83.

2.9 MAINTENANCE HOLES and HAND HOLES

Precast units must be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes. Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C857 and ASTM C478. Top, walls, and bottom must consist of reinforced concrete. Walls and bottom must be of monolithic concrete construction. Concrete for precast work must have a 28-day compressive strength of not less than 4000 psi. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers must fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, must be adequate to accommodate the cable. Structures must be identified with the manufactures name embedded in or otherwise permanently attached to an interior wall face.

2.9.1 Design for Precast Structures

ACI 318M. In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:

a. Angle of Internal Friction (phi) = 30 degrees

b. Unit Weight of Soil (Dry) = 110 pcf, (Saturated) = 130 pcf

c. Coefficient of Lateral Earth Pressure (Ka) = 0.33

d. Ground Water Level = 3 feet below ground elevation

e. Vertical design loads must include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact. Live loads must consider all types and magnitudes of vehicular (automotive, industrial, or aircraft) traffic to be encountered. The minimum design vertical load must be for H20 highway loading per AASHTO HB-17.

f. Horizontal design loads must include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, must be considered, along with a pulling-in iron design load of 6000 pounds.

g. Each structural component must be designed for the load combination and positioning resulting in the maximum shear and moment for that particular component.

h. Design must also consider the live loads induced in the handling, installation, and backfilling of the manholes. Provide lifting devices to ensure structural integrity during handling and installation.

2.9.2 Construction

Structure top, bottom, and wall must be of a uniform thickness of not less than 6 inches. Thin-walled knock-out panels for designed or future duct bank entrances are not permitted. Provide quantity, size, and location of duct bank entrance windows as directed, and cast completely open by the pre-caster. Size of windows must exceed the nominal duct bank envelope dimensions by at least 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows must be a minimum of 6 inches from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. Provide drain sumps a minimum of 12 inches in diameter and 4 inches deep for precast structures.

2.9.3 Joints

Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to ASTM C990. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

2.9.4 Handhole Frames and Covers

Frames and covers of steel must be welded by qualified welders in accordance with standard commercial practice. Steel covers must be rolled-steel floor plate having an approved anti-slip surface. Hinges must be of stainless steel with bronze hinge pin, 5 by 5 inches by approximately 3/16 inch thick, without screw holes, and must be for full surface application by fillet welding. Hinges must have non-removable pins and five knuckles. The surfaces of plates under hinges must be true after the removal of raised anti-slip surface, by grinding or other approved method.

2.9.5 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

The metal portion of the racks and arms must be zinc-coated after fabrication.

2.9.5.1 Cable Rack Stanchions

The wall bracket or stanchion mist be 4 inches by approximately 1-1/2 inch by 3/16 inch channel steel. Cable racks must contain a minimum of 47 hook spaces. All racks and hooks shall be of galvanized metal.

2.9.5.2 Rack Arms

Cable rack arms must be galvanized steel. Rack arm length must be a minimum of 8 inches and a maximum of 12 inches.

2.9.6 Driven Ground Rods

Provide copper-clad steel ground rods conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used for rods 20 feet or longer.

2.9.7 Cable Tags In Maintenance Holes, Handholes, And Vaults

Provide polyethylene tags for each telecommunications cable or wire located in maintenance holes, hand holes, and vaults and labeled in accordance with ARNEC and TIA-606. Handwritten labeling is prohibited.

2.9.7.1 POLYETHYLENE CABLE TAGS

Provide polyethylene tags that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Provide minimum loop tensile strength ties of 175 pounds. The cable tags to have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags' orientation.

2.10 T-SPAN LINE TREATMENT REPEATERS

Provide pedestal mounted repeaters with non-pressurized housings, sized as indicated, and in accordance with RUS Bull 345-50.

2.11 POLES AND HARDWARE

Provide poles and hardware as specified in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.

2.12 BURIED WARNING AND IDENTIFICATION TAPE

Provide fiber optic media marking and protection in accordance with TIA-590. Provide color, type, and depth of tape in accordance with I3A.

2.13 GROUNDING BRAID

Provide grounding braid that provides low electrical impedance connections for dependable shield bonding in accordance with RUS 1755. Make braid from flat tin-plated copper.

2.14 MANUFACTURER'S NAMEPLATE

Each item of equipment to have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is prohibited for use.

2.15 FIELD FABRICATED NAMEPLATES

Provide laminated plastic nameplates in accordance with ASTM D709 for each patch panel, protector assembly, rack, cabinet, and other equipment. Each nameplate inscription to identify the function and, when applicable, the position. Provide melamine plastic nameplates, 0.125 inch thick, white with black center core, and matte finish surfaces with square corners. Accurately align lettering and engrave into the core. Minimum size of nameplates to be 1 x 2-1/2 inches. Minimum lettering size 1/4 inch high normal block style.

2.16 FACTORY REEL TEST DATA

Test 100 percent OTDR test of FO media at the factory in accordance with TIA-568.1 and TIA-568.3. Use TIA-526-7 for single mode fiber and TIA-526-14, Method B, for multimode fiber measurements. Calibrate OTDR to show anomalies of 0.2 dB minimum. Enhanced performance filled OSP copper cables, referred to as Broadband Outside Plant (BBOSP), in accordance with ICEA S-99-689. Enhanced performance air core OSP copper cables in accordance with ICEA S-98-688. Submit test reports, including manufacture date for each cable reel and receive approval before delivery of cable to the project site.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable. In addition to these requirements install in accordance with the ARNEC, I3A, TIA-758 and RUS Bull 1751F-644.

3.1.1 Damage

Promptly repair indicated utility lines or systems damaged during site preparation and construction. Damages to lines or systems not indicated,

which are caused by Contractor operations, will be treated as "Changes" under the terms of the Contract Clauses. When Contractor is advised in writing of the location of a non-indicated line or system, such notice to provide that portion of the line or system with "indicated" status in determining liability for damages. In every event, immediately notify the Contracting Officer of any damage.

3.1.2 Cable Inspection and Repair

Handle cable and wire provided in the construction with care. Inspect cable reels for cuts, nicks or other damage. Replace or repair damaged cable to the satisfaction of the Contracting Officer. Reel wraps to remain intact on the reel until the cable is placed.

3.1.3 Direct Burial System

Installation in accordance with I3A, and RUS Bull 1751F-640. Under paved areas and roadways install cable in conduit encased in concrete. Slope ducts to drain. Excavate trenches by hand or mechanical trenching equipment. Provide a minimum cable cover of 24 inches below finished grade. Trenches not to be less than 6 inches wide and in straight lines between cable markers. Do not use cable plows. Bends in trenches to have a radius of not less than 36 inches. Where two or more cables are laid parallel in the same trench, space laterally at least 3 inches apart. When rock is encountered, remove rock to a depth of at least 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 1/4 inch. Do not unreel and pull cables into the trench from one end. Cable may be unreeled on grade and lifted into position. Provide color, type, and depth of warning tape as specified in paragraph "BURIED WARNING AND IDENTIFICATION TAPE."

3.1.3.1 Cable Placement

a. Separate cables crossing other cables or metal piping from the other cables or pipe in accordance with I3A. Do not install circuits for communications under or above traffic signal loops.

b. Cables to be in one piece without splices between connections except where the distance exceeds the lengths in which the cable is furnished.

c. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

d. Leave a horizontal slack of approximately 3 feet in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought aboveground. Where cable is brought aboveground, leave additional slack to make necessary connections.

3.1.3.2 Backfill for Rocky Soil

When placing cable in a rocky soil trench, fill the trench with sand or selected soil at least 2 inches thick on the floor of the trench before placement. The backfill for at least 4 inches above the wire or cable to be free from stones, rocks, or other hard or sharp materials which might damage the cable or wire. If the buried cable is placed less than 24 inches in depth, use a protective cover of concrete.

3.1.4 Cable Protection

Provide direct burial cable protection in accordance with NFPA 70.Galvanized conduits which penetrate concrete (slabs, pavement, and walls) with PVC coated and to extend from the first coupling or fitting outside either side of the concrete minimum of 6 inches per 12 inches burial depth beyond the edge of the surface where cable protection is required; seal all conduits on each end. Where additional protection is required, cable may be placed in galvanized iron pipe (GIP) sized on a maximum fill of 40 percent of cross-sectional area, or in concrete encased 4 inches PVC pipe. Conduit may be installed by jacking or trenching. Backfill trenches with earth and mechanically tamped at 6 inches lift so that the earth is restored to the same density, grade, and vegetation as adjacent undisturbed material.

Seal cable ends at all times with coated heat shrinkable end caps (when delivered to the job site, while the cable is stored, and during installation of the cable). The caps to remain in place until the cable is spliced or terminated. Sealing compounds and tape are prohibited substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

3.1.5 UNDERGROUND STRUCTURE CONSTRUCTION

3.1.5.1 Precast Concrete Construction

Set commercial precast structures on 6 inches of level, 90 percent compacted granular fill, 3/4 inch to 1 inch size, extending 12 inches beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation must additionally conform to the manufacturer’s instructions.

3.1.5.2 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices must be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor the irons must be a minimum of 6 inches from the edge of the sump, and in the walls the irons must be located within 6 inches of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron must not be located within 6 inches of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the 6 inch clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 3 foot length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner must be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of 3 inches from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons must have a clear projection into

the structure of approximately 4 inches and must be designed to withstand a minimum pulling-in load of 6000 pounds. Irons must be hot-dipped galvanized after fabrication. In addition, pulling-in irons shall be constructed in accordance with I3A.

3.1.5.3 Cable Racks, Arms, and Insulators

All cable racks, arms, and insulators shall be installed in accordance with the requirements listed in I3A. Methods of anchoring cable racks must be as follows:

a. Provide a 5/8 inch diameter by 5 inch long anchor bolt with 3 inch foot cast in structure wall with 2 inch protrusion of threaded portion of bolt into structure. Provide 5/8 inch steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.

b. Provide concrete channel insert with a minimum load rating of 800 pounds per foot. Insert channel must be steel of the same length as "vertical rack channel;" channel insert must be cast flush in structure wall. Provide 5/8 inch steel nuts in channel insert to receive 5/8 inch diameter by 3 inch long steel, square head anchor bolts.

c. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert must have minimum 800 pound load rating. Provide 5/8 inch diameter by 3 inch long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

3.1.6 Underground Conduit And Duct Systems

3.1.6.1 Requirements

Run conduit in straight lines except where a change of direction is necessary. Provide numbers and sizes of ducts as indicated. Ducts must have a continuous slow downward toward underground structures and away from buildings, laid with a minimum slope of 3 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a maintenance hole, a hand hole, or between maintenance holes or hand holes. Provide ducts with end bells whenever duct lines terminate in structures.

Perform changes in duct bank direction as follows:

a. The minimum manufactured bend radius must be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter.

b. As an exception to the bend radius required above, provide field manufactured long sweep bends having a minimum radius of 25 feet for a change of direction of more than 5 degrees, either horizontally or vertically, using a combination of curved and straight sections. Maximum manufactured curved sections: 30 degrees.

3.1.6.2 Treatment

Ducts must be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers must be made with proper tools

and factory tapers. A coupling recommended by the duct manufacturer must be used whenever an existing duct is connected to a duct of different material or shape. Ducts must be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts must be thoroughly cleaned before being laid. Plastic ducts must be stored on a flat surface and protected from direct rays of the sun.

3.1.6.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.1.6.4 Galvanized Conduit Concrete Penetrations

Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations must be PVC coated and must extend 4 to 6 inches from the point of entry to the termination point.

3.1.6.5 Multiple Conduits

Separate multiple conduits by a minimum distance of 3 inches, except that light and power conduits must be separated from control, signal, and telephone conduits by a minimum distance of 12 inches. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly must consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 10 feet of conduit assembly.

3.1.6.6 Conduit Plugs and Pull Rope

New conduit indicated as being unused or empty must be provided with plugs on each end. Provide a plastic pull rope having 3 feet of slack at each end of unused or empty conduits.

3.1.6.7 Conduit and Duct Without Concrete Encasement

Depths to top of the conduit must be not less than 24 inches below finished grade. Provide not less than 3 inches clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 3 inches, fill and tamp level with original bottom with sand or earth free from particles that would be retained on a 1/4 inch sieve. The first 6 inch layer of backfill cover must be sand compacted as previously specified. The rest of the excavation must be backfilled and compacted in 3 to 6 inch layers. Provide color, type and depth of warning tape as specified in I3A and in section 31 00 00.00 06 EARTHWORK.

3.1.6.8 Ducts Encased in Concrete

Construct underground duct lines of individual conduits encased in concrete. Depths to top of the concrete envelope must be not less than 18 inches below finished grade, except under roads and pavement, concrete envelope must be not less than 24 inches below finished grade. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank must be rectangular in cross-section and must provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 3 inches. Before pouring concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete pouring. Anchoring must be done by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly. Provide steel reinforcing in the concrete envelope as indicated.

3.1.6.8.1 Encasement Under Roads and Structures

Under roads, paved areas, and railroad tracks, install conduits in concrete encasement of rectangular cross-section providing a minimum of 3 inch concrete cover around ducts. Concrete encasement must extend at least 6 feet beyond the edges of paved areas and roads, and 12 feet beyond the rails on each side of railroad tracks. Depths to top of the concrete envelope must be not less than 24 inches below finished grade.

3.1.6.9 Connections to Maintenance Holes

Duct bank envelopes connecting to underground structures must be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section must be larger than the corresponding manhole opening dimensions by no less than 12 inches in each direction. Perimeter of the duct bank opening in the underground structure must be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

3.1.6.10 Partially Completed Duct Banks

During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs.

3.1.7 Excavating, Backfilling, And Compacting

Provide in accordance with I3A, NFPA 70 and Section 31 00 00.00 06 EARTHWORK.

3.1.8 Reconditioning Of Surfaces

3.1.8.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct or direct burial cable. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding, and provide top-soiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

3.1.8.2 Paving Repairs

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists Make repairs as specified in Section 32 13 13.06 06 PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES.

3.1.9 Building Penetrations

Caulk and seal cable access penetrations in walls, ceilings, and other parts of the building. Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.10 Cable Pulling

Test duct lines with a mandrel and clean out to remove foreign material before pulling cables. All mandrel tests shall be in accordance with I3A. Avoid damaging cables in setting up pulling apparatus or in placing tools or hardware. Do not step on cables when entering or leaving the manhole. Do not place cables in ducts other than those shown without prior written approval of the Contracting Officer. Roll cable reels in the direction indicated by the arrows painted on the reel flanges. Set up cable reels on the same side of the manhole as the conduit section in which the cable is to be placed. Level the reel and bring into proper alignment with the conduit section so that the cable pays off from the top of the reel in a long smooth bend into the duct without twisting. Under no circumstances will the cable be paid off from the bottom of a reel. Check the equipment set up prior to beginning the cable pulling to avoid an interruption once pulling has started. Use a cable feeder guide of suitable dimensions between cable reel and face of duct to protect cable and guide cable into the duct as it is paid off the reel. As cable is paid off the reel, lubricate and inspect cable for sheath defects. When defects are noticed, stop pulling operations and notify the Contracting Officer to determine required corrective action. Cable pulling to cease when reel binds or does not pay off freely. Rectify cause of binding before resuming pulling operations. Provide cable lubricants recommended by the cable manufacturer. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

3.1.10.1 Cable Tensions

Submit from the cable manufacturer and the maximum allowable pulling tension. This tension not to be exceeded.

3.1.10.2 Pulling Eyes

Equip cables, 1.25 inches in diameter and larger, with cable manufacturer's factory installed pulling-in eyes. Provide cables with diameter smaller than 1.25 inches with heat shrinkable type end caps or seals on cable ends when using cable pulling grips. Rings to prevent grip from slipping not to be beaten into the cable sheath. Use a swivel of 3/4 inch links between pulling-in eyes or grips and pulling strand.

3.1.10.3 Installation of Cables in Manholes, Hand holes, and Vaults

Do not install cables using the shortest route, but route along those

walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support cables on brackets, and cable insulators at a maximum of 4 feet.
In existing manholes, hand holes, and vaults where ducts are to be terminated, or where cables are to be installed, modify the existing installation of cables, cable supports, and grounding as required with cables arranged and supported as specified for cables.

3.1.10.4 Fiber Optic Cable Slack

Install 20 feet of slack in maintenance holes if the cable is not spliced in maintenance hole. If the fiber optic cable is spliced in the maintenance hole, then 50 feet of slack is required in the maintenance hole on each side of the splice case. Install 20 feet of slack within the building telecommunications spaces on each side of the cable.

3.1.11 Aerial Cable Installation

Install pole as specified in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION. Where physical obstructions make it necessary to pull distribution wire along the line from a stationary reel, use cable stringing blocks to support wire during placing and tensioning operations. Do not place ladders, cable coils, and other equipment on or against the distribution wire. Sag wire in accordance with the data shown. Protect cable installed outside of building less than 8 feet above finished grade against physical damage.

3.1.11.1 Figure 8 Distribution Wire

Perform spiraling of the wire within 24 hours of the tensioning operation. Perform spiraling operations at alternate poles with the approximate length of the spiral being 15 feet. Do not remove insulation from support members except at bonding and grounding points and at points where ends of support members are terminated in splicing and dead-end devices. Ground support wire at poles to the pole ground.

3.1.11.2 Suspension Strand

Place suspension strand as indicated. Tension in accordance with the data indicated. When tensioning strand, loosen cable suspension clamps enough to allow free movement of the strand. Place suspension strand on the road side of the pole line. In tangent construction, point the lip of the suspension strand clamp toward the pole. At angles in the line, point the suspension strand clamp lip away from the load. In level construction place the suspension strand clamp in such a manner to hold the strand below the through-bolt. At points where there is an up-pull on the strand, place clamp to support the strand above the through-bolt. Make the suspension strand electrically continuous throughout the entire length, bond to other bare cables suspension strands, and connect to pole ground at each pole.

3.1.11.3 Aerial Cable

Keep cable ends sealed at all times using cable end caps. Take cable from reel only as it is placed. During placing operations, do not bend cables in a radius less than 10 times the outside diameter of cable. Place temporary supports sufficiently close together and properly tension the cable where necessary to prevent excessive bending. In those instances

where spiraling of cabling is involved, accomplish mounting of enclosures for purposes of loading, splicing, and distribution after the spiraling operation has been completed.

3.1.12 Cable Splicing

3.1.12.1 Copper Conductor Splices

Perform splicing in accordance with I3A, and RUS Bull 1753F-401 except that direct buried splices and twisted and soldered splices are prohibited. Exception does not apply for pairs assigned for carrier application.

3.1.12.2 Fiber Optic Splices

Install all fiber optic cables splices in accordance with I3A and TIA-758.

3.1.13 Surge Protection

All cables and conductors, except fiber optic cable, which serve as communication lines through off-premise lines, to have surge protection installed at each end in accordance with ARNEC, I3A, RUS Bull 1751F-815.

3.1.14 Grounding

Provide grounding and bonding in accordance with RUS 1755, TIA-607, I3A, IEEE C2, and NFPA 70. Ground exposed noncurrent carrying metallic parts of telephone equipment, cable sheaths, cable splices, and terminals.

3.1.14.1 Primary Bus-Bar (PBB)

The PBB is the hub of the basic telecommunications grounding system providing a common point of connection for ground from outside cable, CD, and equipment. Establish a PBB for connection point for cable stub shields to connector blocks and CD protector assemblies as specified in Section 27 10 00.00 48 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

3.1.14.2 Incoming Cable Shields

Accomplish all necessary transfers and cut-overs by the telecommunications contractor as indicated.

3.1.15 Cut-Over

Accomplish all necessary transfers and cut-overs by the telecommunications contractor as indicated.

3.2 LABELING

3.2.1 Labels

Provide labeling for cabling and termination hardware installed in accordance with ARNEC, I3A, and TIA-606. Handwritten labeling is prohibited. Provide stenciled lettering for cable and termination hardware using thermal ink transfer process.

3.2.2 Cable Tag Installation

Install cable tags for each telecommunications cable or wire located in

manholes, hand holes, and vaults including each splice. Tag wire and cable installed and existing wire and cable which are indicated to have splices and terminations provided. The labeling of telecommunications cable tag identifiers in accordance with ARNEC, I3A, and TIA-606. Tag legend, as indicated. Do not provide handwritten letters. Install cable tags so that they are clearly visible without disturbing any cabling or wiring in the manholes, hand holes, and vaults.

3.2.3 Termination Hardware

Label patch panels, distribution panels, connector blocks, and protection modules using color coded labels with identifiers in accordance with ARNEC and TIA-606.

3.3 FIELD APPLIED PAINTING

Provide ferrous metallic enclosure finishes as specified in Section 09 90 00PAINTS AND COATINGS.

3.4 FIELD QUALITY CONTROL

Provide 10 working days notice prior to each test. Correct defective material and workmanship disclosed as the results of the tests. Furnish a signed copy of the test results to the Contracting Officer within 3 working days after the tests for each segment of construction are completed.
Perform testing as construction progresses and do not wait until all construction is complete before starting field tests.

3.4.1 Pre-Installation Tests

Perform the following tests on cable prior to being removed from the cable reel. For cables with factory installed pulling eyes, perform these tests at the factory and certified test results to accompany the cable.

3.4.1.1 Cable Capacitance

Perform capacitance tests on at least 10 percent of the pairs within a cable to determine if cable capacitance is within the limits specified.

3.4.1.2 Loop Resistance

Perform DC-loop resistance on at least 10 percent of the pairs within a cable to determine if DC-loop resistance is within the manufacturer's calculated resistance.

3.4.1.3 Pre-Installation Tests

Provide results of pre-installation tests to the Contracting Officer at least 5 working days before installation is to start. Results to indicate reel number of the cable, manufacturer, size of cable, pairs tested, and recorded readings. When pre-installation tests indicate that cable does not meet specifications, remove cable.

3.4.2 Acceptance Tests

Perform acceptance testing of all installed cabling in accordance with ARNEC, TIA-568.0, TIA-568.2, TIA-568.3, TIA-568.4, RUS Bull 1753F-201, and as specified. Provide personnel, equipment, instrumentation, and supplies

necessary to perform required testing. Notification of any planned testing to be given to the Contracting Officer at least 14 days prior to any test unless specified otherwise. Testing not to proceed until after the Contractor has received written Contracting Officer's approval of the test plans as specified. Test plans to define the tests required to ensure that the system meets technical, operational, and performance specifications. The test plans to define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans to identify the capabilities and functions to be tested. Provide test reports in booklet form showing all field tests performed, upon completion and testing of the installed system. Measurements to be tabulated on a pair by pair or strand by strand basis.

3.4.2.1 Copper Conductor Cable

Perform the following acceptance tests in accordance with TIA-568.0 and TIA-568.2:

a. Wire map (pin to pin continuity);

b. Continuity to remote end;

c. Crossed pairs;

d. Reversed pairs;

e. Split pairs;

f. Shorts between two or more conductors

3.4.2.2 Fiber Optic Cable

Test fiber optic cable in accordance with ARNEC, TIA-568.0, TIA-568.3, TIA-526-7, TIA/EIA-455, and as specified. Perform 2 optical tests on all optical fibers: Optical Time Domain Reflectometry (OTDR) Test and Attenuation Test. In addition, perform a width test on all multimode optical fibers. These tests to be performed on the completed end-to-end spans which include the near-end pre-connectorized single fiber cable assembly, outside plant as specified, and the far-end pre-connectorized single fiber cable.

a. OTDR Test: Used to determine the adequacy of the cable installations by showing any irregularities, such as discontinuities, micro-bendings or improper splices for the cable span under test. A reference length of fiber, 150 feet minimum, used as the delay line to be placed before the new end connector and after the far end patch panel connectors for inspection of connector signature. Conduct OTDR test and provide calculation or interpretation of results in accordance with TIA-526-7 for single-mode fiber and TIA-526-14 for multimode fiber. Splice losses not to exceed 0.3 db.

b. Attenuation Test: End-to-end attenuation measurements to be made on all fibers, in both directions, using an 850 and 1300 (multimode fiber) or 1310 and 1550 (single-mode) nanometer light source at one end and the optical power meter on the other end to verify that the cable system attenuation requirements are met in accordance with TIA-455-46A for multimode and TIA-526-7 for single-mode fiber optic cables. The measurement method in accordance with TIA-455-78-B. Attenuation losses not to exceed 0.5 db/km at 1310 nm and 1550 nm for

single-mode fiber. Attenuation losses not to exceed 5.0 db/km at 850 nm and 1.5 db/km at 1300 nm for multimode fiber.

3.4.3 Soil Density Tests

Determine soil-density compaction of backfill material in accordance with ASTM D1557, Method D.

-- End of Section --