AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
J	1 / 2

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO.(If applicable)
0001	29-Mar-2006		

6. ISSUED BY CODE W912P8

USACE, CONTRACTING DIVISION
ATTN: CEMVN-CT, ROOM 172
7400 LEAKE AVE.
NEW ORLEANS LA 70118-3651

7. ADMINISTERED BY (If other than item 6) CODE

See Item 6

8. NAME AND ADDRESS OF CONTRACTOR (No., Street, County, State and Zip Code)

CODE FACILITY CODE

X	9A. AMENDMENT OF SOLICITATION NO. W912P8-06-R-0125
X	9B. DATED (SEE ITEM 11) 25-Mar-2006
	10A. MOD. OF CONTRACT/ORDER NO.
	10B. DATED (SEE ITEM 13)

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

[X] The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offer [ ] is extended, [X] is not extended.

Offer must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended by one of the following methods:
(a) By completing Items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted;
or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE
RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN
REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS.
IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

[ ] A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

[ ] B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(B).

[ ] C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

[ ] D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor [ ] is not, [ ] is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

The above numbered solicitation for Engineering Installation Plan Development & System Procurement and Installation of Supervisory Control and Data Acquisition (SCADA) and Closed Circuit Television (CCTV) Systems to Monitor and Control Pumps and Engines at the Interim Closure Structures on 17th St, Orleans and London Canals in Orleans Parish, New Orleans, LA is hereby amended as follows:
Control and electrical drawings 1 thru 33 are added.
Reference drawings 1 thru 28 are added.
Unified Facilities Guide Specifications are added (to be edited by the contractor receiving the award). See Page 2 for a list of the guide specifications.

PROPOSAL DUE DATE AND TIME OF 5 APRIL 2006, 2:00 P.M., LOCAL TIME AND PLACE, NEW ORLEANS, LA, REMAINS UNCHANGED.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print) TEL: EMAIL:	
15B. CONTRACTOR/OFFEROR (Signature of person authorized to sign)	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY (Signature of Contracting Officer)	16C. DATE SIGNED 29-Mar-2006

SECTION SF 30 BLOCK 14 CONTINUATION PAGE

SUMMARY OF CHANGES

Unified Facilities Guide Specifications

13801 – Utility Monitoring and Control System (UMCS)

16003S – General Electrical Provisions

16050S – Gasic Electrical Materials and Methods

16121S – Fiber Optic Cable

16262N – Installation of Uninterruptible Power Supply (UPS) System

16713N – Fiber Optic (FO) Outside Plant (OSP) Media

16768A – Fiber Optic Data Transmission System

16798A – Two-Way Radio Data Ethernet Transmission System

(End of Summary of Changes)

****
****
USACE / NAVFAC / AFCESA / NASA UFGS-13801 (August 2004)

Preparing Activity: USACE

MasterFormat™ 2004 - 28 40 00
Superseding
UFGS-13801A (December 2001)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005
****
****

SECTION TABLE OF CONTENTS

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13801

UTILITY MONITORING AND CONTROL SYSTEM (UMCS)

08/04

PART 1 GENERAL

1.1 REFERENCES

1.2 DEFINITIONS

1.3 SYSTEM DESCRIPTION

1.3.1 System Requirements

1.3.2 Symbols, Definition and Abbreviations

1.3.3 System Units and Accuracy

1.4 SUBMITTALS

1.5 PROJECT SEQUENCING

1.6 QUALITY CONTROL (QC) CHECKLISTS

1.7 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

1.8 MAINTENANCE AND SERVICE

1.8.1 Work Coordination

1.8.2 Work Control

1.8.3 Working Hours

1.8.4 Equipment Repairs

1.8.5 Replacement, Modernization, Renovation

1.8.6 Access To UMCS Equipment

1.8.7 Records, Logs, and Progress Reports

1.8.8 Preventive Maintenance Requirements

1.8.8.1 Preventive Maintenance Work Plan

1.8.8.2 Semiannual Maintenance

1.8.8.3 Maintenance Procedures

1.8.9 Service Call Reception

1.8.10 Service Call Work Warranty

1.8.11 System Modifications

1.9 UMCS IP Network

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

2.1.1 Product Certifications

2.1.2 Product Sourcing

2.1.3 General Requirements

2.1.4 Product Data Sheets

2.2 NETWORK HARDWARE

2.2.1 Nameplates

2.2.2 Building Point of Connection (BPOC) Hardware

2.2.2.1 EIA 709.1B TP/FT-10 to IP Router

2.2.2.2 EIA 709.1B Gateway

2.2.3 IP Network Hardware

2.2.3.1 Wire and Cables.

2.2.3.2 Fiber Optic Patch Panel.

2.2.3.3 Fiber Optic Media Converter

2.2.3.4 Ethernet Switch

2.2.3.5 IP Router

2.3 COMPUTER HARDWARE

2.3.1 Nameplates

2.3.2 Server Hardware

2.3.3 Workstation Hardware (Desktop and Laptop)

2.3.4 PRINTERS

2.3.4.1 Alarm Printer

2.3.4.2 Laser Printer

2.3.4.3 Color Printer

2.4 COMPUTER SOFTWARE

2.4.1 Operating System (OS)

2.4.2 Office Automation Software

2.4.3 Virus Protection Software

2.4.4 EIA 852 Configuration Server

2.4.5 EIA 709.1B Network Configuration Tool

2.4.6 Monitoring and Control (M&C) Software

2.4.6.1 Passwords
2.4.6.2 Protocol Drivers
2.4.6.3 System Graphic Displays
2.4.6.4 Scheduling
2.4.6.5 Alarms
2.4.6.6 Trending
2.4.6.7 Electrical Power Demand Limiting
2.4.6.8 Demand Limiting with Real-Time Pricing
2.4.6.9 Programming Language
2.4.6.10 Report Generation
2.5 UNINTERRUPTIBLE POWER SUPPLY (UPS)
2.6 RACKS AND ENCLOSURES
2.6.1 Enclosures
2.6.2 Equipment Racks
2.7 FACTORY TEST
PART 3 EXECUTION
3.1 EXISTING CONDITIONS SURVEY
3.2 DRAWINGS AND CALCULATIONS
3.2.1 Network Bandwidth Usage Calculations
3.2.2 UMCS Contractor Design Drawings
3.2.3 As-Built Drawings
3.3 INSTALLATION REQUIREMENTS
3.3.1 Installation
3.3.1.1 Isolation, Penetrations of Buildings and

Clearance from Equipment

3.4 INSTALLATION OF EQUIPMENT

3.4.1 Wire and Cable Installation

3.4.2 Grounding

3.4.3 Power-Line Surge Protection

3.4.4 Computer Hardware and Software

3.4.4.1 Hardware Installation

3.4.4.2 Software Installation

3.4.5 Network Hardware

3.4.6 IP Addresses

3.4.7 IP Network Installation

3.5 INTEGRATION OF BUILDING LEVEL CONTROLS

3.5.1 Integration of EIA 709.1B (per Section 15951) Systems

3.5.2 Integration of Legacy (not per Section 15951) EIA 709.1B Systems

3.5.3 Integration of Legacy non-EIA 709.1B Systems at Building via Gateway

3.5.4 Integration of Legacy non-EIA 709.1B Systems at M&C Server via Protocol Driver

3.6 START-UP AND START-UP TESTING

3.7 PERFORMANCE VERIFICATION TEST (PVT)

3.7.1 PVT Phase I Procedures

3.7.2 PVT Phase I

3.7.3 PVT Phase II

3.8 TRAINING

3.8.1 Training Documentation

3.8.2 Basic Operator Training

3.8.3 Advanced Operator Training

3.8.4 Operator Refresher Training

-- End of Section Table of Contents -

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USACE / NAVFAC / AFCESA / NASA UFGS-13801 (August 2004)

Preparing Activity: USACE

MasterFormat™ 2004 - 28 40 00
Superseding
UFGS-13801A (December 2001)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005
****

SECTION 13801

UTILITY MONITORING AND CONTROL SYSTEM (UMCS)

08/04

****
NOTE: This guide specification covers the requirements for a Utility Monitoring and Control System (UMCS) based on open system technologies including the EIA 709.1B communication protocol and LonWorks Network Services (LNS).

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

****

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NOTE: Additional information and guidance on use of this guide specification is contained in ECB 2004-11., which may be found on the Internet on the TechInfo web site at:

http://www.hnd.usace.army.mil/techinfo/ECbull.htm

****

PART 1 GENERAL

1.1 REFERENCES

****

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 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.

****

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 NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI INCITS 154	(1988; R 1999) Office Machines and Supplies - Alphanumeric Machines-Keyboard Arrangement

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE Fundamentals Handbook	(2001) Fundamentals Handbook

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 709.1B	(2002) Control Network Protocol Specification
EIA 709.3	(1998) Free-Topology Twisted-Pair Channel Specification
EIA 852	(2001) Tunneling Component Network Protocols Over Internet Protocol Channels
TIA/EIA 568-A	(2001) Commercial Building Telecommunications Wiring Standard - 3 Parts
TIA/EIA 606	(1993) Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
TIA/EIA 607	(1994) Commercial Building Grounding/Bonding Requirement Standard

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991; R 1995) Recommended Practice for

Surge Voltages in Low-Voltage AC Power Circuits

IEEE Std 100 (2000) The Authoritave Dictionary of IEEE Standards Terms

IEEE Std 802.1D (1998) Media Access Control Bridges

IEEE Std 802.2 (1998) Standards for Local Area Networks: Logical Link Control

IEEE Std 802.3 (2002) Information Technology - Telecommunications and Information Exchange Between Systems LAN/MAN -Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)ISO OSI Model Open Systems Interconnection Reference ModelLONMARK INTERNATIONAL (LonMark)LonMark SNVT List (2002) LonMark SNVT Master List; Version 11 Revision 2LonMark XIF Guide (2001) LonMark External Interface File Reference Guide; Revision 4.0BNATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)NEMA 250 (2003) Enclosures for Electrical Equipment (1000 Volts Maximum)NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)NFPA 262 (2002) Test for Flame-Propagation and Smoke Density Values for Electrical and Optical Fiber Cables Used in Spaced Transporting Environmental AirNFPA 70 (2005) National Electrical CodeTHE INTERNET ENGINEERING TASK FORCERFC 1112 (1989) Host Extensions for IP Multicasting (IGMP)RFC 1371 (1992) Choosing a "Common IGP" for the IP InternetRFC 1812 (1995) Requirements for IP Version 4 RoutersRFC 1918 (1996) Address Allocation for Private Internets

RFC 2131 (1997) Dynamic Host Configuration ProtocolRFC 2784 (2000) Generic Routing Encapsulation (GRE)RFC 768 (1980) User Datagram Protocol (UDP)RFC 791 (1981) Internet Protocol (IP)RFC 792 (1981) Internet Control Message Protocol

(ICMP)RFC 793 (1981) Transmission Control Protocol (TCP)RFC 821 (2001) Simple Mail Transfer Protocol (SMTP)RFC 826 (1982) Ethernet Address Resolution

Protocol (ARP)

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-2202 (Rev A) Energy Monitoring and Control
Systems, Factory Tests

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)
FCC EMC (2002) FCC Electromagnetic Compliance

Requirements
FCC Part 15 Radio Frequency Devices (47 CFR 15)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
47 CFR 15 Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)UL 1778 (2003) Uninterruptible Power SystemsUL 60950 (2000) Safety of Information Processing

and

Business Equipment
UL 916 (1998; Rev thru Feb 2004)
Energy
Management Equipment

1.2 DEFINITIONS

The following list of definitions may contain terms not found elsewhere in this Section but are included here for completeness.

a. Application Specific Controller: A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.

b. Binary: A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

c. Binding: The act of establishing communications between EIA 709.1B devices by associating the output of a device to the input of another.

d. Building Control Network: The EIA 709.1B control network installed under Section 15951 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS consisting of a backbone and one or more local control busses.

e. Building Point of Connection (BPOC): The BPOC is the point of connection between the UMCS network backbone (an IP network) and the building control network backbone. The hardware at this location, that provides the connection is referred to as the BPOC Hardware. In general, the term "BPOC Location" means the place where this connection occurs, and "BPOC Hardware" means the device that provides the connection. Sometimes the term "BPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.

f. Channel: A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is

dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

g. Configuration Parameter: Controller setting usually written to EEPROM. Also see 'Standard Configuration Parameter Type (SCPT)'

h. Control Logic Diagram: A graphical representation of control logic for multiple processes that make up a system.

i. Domain: A grouping of up to 32,385 nodes that can communicate directly with each other. (Devices in different domains cannot communicate directly with each other.) Part of the Node Addressing scheme.

j. Explicit Messaging: A method of communication between devices where each message contains a message code that identifies the type of message and the devices use these codes to determine the action to take when the message is received. These messages are non-standard and often vendor (application) dependent.

k. External Interface File (XIF): A file which documents a device's external interface, specifically the number and types of LonMark objects; the number, types, directions, and connection attributes of network variables; and the number of message tags.

l. Functional Profile: The description of one or more LonMark Objects used to classify and certify devices.

m. Gateway: A device that translates from one protocol to another. Gateways are also called Communications Bridges or Protocol Translators.

n. General Purpose Programmable Controller (GPPC): Unlike an ASC, a GPPC is not furnished with a fixed application program. A GPPC can be (re-)programmed, usually using vendor-supplied software.

o. LonMark Object: A collection of network variables, configuration parameters, and associated behavior defined by LonMark International and described by a Functional Profile. Defines how information is

exchanged between devices on a network (inputs from and outputs to the network).

p. LNS Plug-in: Software which runs in an LNS compatible software tool. Device configuration plug-ins provide a 'user friendly' interface to configuration parameters.

q. LonMark: See LonMark International. Also, a certification issued by LonMark International to EIA 709.1B devices.

r. LonMark International: Standards committee consisting of numerous independent product developers and systems integrators dedicated to determining and maintaining the interoperability guidelines for the LonWorks industry. Maintains guidelines for the interoperability of EIA 709.1B devices and issues the LonMark Certification for EIA 709.1B devices.

s. LonMark Interoperability Association: See 'LonMark International'.

t. LonWorks: The overall communications technology, developed by Echelon Corporation, for control systems. The term is often used to refer to the technology in general, and may include reference to any/all of the: protocol, network management, and interoperability guidelines where the technology is based on the EIA 709.1B protocol and employs interoperable devices along with the capability to openly manage these devices (via multiple vendors) using a network

configuration (or service) tool.

u. LonWorks Network Services (LNS): A network management and database standard for EIA 709.1B devices.

v. Monitoring and Control (M&C) Software: The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

w. Network Variable: See 'Standard Network Variable Type (SNVT)'.

x. Network Configuration Tool: The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

y. Node: A device that communicates using the EIA 709.1B protocol and is connected to an EIA 709.1B network.

z. Node Address: The logical address of a node on the network. Variations in node addressing are possible, but the 'Domain, Subnet, Node' format is the established standard for this specification.

aa. Node ID: A unique 48-bit identifier assigned (at the factory) to each EIA 709.1B device. Sometimes called the Neuron ID.

bb. Program ID. An identifier (number) stored in the device (usually EEPROM) that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and the intended device usage.

cc. Repeater: A device that connects two control network segments and retransmits all information received on one side onto the other.

dd. Router: A device that connects two channels and controls traffic between the channels by retransmitting signals received from one subnet onto the other based on the signal destination. Routers are used to subdivide a control network and to control bandwidth usage.

ee. Segment: A 'single' section of a control network that contains no repeaters or routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.

ff. Service Pin: A hardware push-button on a device which causes the device to broadcast a message (over the control network) containing its Node ID and Program ID. This broadcast can also be initiated via software.

gg. Standard Configuration Parameter Type (SCPT): Pronounced 'skip-it'. A standard format type (maintained by LonMark International) for Configuration Parameters.

hh. Standard Network Variable Type (SNVT): Pronounced 'snivet'. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

ii. Subnet: Consists of a logical (not physical) grouping of up to 127
nodes, where the logical grouping is defined by node addressing. Part
of the Node Addressing scheme.

jj. TP/FT-10: A Free Topology Twisted Pair network defined by EIA

709.3. This is the most common media type for an ANSI-709.1 control
network.

kk. UMCS Network: An IP network connecting multiple building level
control networks using the EIA 852 standard.

ll. User-defined Configuration Parameter Type (UCPT): Pronounced 'u-keep-it'. A Configuration Parameter format type that is defined by the device manufacturer.

mm. User-defined Network Variable Type (UNVT): A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.3 SYSTEM DESCRIPTION

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NOTE: Designer is to add location and site specific requirements.

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The Utility Monitoring and Control System (UMCS) shall perform

supervisory control and monitoring of a base-wide EIA 709.1B (LonWorks) network using LonWorks Network Services (LNS) as specified and shown. The UMCS shall interface to local EIA 709.1B building controls installed per Section 15951 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS, as well as existing legacy systems. The UMCS shall maintain the LNS database(s) for the entire network.

1.3.1 System Requirements

The Contractor shall provide a UMCS in accordance with UL 916 and with the
following characteristics:

a. The UMCS shall include an IP network as shown and specified and
shall interface to building level control networks using EIA 709.1B
TP/FT-10 to IP Routers or IP Routers as specified.

b. The system shall perform supervisory monitoring and control functions including but not limited to Scheduling, Alarm Handling, Trending, Report Generation and Electrical Peak Demand Limiting as specified.

c. The system shall include a user interface which provide a Graphical User Interface which shall allow for graphical navigation between systems, graphical representations of systems, access to real-time data for systems, ability to override points in a system, access to all supervisory monitoring and control functions.

d. All software used by the UMCS shall be licensed to and delivered to the installation as specified.

e. All necessary documentation, configuration information, configuration tools, programs, drivers, and other software shall be licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor.

f. The Contractor shall provide sufficient documentation and data, including rights to documentation and data, such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor.

g. All communication between the UMCS and building networks shall be via the EIA 709.1B protocol over the IP network in accordance with EIA

852.

1.3.2 Symbols, Definition and Abbreviations

Symbols, definitions, and engineering unit abbreviations used in information displays, submittals and reports shall be as shown in the contract drawings. Symbols, definitions and abbreviations not in the contract drawings shall conform at a minimum to IEEE Std 100 and the ASHRAE Fundamentals Handbook, as applicable.

1.3.3 System Units and Accuracy

System displays, print-outs and calculations shall be performed in [metric (SI)][English (inch-pound)] units. Calculations shall have accuracy equal

to or exceeding sensor accuracy as specified in Section 15951 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS. Displays and printouts shall have precision and resolution equal to or exceeding sensor accuracy as specified in Section 15951 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS.

1.4 SUBMITTALS

****
**********NOTE: The submittals included in this guide specification are critical for new projects and require Government review. Any added submittals normally should be for information only and reviewed through the Contractor Quality Control system.
****
****

****
**********NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A “G” following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a “G”. Only delete an existing “G” if the submittal item is not complex and can be reviewed through the Contractor’s Quality Control system. Only add a “G” if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force
and NASA projects, or choose the second bracketed
item for Army projects.

****
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****
**********NOTE: The acquisition of all technical data, data bases and computer software items that are identified herein will be accomplished strictly in accordance with the Federal Acquisition Regulation (FAR) and the Department of Defense Acquisition Regulation Supplement (DOD FARS). Those regulations

as well as the Services implementations thereof should also be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost. Specifically, the Rights in Technical Data and Computer Software Clause, DOD FARS 52.227-7013, and the Data Requirements Clause, DOD FAR 52.227-7031, as well as any requisite software licensing agreements will be made a part of the CONTRACT CLAUSES or SPECIAL CONTRACT REQUIREMENTS. In addition, the appropriate DD Form 1423 Contract Data Requirements List, will be filled out for each distinct deliverable data item and made a part of the contract. Where necessary, a DD Form 1664, Data Item Description, will be used to explain and more fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to ensure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government.

Include with the request for proposals a completed DD Form 1423, Contract Data Requirements List. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly specified, both description and quantity being required.
****

Government approval is required for submittals with a "G" designation;
submittals not having a "G" designation are for [Contractor Quality Control
approval.][information only. When used, a designation following the "G"
designation identifies the office that will review the submittal for the
Government.]

Technical data packages consisting of computer software and technical data (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications shall be delivered strictly in accordance with the CONTRACT CLAUSES and

in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and shall contain no proprietary information and shall be delivered with unrestricted rights.

The following shall be submitted in accordance with Section 01330 SUBMITTAL
PROCEDURES, the CONTRACT CLAUSES and DD Form 1423 and according to the
sequencing specified in paragraph PROJECT SEQUENCING:

SD-02 Shop Drawings

UMCS Contractor Design Drawings[; G][; G, [_____]]

UMCS Contractor Design Drawings shall be submitted in hard copy
and on CDROM in [AutoCAD][Microstation] format.

Draft As-Built Drawings[; G][; G, [_____]]

Draft As-Built Drawings shall be
submitted in hard copy and on
CDROM in [AutoCAD][Microstation] format.
Final As-Built Drawings[; G][; G, [_____]]
Final As-Built Drawings shall be
submitted in hard copy and on
CDROM in [AutoCAD][Microstation] format.
SD-03 Product Data
Product Data Sheets[; G][; G, [_____]]

Copies of all manufacturer catalog cuts and specification sheets
for all products (equipment) specified in PART 2 and supplied
under this contract shall be submitted.

Computer Software[; G][; G, [_____]]

The most recent versions of all computer software provided under this specification shall be delivered as a Technical Data Package.

The user manuals for all software delivered for this project shall be submitted with the software.

SD-05 Design Data

Network Bandwidth Usage Calculations[; G][; G, [_____]]

[Four][___] copies of the Network Bandwidth Usage Calculations shall be submitted.

SD-06 Test Reports

Existing Conditions Report[; G][; G, [_____]]

[Four][___] copies of the Existing Conditions Report shall
submitted.

Factory Test Procedures[; G][; G, [_____]]

[Four][___] copies of the Factory Test Procedures shall be
submitted. The Factory Test Procedures may be submitted as a
Technical Data Package.

Factory Test Report[; G][; G, [_____]]

[Four][___] copies of the Factory Test Report shall be

submitted. The Factory Test Report may be submitted as a
Technical Data Package.

Start-Up and Start-Up Testing Report[; G][; G, [_____]]

[Four][___] copies of the Start-Up and Start-Up Testing Report

shall be submitted. The Start-Up and Testing report may be submitted as a Technical Data Package.

PVT Phase I Procedures[; G][; G, [_____]]

[Four][___] copies of the PVT Phase I Procedures shall be submitted. The PVT Procedures may be submitted as a Technical Data Package.

PVT Phase I Report[; G][; G, [_____]]

[Four][___] copies of the PVT Phase I Report shall be submitted. The PVT Phase I Report may be submitted as a Technical Data Package.

PVT Phase II Report[; G][; G, [_____]]

[Four][___] copies of the PVT Phase II Report shall be submitted. The PVT Phase II Report may be submitted as a Technical Data Package.

Pre-Construction QC Checklist[; G][; G, [_____]]

[Four][___] copies of the Pre-Construction QC Checklist shall be submitted.

Post-Construction QC Checklist[; G][; G, [_____]]

[Four][___] copies of the Post-Construction QC Checklist shall be submitted.

SD-10 Operation and Maintenance Data

Preventive Maintenance Work Plan[; G][; G, [_____]]

[Four][___] copies of the Preventive Maintenance Work Plan shall be submitted. The Preventive Maintenance Work Plan may be submitted as a Technical Data Package.

Basic Operator Training Documentation[; G][; G, [_____]]

Training manuals for Basic Operator Training shall be delivered for each trainee on the Course Attendance List with [two][___] additional copies delivered for archival at the project site. [two][___] copies of the Course Attendance List shall be delivered with the archival copies. The Basic Operator Training Documentation may be submitted as a Technical Data Package.

Advanced Operator Training Documentation[; G][; G, [_____]]

One set of training manuals shall be delivered for each trainee on the Course Attendance List with [two][___] additional copies delivered for archival at the project site. [two][___] copies of the Course Attendance List shall be delivered with the archival copies. The Advanced Operator Training Documentation may be submitted as a Technical Data Package.

Operator Refresher Training Documentation[; G][; G, [_____]]

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One set of training manuals shall be delivered for each trainee on the Course Attendance List with [two][___] additional copies delivered for archival at the project site. [two][___] copies of the Course Attendance List shall be delivered with the archival copies. The Operator Refresher Training Documentation may be submitted as a Technical Data Package.

Operation and Maintenance (O&M) Instructions[; G][; G, [_____]]

[Four][__] bound O&M Instructions[and [___] copies of the Instructions in PDF format on CD-ROM] shall be delivered. Bound Instructions shall be indexed and tabbed.[Instructions in PDF form shall be a single PDF file, or multiple PDF files with a PDF file table of contents containing links to the other files.] O&M Instructions may be submitted as a Technical Data Package.

SD-11 Closeout Submittals

Closeout QC Checklist[; G][; G, [_____]]

[Four][___] copies of the Closeout QC Checklist shall be submitted.

1.5 PROJECT SEQUENCING

TABLE I: PROJECT SEQUENCING specifies the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3: EXECUTION (denoted by an 'E' in the

'TYPE' column).

a. Sequencing for submittals: The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01330 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, the Contractor shall revise the submittal and resubmit it to the Government within [14][__] days of notification that the submittal has been rejected. Upon re-submittal there shall be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

b. Sequencing for Activities: The sequencing specified for activities
indicates the earliest the activity may begin.

c. Abbreviations: In TABLE I the abbreviation AAO is used for 'after
approval of' and 'ACO' is used for 'after completion of'.

TABLE I. PROJECT SEQUENCING

SEQUENCING
(START OF ACTIVITY or
ITEM # TYPE DESCRIPTION DEADLINE FOR
SUBMITTAL)

1 S Factory Test Procedures 2 Perform Factory Test AAO #1 3 S Factory Test Report [__] days ACO #2 4 S Existing Conditions Report [__] days AAO #3 5 S Design Drawings [__] days AAO #3 6 S Product Data Sheets [__] days AAO #3 7 S Network Bandwidth Calculations [__] days AAO #3 8 S Pre-construction QC Checklist [__] days AAO #3 9 E Install UMCS AAO #4 thru #8 10 E Start-Up and Start-Up Testing ACO #9 11 S Post-Construction QC Checklist [__] days ACO #10

TABLE I. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
12	S	Computer Software	[__] days ACO #10
13	S	Start-Up and Start-Up	[__] days ACO #10

		Testing Report	
14	S	Draft As-Built Drawings	[__] days ACO #10
15	S	PVT Phase I Procedures	[__] days before scheduled start of #16 and AAO #13
16	E	PVT Phase I	AAO #15 and #14
17	S	PVT Phase I Report	[__] days ACO #16
18	S	Preventive Maintenance Work Plan	AAO #13
19	S	O&M Instructions	AAO #13
20	S	Basic Operator Training Documentation	AAO #13 and [__] days before scheduled start of #21

21 E Basic Operator Training AAO #18, #19 and #20

(PVT Phase II) 22 S PVT Phase II Report [__] days ACO #21 23 S Final As-Built Drawings [__] days AAO #22

24 S Advanced Operator Training [__] days before scheduled Documentation start of #25 and AAO #20

25 E Advanced Operator Training ACO #21, [__] days AAO #24, and no later than [60] days ACO #21

26 S Operator Refresher Training [__] days before #27 and Documentation AAO #20 and #24 27 E Operator Refresher Training between [__] and [__] days ACO #21 and AAO item 26 28 S Closeout QC Checklist ACO #25

1.6 QUALITY CONTROL (QC) CHECKLISTS

The Contractor's Chief Quality Control (QC) Representative shall complete the QC Checklist in APPENDIX A and submit a Pre-Construction QC Checklist, Post-Construction QC Checklist and a Closeout QC Checklist as specified. The QC Representative shall verify each item in the Checklist and initial in the provided area to indicate that the requirement has been met. The QC Representative shall sign and date the Checklist prior to submission to the Government.

1.7 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

The UMCS Operation and Maintenance Instructions shall include:

a. Procedures for the UMCS system start-up, operation and shut-down.

b. Final As-Built drawings.

c. Routine maintenance checklist. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state

the frequency of the maintenance activity, and the fourth column for additional comments or reference.

d. Qualified service organization list.

e. Start-Up and Start-Up Testing Report.

f. Performance Verification Test (PVT) Procedures and Reports.

1.8 MAINTENANCE AND SERVICE

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NOTE: The maintenance and service to be provided by the Contractor for the duration of the IDIQ or maintenance contract is specified in this paragraph. The Maintenance and Service may need to be a separate bid item funded by O&M funds. If the UMCS networking equipment and supporting infrastructure is Government furnished equipment (see IP Network Installation paragraph in PART 3), it may be desirable to limit maintenance and service to Contractor supplied items.

Requirements should be coordinated with "WARRANTY MANAGEMENT" in Section 01780A CLOSEOUT

SUBMITTALS

****

The Contractor shall perform inspection, testing, cleaning, and part or component replacement as specified and as required to maintain the warranty. Work includes providing necessary preventive and unscheduled maintenance and repairs to keep the UMCS operating as specified, and accepted by the Government, and other services as specified. Work shall comply with manufacturer's recommendations and industry standards. The Contractor shall provide technical support via telephone during Contractor's regular working hours.

1.8.1 Work Coordination

The Contractor shall schedule and arrange work to cause the least interference with the normal Government business and mission. In those cases where some interference may be essentially unavoidable, the Contractor shall coordinate with the Government to minimize the impact of the interference, inconvenience, equipment downtime, interrupted service and personnel discomfort.

1.8.2 Work Control

When the Contractor completes work on a system or piece of equipment, that system or piece of equipment shall be free of missing components or defects which would prevent it from functioning as originally intended and designed. Replacements shall conform to the same

specifications as the
original equipment. During and at completion of work, debris shall not be
allowed to spread unnecessarily into adjacent areas nor accumulate in the
work area itself.

1.8.3 Working Hours

Working hours are from [7:30 A.M.][___] to [4:00 P.M.][___] local time

Mondays through Fridays except Federal holidays.

1.8.4 Equipment Repairs

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NOTE: Select repair times

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Equipment repairs shall be initiated and completed within the following
time periods. Time periods shall be measured as actual elapsed time from
first notification, including working and non-working hours:

a) for non-redundant computer server hardware, initiate within

[4][___] hours and complete within [8][___] hours

b) for non-redundant computer workstation hardware, initiate within

[4][___] hours and complete within [8][___] hours

c) for redundant computer server hardware, initiate within [36][___]

hours and complete within [5][___] days

d) for redundant computer workstation hardware, initiate within

[2][___] days and complete within [5][___] days

e) for active (powered) network hardware, initiate within [4][___]

hours and complete within [6][___] hours

f) for cabling and other passive network hardware, initiate within

[16][___] hours and complete within [5][___] days.

Repair is the restoration of a piece of equipment, a system, or a facility to such condition that it may be effectively used for its designated purposes. Repair may be overhaul, reprocessing, or replacement of nonfunctional parts or materials or replacement of the entire unit or system..

1.8.5 Replacement, Modernization, Renovation

The Government may replace, renovate, or install new equipment at Government expense and by means not associated with this contract. Replaced, improved, updated, modernized, or renovated systems and equipment interfaced to the system may be added to the Contractor's maintenance and service effort as a modification.

1.8.6 Access To UMCS Equipment

Access by the Contractor shall be in accordance with the following:

a. The Contractor shall be responsible for coordinating access to facilities and arranging that they be opened and closed during and after the accomplishment of the work effort. For Contractor access to a controlled facility the Contractor shall contact the Government for assistance.

b. The Government may provide keys for access to UMCS equipment where the Government determines such key issuance is appropriate. The Contractor shall establish and implement methods of ensuring that keys issued to the Contractor by the Government are not lost or misplaced, are not used by unauthorized persons, and are not duplicated.

1.8.7 Records, Logs, and Progress Reports

The Contractor shall keep records and logs of each task, and shall organize cumulative chronological records for each major component, and for the complete system. A continuous log shall be maintained for the UMCS. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the UMCS.

1.8.8 Preventive Maintenance Requirements

The Contractor shall perform maintenance procedures as described below, or more often if required by the equipment manufacturer.

1.8.8.1 Preventive Maintenance Work Plan

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NOTE: Designer will delete if not required by the

user.

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The Contractor shall prepare a Preventive Maintenance Work Plan to schedule all required preventive maintenance. Government approval of the Work Plan shall be obtained as specified in paragraph PROJECT SEQUENCING. The Contractor shall strictly adhere to the approved work plan to facilitate Government verification of work. [If the Contractor finds it necessary to reschedule maintenance, a written request shall be made to the Government detailing the reasons for the proposed change at least five days prior to the originally scheduled date. Scheduled dates shall be changed only with the prior written approval of the Government.]

1.8.8.2 Semiannual Maintenance

Contractor shall perform the following Semiannual Maintenance as specified:

a. Perform data backups on all Server Hardware.

b. Run system diagnostics and correct diagnosed problems.

c. Perform fan checks and filter changes for UMCS hardware.

d. Perform all necessary adjustments on printers.

e. Resolve all outstanding problems.

f. Install new ribbons, ink cartridges and toner cartridges into printers, and ensure that there is at least one spare ribbon or cartridge located at each printer.

1.8.8.3 Maintenance Procedures

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NOTE: Select whether notice must be given for maintenance that will result in downtime (off-line) or for any maintenance that MAY result in downtime. A selection of 'will' is recommended unless the project site requests otherwise.

Select appropriate down-times and notice times.
****
****

a. Maintenance Coordination: Any scheduled maintenance event that [will][may] result in component downtime shall be coordinated with the Government as follows. Time periods shall be measured as actual elapsed time from beginning of equipment off-line period, including working and non-working hours.

(1) for non-redundant computer server hardware, provide [14][___]

days notice, components shall be off-line for no more than [8][___] hours

(2) for non-redundant computer workstation hardware, provide [7][___] days notice, components shall be off-line for no more than [8][___] hours

(3) for redundant computer server hardware, provide [7][___] days notice, components shall be off-line for no more than [36][___] hours

(4) for redundant computer workstation hardware, provide [4][___] days notice, components shall be off-line for no more than [48][___] hours

(5) for active (powered) network hardware, provide [14][___] days notice, components shall be off-line for no more than [6][___] hours

(6) for cabling and other passive network hardware, provide [21][___] days notice, components shall be off-line for no more than [12][___] hours.

b. Software/Firmware: Software/firmware maintenance shall include operating systems, application programs, and files required for the proper operation of the UMCS regardless of storage medium. User (project site) developed software is not covered by this contract, except that the UMCS software/firmware shall be maintained to allow user creation, modification, deletion, and proper execution of such user-developed software as specified. The Contractor shall perform diagnostics and corrective reprogramming as required to maintain total UMCS operations as specified. The Contractor shall back up software before performing any computer hardware and software maintenance. The Contractor shall not modify any parameters without approval from the Government. Any approved changes and additions shall be properly documented, and the appropriate manuals shall be updated.

****
**********NOTE: Network maintenance should only be required for Contractor furnished networks. If using a Government furnished network delete the requirement.
****
****

[c. Network: Network maintenance shall include testing transmission
media and equipment to verify signal levels, system data rates, errors
and overall system performance.]

1.8.9 Service Call Reception

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NOTE: Designer should coordinate with the project
site to determine if they want the Contractor to be
responsible for answering service calls only during
working hours or 24-7.

****
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a. A Government representative will advise the Contractor by phone or in person of all maintenance and service requests, as well as the classification of each based on the definitions specified. A description of the problem or requested work, date and time notified, location, classification, and other appropriate information will be placed on a Service Call Work Authorization Form by the Government.

b. The Contractor shall have procedures for receiving and responding to service calls [24 hours per day, seven days a week, including weekends and holidays][during regular working hours]. A single telephone number shall be provided by the Contractor for receipt of service calls during regular working hours. Service calls shall be considered received by the Contractor at the time and date the telephone call is placed by the authorized Government representative.

c. The Contractor shall separately record each service call request, as received on the Service Call Work Authorization form and shall complete the Service Call Work Authorization form for each service call. The completed form shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion.

d. The Contractor shall respond to each service call request within [two][___] working hours. The status of any item of work must be provided within [four][___] hours of the inquiry during regular working hours, and within [16][___] hours after regular working hours or as needed to meet the Equipment Repair requirements as specified.

1.8.10 Service Call Work Warranty

The Contractor shall provide a [1 year][___] unconditional warranty on service call work. The warranty shall include labor and

material necessary
to restore the equipment involved in the initial service call to a fully
operable condition. In the event that Contractor service call work causes
damage to additional equipment, the Contractor shall be liable for labor
and material to restore the system to full operation. Contractor response
to service call warranty work shall be the same as required by the initial
service call.

1.8.11 System Modifications

The Contractor shall make recommendations for system modification in
writing to the Government. No system modifications shall be made without
prior approval of the Government. Any modifications made to the system
shall be incorporated into the Operations and Maintenance Instructions, and
other documentation affected. The Contractor shall make available to the
Government software updates for all software furnished under this

specification during the life of this contract. There shall be at least
one scheduled update near the end of the contract period, at which time the
Contractor shall make available the latest released version of all software
provided under this specification, and shall install and validate it upon
approval by the Government.

1.9 UMCS IP Network

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**********NOTE: The designer must decide if the UMCS network is Government furnished or is to be installed by the Contractor. If it is to be installed by the Contractor, keep the text below. If it is Government furnished replace the text with a

brief description of the furnished network. If it is partially Government furnished, keep the text below and add a description of the Government furnished portions. Basic information to include is: media type, wiring location and access, network bandwidth, Project Site POC for coordination of shared network.

Note that similar editing is required in PART 3 IP Network Installation.
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The IP UMCS network shall provide speeds of at least 100 Mbps on the entire network using the IP protocol. The Bit Error Rate (BER) of the data communications components shall be no greater than one error in 10E9 for the entire network.

The UMCS Network shall support EIA 709.1B communications in accordance with EIA 852 and all other necessary UMCS functionality. The Network shall use the following protocols for layers 1 through 7 as defined in the ISO OSI Model:

a. OSI Layer 1. The physical layer shall be in conformance with IEEE Std 802.3 (Ethernet) and operate at at least 100 megabits per second Mbps (100Base-T and 100Base-FX). Higher speed protocols may be used. If higher speed physical layers are used, bridging hardware shall be provided to ensure compatibility with 100 Mbps devices.

b. OSI Layer 2. The data-link layer shall be the IEEE Std 802.2 Logical Link Control (LLC), Type 1, Class 1, in combination with the IEEE Std 802.3 Protocol.

c. OSI Layer 3. The network layer shall be the Internet Protocol (IP; RFC 791), the Internet Control Message Protocol (ICMP; RFC 792), and

the Address Resolution Protocol (ARP; RFC 826).

d. Layers 4 - 7. Network shall support all layer 4 protocols supported by IP (RFC 791) including but not limited to ICMP (RFC 792), IGMP (RFC 1112), TCP (RFC 793), UDP (RFC 768), IGP (RFC 1371, GRE (RFC 2784) and protocols required by [EIA 852][___].

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

2.1.1 Product Certifications

Computing devices, as defined in 47 CFR 15, supplied as part of the UMCS shall be certified to comply with the requirements of Class B computing devices.

2.1.2 Product Sourcing

Contractor supplied units of the same type of equipment shall be products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and the model and serial number in a conspicuous place. Materials and equipment shall be new standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products.

2.1.3 General Requirements

The Contractor shall provide components which meet the following

requirements:

a. Portions of the data communications equipment system installed in unconditioned spaces shall operate properly in an environment with ambient temperatures between -7 and +66 degreesC (+20 and 150 degreesF) and ambient relative humidity between 20% and 95% noncondensing.

b. Components shall accept 100 to 125 volts AC (Vac) , 60 Hz, single phase, three wire with a three-pronged, dedicated circuit outlet or be provided with a transformer to meet the component's power requirements.

c. The equipment shall meet the requirements of NFPA 70, UL 60950, NFPA 262, FCC EMC, and FCC Part 15.

2.1.4 Product Data Sheets

For each product specified in this contract, manufacturer catalog cuts and sheets which indicate conformance to product requirements shall be submitted as specified.

2.2 NETWORK HARDWARE

2.2.1 Nameplates

Laminated plastic nameplates shall be provided for all network hardware. Each nameplate shall identify the function, network address and identifier of the device. Laminated plastic shall be 3 mm (.125 inch) thick, white with black center core. Nameplates shall be a minimum of 25x75 mm (1x3 inch) with minimum 6 mm (.25 inch) high engraved block lettering. Nameplates shall be attached to the device in conspicuous location.

2.2.2 Building Point of Connection (BPOC) Hardware

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NOTE: FYI: BPOCs are the interface between 13801 and 15951.

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2.2.2.1 EIA 709.1B TP/FT-10 to IP Router

EIA 709.1B TP/FT-10 to IP Routers shall perform layer 3 routing of EIA 709.1Bpackets over an IP network in accordance with EIA 852. The router shall provide the appropriate connection to the IP network and connections to the EIA 709.3 TP/FT-10 network. EIA 709.1B TP/FT-10 to IP Routers shall support the Dynamic Host Configuration Protocol (DHCP; RFC 2131 for IP configuration the use of an EIA 852 Configuration Server (for EIA 852 configuration), but shall not rely on these services for configuration. EIA 709.1B TP/FT-10 to IP Routers shall be capable of manual configuration.

2.2.2.2 EIA 709.1B Gateway

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NOTE: FYI: Gateways will be used only for integration of legacy systems. Gateways should not be used to allow a new, non-EIA 709.1B system to be installed.

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Gateways shall have the appropriate connection on the building-side (non-
EIA 709.1B side) to interface to the building DDC system, and shall meet
the following requirements:

a. It shall be capable of being installed, configured and programmed
for the designated application and through the use of instructions in

the manual supplied by the Contractor.

b. All software required for gateway configuration shall be provided.

c. It shall provide bi-directional protocol translation between the building level control protocol and EIA 709.1B.

d. It shall allow bi-directional mapping between Standard Network Variable Types (SNVTs) according to the LonMark SNVT List on the EIA 709.1B side and points on the building control network.

****
****
NOTE: FYI: The following item allows both translation from Legacy to IP and translation from Legacy to TP/FT-10 followed by TP/FT-10 to IP conversion.

****
****

d. It shall communicate on the EIA 709.1B over an IP network in accordance with EIA 852. Contractor may provide a EIA 709.1B TP/FT-10 to IP Router co-located with the protocol translator to meet this requirement.

e. It shall allow binding of its standard network variables (SNVTs).

f. For the EIA 709.1B network, it shall be capable of transmitting data using the "min, max, and delta" (throttling and heartbeat) methodology.

g. It shall provide the ability to label SNVTs that are mapped to or from third party devices.

****

****

NOTE: Indicate if additional capability may be required. Note that since the Legacy system should not change this requirement shouldn't be needed, and when used will normally be intended to cover the case of 'forgotten' points (when the mapping requirements from the legacy system have not been fully/properly identified).
****
****

h. It shall provide capacity for mapping all required points as shown[
plus an additional [50%][___]] from the legacy side as SNVTs on the EIA
709.1B side and vice-versa.

i. It shall be capable of supporting polled and synchronous modifiers
for network variables.

j. It shall supply a LonMark external interface file (XIF) as defined
in the LonMark XIF Guide for use with LNS tools and utilities.

k. It shall have a "service pin" which, when pressed, will cause the
Gateway to broadcast its 48-bit NodeID and ProgramID over the network.

l. It shall provide a configurable self-documenting string.

m. It shall retain its configuration after a power loss of an
indefinite time, and shall automatically return to its pre-power loss
state once power is restored.

2.2.3 IP Network Hardware

2.2.3.1 Wire and Cables.

****
**********NOTE: Indicate type of fiber and type

of connectors to be used, or if it's left to the Contractor to decide. If using any of the project sites IT infrastructure, coordinate with the DOIM (IT group) to determine which type of fiber to specify. Use of Multimode fiber for interior work is recommended. Use of SC type connectors is recommended.

****

a. Interior LAN Copper Cable: Interior Copper LAN cable shall meet or exceed all requirements of Category 5 cable as specified in TIA/EIA 568-A. Terminations, patch panels, and other hardware shall meet or exceed Category 5 specifications and shall be as specified in SECTION 16710 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. Cabling products shall be tested and certified for use at data speeds up to at least 100 Mbps.

Other types of media commonly used within IEEE Std 802.3 LANs (e.g., 10Base-T and 10Base-2) shall be used only in cases to interconnect with existing media. Short lengths of media and transceivers may be used in these applications. The Contractor shall provide separately orderable media, taps and connectors.

b. Interior Fiber Optic Cable: Interior Fiber Optic Cable shall be [Multimode][Singlemode][Multimode or Singlemode] fiber, [62.5/125][10/125][62.5/125 micron for multimode or 10/125 micron for

singlemode] with [SC][ST][SC or ST] connectors as specified in TIA/EIA 568-A. Terminations, patch panels, and other hardware shall be compatible with the specified fiber and shall be as specified in SECTION 16710 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. The data communications equipment shall use the [850-nm range of multimode][1310-nm range of singlemode][850-nm range of multimode or 1310-nm range of singlemode] fiber-optic cable. Fiber-optic cable shall be suitable for use with the 100Base-FX standard as defined in IEEE Std 802.3.

c. Exterior Fiber Optic Cable: Exterior Fiber Optic Cable shall be [Multimode][Singlemode][Multimode or Singlemode] Fiber, [62.5/125][10/125][62.5/125 micron for multimode or 10/125 micron for singlemode] micron with [SC][ST][SC or

ST] connectors as specified in TIA/EIA 568-A. Terminations, patch panels, and other hardware shall be compatible with the specified fiber and shall be as specified in Section 16713N FIBER OPTIC (FO) OUTSIDE PLANT (OSP) MEDIA. The data communications equipment shall use the [850-nm range of multimode][1310-nm range of singlemode][850-nm range of multimode or 1310-nm range of singlemode] fiber-optic cable. Fiber-optic cable shall be suitable for use with the 100Base-FX standard as defined in IEEE Std
802.3.

2.2.3.2 Fiber Optic Patch Panel.

Fiber Optic Patch Panels shall be wall or rack mountable and designed to provide termination facilities for up to 24 fibers. Unit shall also have capability to be equipped with spliced trays, six packs (for adapters), and blank panels for easy termination of the fiber bundles and tube cables. Fiber-optic terminating equipment shall provide for mounting of ST or SC connectors on an optical patch panel. Fiber-cable management and cable-routing hardware shall be provided by the Contractor to assure conformance to minimum fiber and cable bend radii. Connectors on the patch panel shall be ST or SC feed through. Access to both sides of the panel shall be provided by the Contractor. The patch panel for the connectors shall be mounted to facilitate rearrangement and identification. Each apparatus shall have cabling and connection instructions associated with it.

2.2.3.3 Fiber Optic Media Converter

Fiber Optic media converter shall provide media conversion between layer 1
copper and fiber media to support data rates equal to the greater of the
physical layer or 100 Mbps as specified in IEEE Std 802.3.

2.2.3.4 Ethernet Switch

Switches shall be IEEE Std 802.3 bridges which shall function as the center of a distributed-star architecture and shall be "learning" bridges with spanning tree algorithms per IEEE Std 802.1D. The switch shall support the connected media types and shall have a minimum of 150% the required ports and no

fewer than 4 ports. One port shall be switch selectable as an uplink port.

2.2.3.5 IP Router

The Contractor shall provide IP router network equipment. The routers shall be fully configurable for protocol types, security, and routing selection of sub-networks. The router shall meet all requirements of RFC 1812.

2.3 COMPUTER HARDWARE

2.3.1 Nameplates

Laminated plastic nameplates shall be provided for each server and workstation. Each nameplate shall identify the function, network address and identifier of the server or workstation. Laminated plastic shall be 3mm (.125inch) thick, white with black center core. Nameplates shall be a minimum of 25x75mm (1x3inches) with minimum 6mm (.25inch) high engraved block lettering. All nameplates shall be attached to the device in conspicuous location.

2.3.2 Server Hardware

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NOTE: Coordinate with the Project Sites DOIM (IT group) and include the sites 'standard' server redundancy requirements.

****
****

Computer Server Hardware (server) shall be a standard unmodified digital computer of modular design currently being manufactured. The modular components of the server shall be products of a single manufacturer which advertises service in all 48 contiguous states. Server hardware shall meet the following minimum requirements.

a. Processor speed: Minimum 250% of the stated requirements of the software to be installed on the server.

b. Random Access Memory (RAM): Minimum 250% of the stated requirements

of the software to be installed on the server.

c. Communications ports: One serial port, one enhanced parallel port and one USB port in addition to any ports required for the keyboard and mouse.

d. Hard Drives and Controller: Controller and Drives shall provide at least [120GB] [___] usable disk space with an average seek time of 7 milliseconds or less using hardware RAID (Redundant Array of Inexpensive Disks) at levels 1 or 5 (RAID-1 or RAID-5).

e. CD/DVD-RW Drive: Combo CD-RW with 32x read, 24x write and 16x rewrite and DVD-RW with 12x read; 4x re-write; 2x write.

f. Floppy Disk Drive and controller: High density (1.44MB) disk drive 90mm (3.5inch) diameter size.

g. Video output card: Support at least 16 bit color at a minimum resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.

h. Network Interface Card (NIC): Integrated [100Base-T Ethernet NIC with an RJ45 connector.][100Base-FX Ethernet NIC with an [SC][ST] connector.]

i. Monitor: Sized as shown but no less than 432mm (17inches) with a minimum resolution of 1024 by 768 pixels, non-interlaced, a maximum dot pitch of 0.28 millimeters, and a minimum refresh rate of 70Hz.

j. Keyboard: 101 key keyboard having a minimum 64 character standard ASCII character set based on ANSI INCITS 154.

k. Mouse: 2-button mouse with a minimum resolution of 400 dots per inch.

l. Hot-swappable redundant power supplies.

2.3.3 Workstation Hardware (Desktop and Laptop)

Computer Workstation Hardware (workstation) shall be a standard unmodified digital desktop computer of modular design or a laptop as shown. The modular components of the desktop, or the laptop, shall be products of a single manufacturer which advertises service in all 48 contiguous states. Workstations shall meet the following minimum requirements.

a. Processor speed: 150% the stated requirements of the software to be installed on the workstation.

b. Random Access Memory (RAM): 150% the stated requirements of the software to be installed on the workstation.

c. Communications ports:

(1) Desktop: One serial port, one enhanced parallel port and two USB ports in addition to any ports required for the keyboard and mouse.

(2) Laptop: One serial port, one enhanced parallel port, one USB port, one PCMCIA card slot, and one additional USB or PS/2 port for a mouse.

d. Hard Drive and controller:

(1) Desktop: [60GB] [___] formatted disk space with an average seek time of 7 milliseconds or less.

(2) Laptop: [40GB] [___] formatted disk space with an average seek time of 10 milliseconds or less.

e. CD-RW Drive: 24x read; 12x re-write; 24x write. For laptops the CD-RW drive [shall be a fixed drive][shall be a fixed or modular-bay

drive][shall be a fixed, modular-bay or external drive].

f. Floppy Disk Drive and controller: High density (1.44MB) disk drive
90mm (3.5inch) diameter size. For laptop workstations the floppy disk
drive [shall be a fixed drive][shall be a fixed or modular-bay drive][shall be a fixed, modular-bay or external drive].

g. Video output card:

(1) Desktop: Support at least 32 bit color at a minimum resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.

(2) Laptop: Support at least 16 bit color at a minimum resolution
of 1024 by 768 at a minimum refresh rate of 60 Hz.

h. Network Interface Card (NIC):

(1) Desktop: Integrated [100Base-TX Ethernet NIC with an RJ45
connector.][100Base-FX Ethernet NIC with an [SC][ST] connector]

(2) Laptop: Integrated or PCMCIA 100Base-TX Ethernet NIC with an
RJ45 connector.

i. Monitor:

(1) Desktop: Monitor sized as shown but no less than 482mm (19inches) with a maximum supported resolution of no less of 1280
by 1024 pixels, non-interlaced, and a maximum dot pitch of 0.28 millimeters.

(2) Laptop: LCD Screen sized as shown but no less than 305mm
(12inches) with a maximum supported resolution of no less than 1024 by 768 pixels

j. Keyboard:

(1) Desktop: 101 key keyboard having a minimum 64 character standard ASCII character set based on ANSI INCITS 154.

(2) Laptop: Standard laptop keyboard.

k. Mouse:

(1) Desktop: 2-button mouse with a minimum resolution of 400 dots
per inch.

(2) Laptop: Integrated touch-pad.

2.3.4 PRINTERS

Printers shall be local or network printers as shown. Local printers shall have a parallel or USB interface. Network printers shall have a 100Base-T interface with an RJ45 connection and shall have a firmware print spooler compatible with the Operating System print spooler.

2.3.4.1 Alarm Printer

The dot matrix alarm printers shall have a minimum 96 character standard ASCII character set based on ANSI INCITS 154 and with graphics capability. The printers shall have adjustable sprockets for paper width up to 11 inches, print at least 80 columns per line and have a minimum speed of 200 characters per second. Character spacing shall be selectable at 10, 12 or 17 characters per inch. The printers shall use sprocket-fed fanfold paper.
The units shall have programmable control of top-of-form.[Printers shall
include floor stands with paper racks.]

2.3.4.2 Laser Printer

Laser printers shall meet the following minimum

requirements:

a. Resolution: 600 by 600 dots per inch.

b. Printing Time: 10 pages per minute.

c. Data Buffer Size: 10 Megabytes.

d. Media Size: 8.5x11 inches as shown.

e. Paper Cassette: 250 sheet capacity.

2.3.4.3 Color Printer

The color printer shall use ink jet technology, shall be a full-color printer, and shall meet the following minimum requirements:

a. Resolution: 600 by 600 dots per inch.

b. Printing Time: 2 pages per minute.

c. Data Buffer Size: 16 Megabytes.

d. Colors: Printer shall have a separate replaceable black ink cartridge or print head.

e. Media Type: Paper and transparency film.

f. Media Size: 8.5x11 inches and as shown.

g. Paper Cassette: 250 sheet capacity.

2.4 COMPUTER SOFTWARE

2.4.1 Operating System (OS)

The operating system (OS) shall fully support all installed software and peripherals and shall be able to obtain screen capture of the monitor display being viewed.

2.4.2 Office Automation Software

Office Automation Software shall consist of the [e-mail,]spreadsheet and word processing portions of the project site's standard office automation software.

2.4.3 Virus Protection Software

Virus Protection Software shall consist of the project site's standard virus protection software complete with a virus definition update subscription.

2.4.4 EIA 852 Configuration Server

The EIA 852 configuration server shall meet the requirements of EIA 852.

2.4.5 EIA 709.1B Network Configuration Tool

The network configuration tool shall meet the following minimum requirements:

a. It shall solely use LonWorks Network Services (LNS) for all network configuration and management of EIA 709.1B devices.

b. It shall be capable of executing LNS plug-ins.

c. It shall be capable of performing network database reconstruction

of an EIA 709.1B control network, such that if connected to an existing EIA 709.1B network it has the ability to query the network and create an LNS database for that network and an associated network drawing.

d. It shall allow configuration of the network while off-line such that an operator may set up changes to the network while disconnected from the network, and then execute all of them once connected.

e. It shall have a graphics-based user interface, and be able to display and print a graphical representation of the control network.

f. It shall be capable of generating and printing the following reports:

(1) Table containing domain/subnet/node address and node identifier for the entire network or any subset thereof, selected by the user.

(2) Table containing Standard Network Variable (SNVT) input and output details for any EIA 709.1B device on the network

(3) Table containing Standard and User-Defined Configuration Properties (SCPTs and UCPTs) for any EIA 709.1B device on the network.

g. It shall be capable of merging two existing standard LNS databases into a single standard LNS database.

2.4.6 Monitoring and Control (M&C) Software

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NOTE: Designer should choose the minimum number of points and clients the M&C software is required to accommodate based on the project site's master plan.

The initial number of points to be accommodated should be chosen such that it is sufficient to cover all current and known future projects. The total system expansion requirement should be based on potential/anticipated future projects.

{Points means "points that the M&C software can read/write on the network'. In general, points will be SNVTs, but they may include configuration properties and/or variables (points) from a legacy system (via a protocol driver).}

Web based clients are not specifically addressed here. The Contractor may provide web-based or non-web-based clients as needed to meet the M&C software functional requirements. If web based clients are specifically required or are not allowed, edit the M&C Software requirements accordingly See the UFC for more information.

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NOTE: FYI: The following paragraphs/pages (the M&C software requirements) specify functionality that is required for the M&C Software but that may not be

achievable due to lack of data/support at the building level. In order to meet future needs these requirements should be kept. It is expected that they are usually part of the 'standard' capabilities of this type of software.

****

The monitoring and control (M&C) software shall be an LNS-compatible client-server software package. The software shall accommodate [___] points and shall be expandable via licensing upgrade to accommodate up to [50,000][___] points without requiring additional software installation. The server software shall support clients as specified and shown and shall be expandable via licensing upgrade to support no less than [50][___] total clients and no less than [20][___] clients simultaneously without requiring additional server software installation.

2.4.6.1 Passwords

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NOTE: Designer must choose if password management for M&C software is performed
a) by the OS
or
b) by the M&C software itself
or
c) if the decision is left to the Contractor.

****

The M&C software shall provide user-based access to M&C functionality. The M&C Software shall [obtain user information from the OS][or][manage M&C user information] and shall recognize at least [100][___] separate users and have at least 4 levels of user permissions. User permission levels (from most restrictive to most permissive) shall include:

a. Permission Level 1: View System Graphic Displays.

b. Permission Level 2: Permission Level 1 plus acknowledge alarms and set up (configure) trends and reports.

c. Permission Level 3: Permission Level 2 plus override SNVTs and set up (configure) alarms, schedules and demand limiting

d. Permission Level 4: Permission Level 3 plus create and modify System Graphic Displays and create custom programs.

Passwords shall not be displayed. The system shall maintain a disk file logging all activity of the system. If the file format is not plain ASCII text, the Contractor shall provide a means to export or convert the file to plain ASCII text. This file shall maintain, as a minimum, a record of all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications. Passwords shall not be logged. The activity log shall be maintained at the server hardware. The system shall automatically provide a mechanism for archiving the log files for long term record storage.

2.4.6.2 Protocol Drivers

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NOTE: FYI: one of the integration methods for legacy

systems is to use a protocol driver (a 'software gateway') in the M&C software to integrate the legacy system.

****

The M&C Software may include drivers to other (non-EIA 709.1B) protocols. The protocol driver shall allow all M&C Software functions to write values to and read values from points on the legacy system. The M&C software shall support reading points from the legacy system and writing these values to SNVTs on the EIA 709.1B network, and reading SNVTs from the EIA 709.1B network and writing these values to points on the legacy network. Use of the driver to integrate additional legacy systems shall not require programming but may require configuration.

2.4.6.3 System Graphic Displays

The monitoring and control (M&C) software shall include graphical displays through which an operator can perform real-time access and manipulation of the M&C functions as specified and shown. The graphical displays shall consist of building-level system (air handler units, VAV boxes, chillers, boilers etc) graphic displays, alarm displays, scheduling displays, trending displays, and demand limiting displays. Data associated with an active display shall be updated at least once every 5 seconds.

a. Navigation Scheme: System graphic displays of building-level systems and points shall be hierarchical displays using a building-to-equipment point-and-click navigation scheme. Each display shall show the building name and number. Each display shall show system

wide data such as outside air temperature and humidity in the case of an HVAC system application.

(1) Each Building or Building Sub-Area display shall show the building foot print and basic floor plan, and shall clearly show and distinguish between the individual zones and the equipment serving each zone and space. The building display shall also show all space sensor and status readings, as applicable, for the individual zones such as space temperature, humidity, occupancy status, etc. The building display shall show the locations of individual pieces of monitored and controlled equipment.

(2) Each equipment display shall show a [one-line diagram control schematic][3-dimensional] representation of the individual pieces of equipment using the symbols and M&C point data types as specified. Different colors and textures shall be used to indicate various components and real time data. Color and texture meanings shall be consistent across all displays.

(3) Each display shall clearly distinguish between the following point data types and information:

(a) Real-time data.

(b) User-entered data.

(c) Overridden or operator-disabled points.

(d) Devices in alarm (unacknowledged).

(e) Out-of-range, bad, or missing data.

b. Navigation Commands: The system graphic displays shall support English language operator commands via point-and-click mouse or keyboard entry for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands shall be usable from any operator workstation with individual operator passwords as specified.

(1) Command Input: Operator's commands shall be full words and acronyms selected to allow operators to use the system without extensive training or any data processing backgrounds. The system shall prompt the operator in full words and acronyms for all required information, identifying acceptable command formats. The operator's response shall be a point-and-click selection, word, phrase, or acronym including parameters where required.

(2) Command Input Errors: The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors. The system shall explain to the operator why the command cannot be executed. Conditions for which operator error assist messages shall be generated include:

(3) Special Functions: The system shall provide the following point-and-click mouse functions, in addition to all other commands specified:

(a) HELP: shall produce an indexed or menu-driven display of

all commands available to the operator. The HELP command, followed by a specific command shall produce a context sensitive listing with a short explanation of the purpose, use, and system reaction to that command.

(b) DISPLAY DIAGRAM: shall display diagrams of specific utility systems or other systems as specified.

(c) DIAGRAM DEVELOPMENT: shall allow the user to develop diagrams of specific utility systems or other systems as specified.

(d) PRINT REPORT: Shall allow the operator to initiate printing of reports.`

(4) Operator's Commands: The operator's commands shall provide the means for entry of control and monitoring commands, and for retrieval of information. Processing of operator commands shall commence within 1 second of entry, with some form of acknowledgment provided at that time. The operator's commands

(a) The command used is incorrect or incomplete.

(b) The operator is restricted from using that command.

(c) The command addresses an out-of-range or bad data point.

(d) The command addresses a point that does not exist.

(e) The command would violate constraints.

shall perform tasks, including:

(a) Request a display of any SNVT or calculated point or any group of related SNVTs and calculated points

(b) Startup and shutdown selected systems or devices.

(c) Override any SNVT point to an operator selected value.

(d) Release the override of a SNVT.

(e) Modify time and event scheduling.

(f) Initiate reports.

(g) Generate and format reports.

(5) System Graphic Display Hierarchy: The system graphic display
shall have a hierarchical structure with at least five

levels:

(a) Unit: The unit that a point is associated with, such as an AHU.

(b) Building Sub-Area: A part of a building.

(c) Building: The building that a point is located in or near.

(d) Building Group: A group of buildings.

(e) Facility: Installation included in the UMCS.

c. Display Editor: The display editor shall enable the user to create, modify, and delete displays and graphic symbols. The primary use shall be for adding and modifying one-line diagrams, status displays, system summaries, and system directories, as new controllers, points, data, and other necessary changes are made. The basic functions shall include:

(1) Create and save displays and graphic symbols.

(2) Group and ungroup graphic symbols. The grouped symbol shall be manipulated as a single symbol.

(3) Modify a portion of a graphic symbol.

(4) Save graphic symbols as a library object.

(5) Rotate and mirror a graphic symbol.

(6) Delete a graphic symbol.

(7) Place a graphic symbol on a display.

(8) Cancel the display of a graphic symbol.

(9) Assign conditions which automatically initiate the display.

(10) Overlay alphanumerics and graphics.

(11) Save new, modified, or existing graphics as new graphics.

(12) Integrate real-time data with the display.

(13) Define the background color.

(14) Define the foreground color.

(15) Locate the symbols.

(16) Position and edit alphanumeric descriptors.

(17) Establish connecting lines.

(18) Establish sources of latest data and location of readouts.

(19) Display analog values as specified.

(20) Cursor control (up, down, right, left).

(21) Create and display alphanumeric displays.

(22) Assign graphics a depth such that when there are coincident graphics the one with the lower depth is displayed.

(23) Modify graphic properties based on SNVT values, calculated values or values obtained from a legacy system.

(24) Creating conditional displays such that different graphic symbols or text are displayed based on SNVT values, calculated values or values obtained from a legacy system.

(25) Symbols Library: The library of callable display symbols shall include: Pump, Motor, Two- and Three-way Valves, Flow Sensing Element, Point and Averaging Temperature Sensors, Pressure Sensor, Humidity Sensor, Single and Double Deck Air Handling Unit, Fan, Chiller, Boiler, Air Compressor, Chilled Water Piping, Steam Piping, Hot Water Piping, Ductwork, Unit Heater, Pressure Reducing Valve, Damper, Electric Meter, Limit Switch, Flow Switch, High-and Low- Point and Averaging Temperature Switches, High- and Low-Pressure Switches, Coil, Solenoid Valve, Filter, Condensing Unit, Cooling Tower, Variable Frequency Drive (VFD), Heat Exchanger, Current Sensing Relays. Symbols shall at a minimum conform to ASHRAE Fundamentals Handbook where applicable.

2.4.6.4 Scheduling

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NOTE: FYI: The M&C software will be the primary

method of scheduling. Building systems have

'backup' scheduling capability in the event of a

loss of communication with the M&C Software Server.
****

The M&C software shall be capable of changing the value of any SNVT in the LNS Database and any point available from a connected legacy system via the protocol driver to any legal value according to a schedule. A minimum of [200][___] user-definable schedules shall be supported and the specified scheduling functions shall be operator accessible and adjustable via graphics display. The graphics display shall include the following fields

and functions:

a. Current date and time. The OS and M&C software shall automatically make Daylight Savings Time adjustments. Daylight savings time adjustment shall be capable of being disabled by the operator.

b. Building name and number.

c. System identifier and name.

d. System group. Systems shall be capable of being grouped by the user to perform according to a common schedule.

e. Weekly schedules. Each system shall have a weekly schedule based on a seven day per week schedule with independent schedules for each day of the week including no less than 6 value changes per day.

f. Holiday and special event schedules. System scheduling shall support holiday and special event calendar schedules independent of the daily schedule. Special event schedules shall include one-time events and recurring events. Scheduling of one-time events shall include the beginning and ending dates and times of the event. Holiday and special event schedules shall have precedence over device weekly schedules.

2.4.6.5 Alarms

The M&C software shall be capable of generating alarms and handling network variable inputs of type SNVT_Alarm from the control network. M&C Software shall be capable of handling and managing no less than [10,000][___] alarm points.

a. Alarm Data. Alarm data to be displayed and stored, as applicable and as specified, shall include:

(1) Identification of alarm including building, system (or sub-system), and device name.

(2) Date and time to the nearest second of occurrence.

(3) Alarm type:

(a) Unreliable: Indicates that the source device has failed due to the sensing device or alarm parameter being out-of-range or bad data.

(b) High Alarm.

(c) Low Alarm.

(4) Alarm set point and deadband(if analog).

(5) Engineering units.

(6) Current value or status of the alarm point.

(7) Alarm priority: There shall be two alarm priority levels; critical and informational. Critical alarms shall remain in alarm until acknowledged by an operator and the alarm condition no longer exists; informational alarms shall remain in alarm until

the alarm condition no longer exists or until the alarm is acknowledged.

(8) Alarm Message: A unique message with a field of 60 characters shall be provided for each alarm. Assignment of messages to an alarm shall be an operator editable function.

(9) Alarm Secondary Message: Secondary messages shall be assignable by the operator for printing to provide further information, such as telephone lists or maintenance functions, and shall be editable by the operator. The system shall provide for 100 secondary messages, each with 25 lines of 60 characters each.

(10) Acknowledgement status of the alarm and, where acknowledged, the time and date of acknowledgement.

(11) User who acknowledged the alarm.

b. Alarm Notification and Routing: The M&C software shall be capable of performing alarm notification and routing functions. Upon receipt or generation of an alarm the M&C software shall immediately perform alarm notification and routing according to an assigned routing for that alarm. The M&C software shall support at least [500][___] alarm routes; an alarm route shall be a unique combination of any of the following activities:

(1) Generate a pop-up up display on designated workstation monitors. The pop-up display shall include identification of the

alarm, date and time of the alarm, alarm message, and current value/status of the alarm point. Alarms shall be capable of being acknowledged from the pop-up display by operators with sufficient permissions. Pop-up displays shall be displayed until acknowledged.

(2) Dial a numeric paging system and leaving a numeric message. The paging system number and numeric message shall be user configurable for each alarm route.

(3) Send an e-mail message via simple mail transfer protocol (SMTP; RFC 821). The e-mail shall contain a scripted message and all alarm data. The e-mail recipient and scripted message shall be user configurable for each alarm route.

(4) Print alarms to designated alarm printers. The printed message shall be the same as the pop-up message.

c. Alarm Display and Acknowledgement. The M&C software shall include an alarm display. A minimum of the most recent [100][___] system alarms shall be available for display at each workstation as shown, along with all associated alarm data. Alarms shall be capable of being acknowledged from this display. Multiple alarms shall be capable of being acknowledged using a single command. Operator acknowledgment of one alarm shall not automatically be considered as acknowledgment of any other alarm nor shall it inhibit reporting of subsequent alarms.

d. Alarm Storage and Reports: The M&C software shall store each alarm and its associated alarm data to hard disk. The stored data shall be user-sortable and formatted for printing.

2.4.6.6 Trending

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NOTE: Designer should determine required number of points M&C software is capable of trending based on the project site's master plan.

****

The M&C software shall be capable of performing real-time trending on a minimum of [5,000][___] points simultaneously with a minimum trending capacity of 100 points per second. The M&C software shall be capable of displaying and printing a graphical representation of each trend, and of multiple trended points on the same graph. The software shall be capable of saving trend logs to a file. If the file format is not plain ASCII text in a Comma-Separated-Value (CSV) format, the Contractor shall provide a means to export or convert the file to plain ASCII text in a CSV format. Each trend shall be user-configurable for:

a. Point to trend.

b. Sampling interval with a minimum sampling interval no greater than 1 second, and a maximum sampling interval no less than 1 hour.

c. Start and Stop Time of Trend: Start and stop times shall be determined by one or more of the following methods:

(1) Start Time and Stop Time

(2) Start Time and Duration

(3) Start Time and number of samples

2.4.6.7 Electrical Power Demand Limiting

****

NOTE: The System Scheduler (referenced below) is specified in Section 15951 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS.

The critical alarm for actual demand exceeding the Electrical Demand Target (EDT) should be routed such that it is received as soon as possible.

Designer must decide if actual demand exceeding EDT causes the EDT to be reset to a higher value.

The billing structure should be obtained from the utility supplying electrical service in order to coordinate equipment demand limit priorities with the project site's Energy Manager. If real time pricing is a part of the billing structure it will also require coordination with the demand limiting program.

****

The UMCS shall be able to monitor and limit the electrical demand using a demand limiting program, subject to the availability of appropriate data and control hardware. The demand limiting program shall operate continuously and shall execute at the M&C Software Server. It shall obtain electrical demand from the installation electric utility meters a minimum of once per minute and predict the electrical peak demand [30][___] minutes into the future. This predicted peak demand value shall be recalculated at a minimum of [one (1)][___] minute intervals. The Electrical Demand Target (EDT) and predicted demand shall be used by the demand limiting program to determine demand limit priority. The EDT shall be user configurable. When the actual demand exceeds the EDT[, the EDT shall be automatically reset to a higher value for the duration of the billing cycle and] a critical alarm shall be broadcast.

a. Demand limit priority level: The Demand limit priority level is a calculated value which is used by the M&C server to determine the group or groups of equipment to be shut off or set points adjusted (Chillers). Six (6) levels of demand priority (zero (0) through five (5)) shall be defined. When no loads are to be shut down the system shall be at demand limit level zero (0). When the predicted demand first exceeds the EDT, the demand limiting program

shall designate the demand limit priority to have a value of 1. Successive levels of demand limit priority shall be based upon the amount (kW) that the predicted demand exceeds the EDT and duration of this excess. The minimum amount of time between changes to the demand limit priority level shall be operator-adjustable with a default value of [15][___] minutes.

b. Demand Limit Schedule and Monitoring Screen: The demand limit software shall use a spreadsheet type table which shall include the following information:

(1) Current demand, predicted demand

(2) Base-wide EDT

(3) Time of day

(4) For each system

(a) Equipment Description

(b) Equipment demand limit priority

(c) SNVT name used to override equipment occupancy mode (via the System Scheduler specified in Section 15951: DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS) or to adjust chiller setpoint.

(d) Maximum off time

(e) Maximum shut-down or setpoint reset intervals per day

(f) Equipment status indicating current occupancy mode for non-chiller equipment and setpoint for chillers

This screen and associated table used for implementing the electrical

power demand limiting algorithm shall have a user interface which

allows the user to edit, add, and delete any item in the table.

c. Equipment shut down and chiller reset. Each mechanical system (air handler, chiller, fan coil unit, etc) shall have associated with it a demand limit priority from 0 to 5. A system with a priority of 5 shall

never be shut down by the demand limiting program. Equipment whose demand limit priority is less than or equal to the base-wide demand limit priority level shall be shut down for a maximum time period of time as shown. Chillers shall have their setpoint reset or shall be shut down as shown. This shall be accomplished by setting the value of the Occupancy Override SNVT (to the System Scheduler)to OC_UNOCCUPIED or by adjusting the Chiller Setpoint via the Chiller Setpoint Override SNVT for the mechanical system as shown on the Demand Limit Schedule in a staged manner such that no less than [15][___] seconds elapses between changing any two SNVTs in a single building. .

d. Equipment re-start: When predicted demand transitions from greater than the EDT to less than the EDT by the EDT Deadband value, the demand limit priority level shall be decremented and the appropriate equipment (equipment with a demand limit priority level greater than the base-wide demand limit

priority) shall have their Occupancy Override SNVT (to the System Scheduler) set to OC_NUL. Chillers that have had setpoint reset shall have their setpoint override released or changed to a value appropriate for the new demand limit priority level. These SNVT changes shall be performed in a staged manner such that no less than [15][___] seconds elapses between changing any two SNVTS in a single building.

e. Manual initiation of demand limiting: The demand limiting program shall be configured to allow an operator to manually override the demand limit priority regardless of predicted demand. This override shall remain until manually released.

f. Program Inputs

(1) Calculated Equipment Demand Limit Priority Level (M&C Software Internal Value).

(2) Time-of-day

(3) Equipment maximum off time

(4) EDT (Electrical Demand Target)

(5) EDT Deadband

(6) Beginning and ending dates of winter and summer billing periods

(7) Length of sliding window interval

(8) Total demand

(9) Operating setpoint and occupancy status (current values)

(10) Beginning and ending dates for each billing cycle

g. Program Output.

(1) Occupancy Override SNVT (to System Scheduler) for each system

(2) Setpoint Override SNVT for each chiller with setpoint reset

(3) Predicted Demand

2.4.6.8 Demand Limiting with Real-Time Pricing

Demand Limiting with Real-Time Pricing shall perform Electrical Power Demand Limiting as specified except that demand limit priority shall be determined by real-time pricing data.

2.4.6.9 Programming Language

The M&C Software shall incorporate a programming (scripting) language for creating custom applications. Actions that shall be available through the

programming language shall include the following functions:

a. Override SNVTs

b. Monitor SNVTs

c. Clock / Timer Functions

d. Math Functions: Addition, subtraction, multiplication, division, exponentiation, trigonometric and logarithmic functions.

e. Loops ("for" and "while")

f. Conditional Branches ("if-then-else")

g. Variable Define / Assignment / Use

h. Provide data to a graphic display

i. Get data from a graphic display

j. Initiate alarm conditions

k. Initiate Reports

l. Logic Functions: ("and", "or" and "not")

m. Bitwise logic functions.

n. User defined subroutines and functions.

2.4.6.10 Report Generation

Software shall be provided with commands to generate and format reports for displaying on current Workstation, printing, and storing on disk. Reports shall be stored by type, date, and time. The destination of each report shall be selectable by the operator. Dynamic operation of the system shall not be interrupted to generate a report. The report generation mode, either automatic or requested, shall be operator assignable. The report shall contain the time and date when the samples were taken, and the time and date when the report was generated. The software shall be capable of saving reports to a file. If the file format is not in a format compatible with the provided Office Automation Software, the Contractor shall provide a means to export or convert the file to a compatible format. Software shall be provided to format and store all data, trends, profiles, reports and logs specified herein in a comma-delimited text format to any media supported by the operating system..

The software shall allow for automatic or manual generation of reports.

For automatic reports the operator shall be able to specify the time the

initial report is to be generated, the time interval between reports, end

of period, and the output format for the report. The operator shall be

able to modify, or inhibit a periodic report. Manual report generation

shall allow for the operator to request at any time the output of any report.

****

NOTE: The list of standard reports should be edited by the designer to remove any reports or sub-items of individual reports not required by the project.

****

The software shall have a report generation utility capable of generating the following standard reports:

a. Electrical Power Usage Report: An electrical power Usage summary, operator selectable for substations, meters, or transducers, individual meters and transducers, any group of meters and transducers, and all meters for an operator selected time period. The report shall include the voltage, current, power factor, electrical demand, electrical power consumption, reactive power (Kvar) for each substation, facility, system or equipment as selected by the operator. The report shall be automatically printed at the end of each summary period and shall include:

(1) Total period consumption.

(2) Demand interval peak for the period, with time of occurrence.

(3) Energy consumption (kWh) over each demand interval.

(4) Time-of-use peak, semi-peak, off-peak, or baseline total kWh consumption.

(5) Reactive power during each demand interval.

(6) Power factor during each demand interval.

(7) Outside air (OA) temperature and relative humidity (RH) taken at the maximum and minimum of OA temperature of the report period with the time and dates of occurrence. At the installation's peak demand interval, the OA temperature and RH shall also be recorded.

(8) Calculated heating and cooling degree days based on a 18.3 degreesC (65 degreesF) balance point. Heating and cooling degree day balance point may be operator adjustable.

b. Electrical Peak Demand Prediction Report: A report based on the demand limiting program. The report shall include:

(1) Electrical Demand Target (EDT).

(2) Actual peak and predicted peak for each demand interval for that day.

(3) Predicted demand for the next demand interval.

c. Energy usage Report: An energy usage summary, operator selectable, for a unit, building, area, installation, and the entire UMCS. The report shall be divided by utility, and shall be capable of reporting on at least four separate utilities. The report shall include the following information:

(1) Beginning and ending dates and times.

(2) Total energy usage for each utility for the current and previous day.

(3) Total energy usage for each utility for the current and previous month.

(4) Maximum 15-minute interval average rate of consumption for each utility for the current and previous day and current and previous month.

(5) Outside air (OA) temperature and OA relative humidity (RH) or dew point for current and previous month and current and previous day:

(a) Average temperature and RH or dewpoint.

(b) Temperature and RH or dewpoint at maximum and minimum OA temperature with time and date of occurrence.

(b) Temperature and RH or dewpoint at maximum and minimum RH or dewpoint with time and date of occurrence.

(c) Temperature and RH or dew point at the installation's peak demand interval with the time and date of occurrence

(6) Calculated degree days.

d. Alarm Report: Outstanding alarms by building or unit, including time of occurrence.

e. Override Report: Points overridden, including time overridden, and identification of operator overriding the point.

f. Run Time Reports: A report totalizing the accumulated run time of individual pieces of equipment. The operator shall be able define equipment groupings and shall be able to generate reports based on these groupings.

g. Cooling Tower Profiles: A cooling tower profile for each cooling tower as shown, including:

(1) Total daily and monthly on-time (each fan).

(2) Number of on and off transitions (each fan).

(3) Maximum and minimum daily condenser water temperature and the time of occurrence for the current and previous months.

h. Chiller usage Report: A report of the operation of each chiller as shown on a daily and monthly basis, including:

(1) Daily run-time in each one of at least 10 discrete loading levels.

(2) Total on-time for each level for the current month.

(3) Monthly average energy use in kWh or Mbtu for total on-time at each level.

2.5 UNINTERRUPTIBLE POWER SUPPLY (UPS)

The uninterruptible power supply (UPS) shall be a self contained device suitable for installation and operation at the location of Server and Workstation hardware and shall be sized to provide a minimum of 20 minutes of operation of the connected hardware. Equipment connected to the UPS shall not be affected in any manner by a power outage of a duration less than the rated capacity of the UPS. UPS shall be complete with all necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of AC input loss and low battery power. The UPS shall be UL 1778 approved. UPS powering Server Hardware shall support notification to the server via serial interface of impending battery failure.

2.6 RACKS AND ENCLOSURES

2.6.1 Enclosures

Enclosures shall meet the following minimum requirements:

a. Outdoors: Enclosures located outdoors shall meet NEMA 250 [Type 3][Type 4] requirements.

b. Mechanical and Electrical Rooms: Enclosures located in mechanical or electrical rooms shall meet NEMA 250 [Type 2][Type 4] requirements.

c. Other Locations: Enclosures in other locations including but not limited to occupied spaces, above ceilings, and plenum returns shall meet NEMA 250 Type 1 requirements.

Enclosures supplied as an integral (pre-packaged) part of another product

are acceptable.

2.6.2 Equipment Racks

Equipment racks shall be either aluminum or steel with bolted or welded construction. Steel equipment racks shall be painted with a flame-retardant paint. Guard rails shall be included with each equipment rack and have a copper grounding bar installed and grounded to the earth. These equipment racks shall be compatible with the electronic equipment provided.

2.7 FACTORY TEST

**********N
OTE: The bracketed text in the below paragraph references the 'old' MIL standards for factory tests. The Corps of Engineers is developing a new factory test procedure, which should replace the MIL standards once available.
****

The Contractor shall perform factory testing of the UMCS as specified. The Contractor is responsible for providing personnel, equipment, instrumentation, and supplies necessary to perform required testing. Written notification of planned testing shall be given to the Government at least 21 days prior to testing, and in no case shall notice be given until after the Contractor has received written Government approval of the specific Factory Test Procedures. The Factory Test Procedures shall define the tests required to ensure that the system meets technical, operational, and performance specifications. The Procedures shall define location of tests, milestones for the tests, and identify simulation programs, equipment, personnel, facilities, and supplies required. The test procedures shall provide for testing all capabilities and functions specified and shown. The Procedures shall be developed from the design documentation[, using the requirements of MIL-STD-2202 as a technical and format requirement][___]. The Procedures shall cover actual equipment to be used by the Contractor for the specified project and shall consist of detailed instructions for test setup, execution, and evaluation of test results. Upon completion of the Factory Test, the Contractor shall prepare a Factory Test Report documenting the results of the Factory Test and submit it as specified.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS SURVEY

The Contractor shall perform a field survey, including but not limited to testing and inspection of equipment to be part of the UMCS, and submit an Existing Conditions Report documenting the current status and its impact on the Contractor's ability to meet this specification. The Contractor shall verify the availability of the building network backbone at the BPOC location, and verify that the building network used EIA 709.1B.

3.2 DRAWINGS AND CALCULATIONS

3.2.1 Network Bandwidth Usage Calculations

The Contractor shall perform UMCS Network Bandwidth Usage Calculations for a normally loaded and a heavily loaded UMCS. Calculations shall be performed for network traffic at the M&C Server.

A heavily loaded network is characterized as one performing the following

activities simultaneously:

a. Trending a number of points equal to the specified minimum M&C software trending capacity at 15 minute intervals.

b. Trending (for loop tuning) 20 points at 2 second intervals.

c. Viewing 500 points via workstations with a 5 second update interval.

d. Transmitting load shed commands (via SNVTs) to 2,000 devices in a 1 minute interval.[

e. Viewing of 10 system display graphic screens of 50 points each via browsers.]

A normally loaded network is characterized as one performing the following activities simultaneously:

a. Trending 500 points equal at 15 minute intervals.

b. Viewing 100 points via workstations with a 5 second update interval.

c. Transmitting load shed commands (via SNVTs) to 200 devices in a 1 minute interval.[

e. Viewing of 2 system display graphic screens of 50 points each via browsers.]

3.2.2 UMCS Contractor Design Drawings

****
*
NOTE: Designer must decide whether to require a specific drawing size (approx... 11x17 or 22x34) or to leave it up to the Contractor.

****

Contractor shall revise and update the Contract Drawings to include details of the system design. Drawings shall be on [ISO A1 (841 by 594 mm) or 34 by 22 inches][or][A3(420 by 297 mm) or 17 by 11 inches] sheets. Details to be shown on the Design Drawing include:

a. Details on logical structure of the network. This includes logical location of all network hardware.

b. Manufacturer and model number for each piece of computer and network hardware.

c. Physical location for each piece of network or computer hardware.

3.2.3 As-Built Drawings

****

*NOTE: The Points Schedule is a submittal from Section 15951 contracts and is a contract drawing for 13801. The 13801 Contractor updates the Points Schedule and submits it as an as-built.

****

The Contractor shall prepare draft as-built drawings consisting of Points Schedule drawings for the entire UMCS and an updated Design Drawing including details of the actual installed system as it is at the conclusion of Start-Up and Start-Up Testing. In addition to the details shown in the design drawings, the as-built drawing shall include:

a. IP address(es) as applicable for each piece of network hardware.

b. IP address for each computer server, workstation and networked printer.

c. Network identifier (name) for each printer, computer server and computer workstation.

d. EIA 709.1B address (domain, subnet, node address) for each EIA 709.1B TP/FT-10 to IP Router.

Contractor shall prepare Draft As-Built Drawings upon the completion of Start-Up and Start-Up Testing and Final As-Built Drawings upon completion of PVT Phase II.

3.3 INSTALLATION REQUIREMENTS

3.3.1 Installation

****

NOTE: Indicate the location of telecommunications closets on the contract drawings.

****

The Contractor shall install system components as shown and specified and in accordance with the manufacturer's instructions and shall provide necessary interconnections, services, and adjustments required for a complete and operable system. Communication equipment and cable grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Fiber Optic cables and wiring in exposed areas, including low voltage wiring but not including network cable in telecommunication closets, shall be installed in metallic raceways or EMT conduit as specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM.

3.3.1.1 Isolation, Penetrations of Buildings and Clearance from Equipment

The UMCS shall be completely installed and ready for operation, as specified and shown. Dielectric isolation shall be provided where

dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exteriors shall be made watertight. Holes in concrete, brick, steel and wood walls shall be drilled or core drilled with proper equipment; conduits installed through openings shall be sealed with materials which are compatible with existing materials. Openings shall be sealed with materials which meet the requirements of NFPA 70 and SECTION 07840 FIRESTOPPING.

3.4 INSTALLATION OF EQUIPMENT

3.4.1 Wire and Cable Installation

System components and appurtenances shall be installed in accordance with NFPA 70, manufacturer's instructions and as shown. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be provided. Components shall be labeled in accordance with TIA/EIA 606. Penetrations in fire-rated construction shall be firestopped in accordance with Section 07840 FIRESTOPPING. Conduits, outlets and raceways shall be installed in accordance with Section 16402 INTERIOR DISTRIBUTION SYSTEM. Wiring shall be installed in accordance with TIA/EIA 568-A and as specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM. Wiring, and terminal blocks and outlets shall be marked in accordance with TIA/EIA 606. Non fiber-optic cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables. Cables not installed in conduit or raceways shall be properly secured and neat in appearance.

3.4.2 Grounding

Signal distribution system ground shall be installed in accordance with

TIA/EIA 607 and Section 16402 INTERIOR DISTRIBUTION SYSTEM. Equipment racks shall be connected to the electrical safety ground.

3.4.3 Power-Line Surge Protection

Equipment connected to ac circuits shall be protected against or withstand power-line surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

3.4.4 Computer Hardware and Software

3.4.4.1 Hardware Installation

Computer Hardware shall be installed as shown. Computer Servers shall be powered through a UPS, and shall be installed and configured such that the server will automatically undergo a clean shutdown upon low battery signal from the UPS.

3.4.4.2 Software Installation

Contractor shall install software as follows:

a. Operating system: The Contractor shall install the OS on each Server and Workstation and configure user names and passwords.

b. Office Automation Software: The Contractor shall install the office automation software on each server and workstation.

c. Virus Protection software: The Contractor shall install the virus protection software on each server and workstation and shall configure weekly virus scans.

d. EIA 852 Configuration Server: The Contractor shall install and configure one EIA 852 Configuration Server. The EIA 852 Configuration Server may be installed on Server Hardware, Workstation Hardware, or an EIA 709.1B TP/FT-10 to IP Router.

e. EIA 709.1B Network Configuration Tool: The Contractor shall install the network configuration tool software as shown. The server version of the software shall be installed on server hardware, and client versions shall be installed on workstation or server hardware.

f. Monitoring and Control Software: The Contractor shall install the monitoring and control software as shown. The server version of the software shall be installed on server hardware, and client versions shall be installed on workstation or server hardware.

3.4.5 Network Hardware

**********N
OTE: If UPS power is available it should be used instead of specifying individual/small UPSs. In these cases, this paragraph should be edited to indicate that the Contractor shall use the provided UPS.
****

The Contractor shall install all network hardware in an enclosure or a telecommunication closet as defined by the project site. IP Network

Hardware shall be powered through a UPS.

3.4.6 IP Addresses

For equipment requiring IP addresses, the Contractor shall [coordinate with the DOIM to obtain IP addresses][choose IP addresses from the list of private IP addresses specified in RFC 1918].

3.4.7 IP Network Installation

**********N
OTE: Part of the UMCS is an IP network which is used to connect the BPOCs, computer servers, computer workstations, and printers. There are three approaches to getting this IP network; the designer must coordinate with the installation DOIM (or equivalent) and select one of the following three options:

a) Share existing basewide IT LAN operated by the DOIM (IT Group). For purposes of discussion with the DOIM, assume that the UMCS will require network bandwidth not to exceed 10 Mbps. DOIM should provide IP addresses to show on contract drawing.

b) use spare existing IT infrastructure (primarily spare inter-building fiber optic cable, UPS power, and physical space in telecommunications closets) to install a physically independent IP network.

c) Install all new networking. Even in cases where options a) or b) are available, this option is permitted to allow Contractor to install new networking (needed for when the supplied network does not meet the Contractors needs).

A single project may require a mixture of options, since use of the IT LAN or existing cables may be an option at some buildings and not others. In any case, network must provide end-to-end transmission speeds of at least 100 Mbps using the IP protocol.

****

****

NOTE: The following bracketed text is for Option a) as described above; remove if no part of the UMCS will be shared.

****

[Government will provide an IP network functioning at at least 100 Mbps as shown in support of the UMCS IP Network. Contractor shall not use the Government Furnished network without additional approval from the Government if the installed UMCS network bandwidth requirements calculated as specified in the Heavily Loaded UMCS Network Bandwidth Calculations exceed [10 Mbps][___].]

****

NOTE: The following bracketed text is for Option b) as described above; remove if no part of the UMCS will use spare infrastructure.

****

[Government will provide equipment as shown in support of an IP Network functioning at at least 100 Mbps.]

****

NOTE: Select the bracketed text in the next paragraph as follows:

select 'shall' if option b) or c) is used for any part of the installation.

select 'may' if option a) is used for the entire installation.

If part of the UMCS network is shared per option a) and part isn't per option b) or c), coordinate with the DOIM (IT group) to ensure that Contractor installed network is compatible with existing IT LAN. (including assignment of IP addresses.)

****

The Contractor [shall][may] install the IP Network in accordance with the following:

a. Determine requirements for and install interior copper LAN cable in accordance with Section 16710 BUILDING TELECOMMUNICATIONS CABLING SYSTEM as needed to meet contract requirements.

b. Determine requirements for and install interior fiber optic cable in accordance with Section 16710 BUILDING TELECOMMUNICATIONS CABLING SYSTEM as needed to meet contract requirements.

c. Determine requirements for and install exterior fiber optic cable in accordance with Section 16713N FIBER OPTIC (FO) OUTSIDE PLANT (OSP) MEDIA as needed to meet contract requirements. All exterior cable shall be buried. When installing fiber, Contractor shall provide at least 6 pairs of fiber.

d. Determine requirements for and install Network Hardware as shown and as needed to meet contract requirements.

3.5 INTEGRATION OF BUILDING LEVEL CONTROLS

****

NOTE: Make sure contract drawing package includes:

1. Points Schedule; make sure Points Schedule includes:

-the SNVTs (points) to be displayed by the M&C Software

-SNVTs that can be overridden by the M&C Software

-SNVT alarm points

-SNVT trend points.

-Alarm routing (also make sure to include the Alarm Routing Schedule)

2. Alarm Routing Schedule drawings.

-Identify and assign priorities, pager telephone numbers, e-mail addresses, and alarms to be be printed.

3. Demand Limit schedule drawing.

-Make sure it includes system name, load shed priority and SNVT needed for shut-down or setpoint reset.

4. Riser Diagram Drawing

-Show the details and location of servers, workstations, printers and other equipment.

2 Control System Schematics for each building-level control system (The as-built drawings from Section 15951}

****

3.5.1 Integration of EIA 709.1B (per Section 15951) Systems

The Contractor shall perform the following tasks to integrate the building system into the UMCS:

****

NOTE: If network is shared with DOIM per option a) above, coordinate use of IP router or Ethernet switch with DOIM, otherwise, leave choice of router vs. switch up to Contractor.

****

a. If the building control network contains an IP backbone, install and configure an [IP router or Ethernet switch][___] to connect the building IP network backbone to the UMCS IP Network. Re-configure EIA 709.1B TP/FT-10 to IP Routers in the building to use the UMCS EIA 852 Configuration Server. Otherwise, install and configure an EIA 709.1B TP/FT-10 to IP Router to connect the building level TP/FT-10 network backbone to the UMCS IP Network.

b. Update the UMCS LNS Database and update UMCS Network representation

(drawings) in the Network Configuration Tool. The LNS database shall be updated by merging the building database with the UMCS database. In cases where the building database is not available the Contractor shall use the Network Configuration Tool software to discover the building network and create an LNS Database for the building and then merge the building database and the UMCS database.

d. Establish network variable bindings as shown and as necessary to support M&C Software functionality:

(1) SNVTs used for display on currently active displays shall be updated (via polling) as necessary to meet display requirements.

(2) SNVTs used for currently active trends shall be updated (via polling) as necessary to meet trend interval requirements.

(3) Alarm SNVTs shall be bound from the device originating the alarm to the M&C Software. Alarms shall be bound shall use the acknowledged service.

(4) SNVTs used for scheduling shall be bound to the appropriate System Scheduler with a maximum send time (minimum time between subsequent transmissions of the SNVT) of 45 minutes, shall be of type SNVT_occupancy, and support the following values: OC_OCCUPIED, OC_UNOCCUPIED and OC_STANDBY.

(5) SNVTs used for overrides shall be polled to the device receiving the override. SNVTs for overriding schedules (via the System Scheduler) shall be of type SNVT_occupancy and shall support the following values: OC_OCCUPIED, OC_UNOCCUPIED, OC_STANDBY and OC_NUL. SNVTs used to override schedules or setpoints for Demand Limiting functions shall use the acknowledged service.

e. Configure M&C Software functionality:

(1) Create graphical pages for System Graphic Displays, including overrides, as shown on the Points Schedule and as specified. SNVTs for monitoring shall be updated while the monitoring graphic for that SNVT is active.

(2) Configure alarm handling as shown on the Points Schedule and Alarm Routing Schedules and as specified.

(3) Configure the scheduling function of the M&C software to schedule systems (SNVTs) as shown on the Points Schedule and as specified. Label schedules and scheduled points with full English-language descriptors. For scheduling and schedule overrides (including Demand Limiting), SNVT values of OC_OCCUPIED correspond to the system operating in occupied mode, OC_UNOCCUPIED corresponds to unoccupied mode and OC_STANDBY corresponds to Warm-Up-Cool-Down mode. For overrides, OC_NUL corresponds to a no override (and is used to release an override).

(4) Create trends for required points as shown on the Points Schedule and as specified. Trend points at [15][__] minute intervals.

(5) Configure Demand Limiting as shown on the Demand Limit Schedule and Points Schedule and as specified.

3.5.2 Integration of Legacy (not per Section 15951) EIA 709.1B Systems

**********NOT

E: Provide a Points Schedule drawing for the legacy system. Otherwise, integrating a legacy EIA 709.1B system is the same as integrating a new EIA 709.1B system. If an LNS database exists, the Contractor will use it and if it doesn't exist the Contractor will 'learn' the network to create one.

****

The Contractor shall perform all tasks required to integrate a EIA 709.1B System installed per Section 15951.

3.5.3 Integration of Legacy non-EIA 709.1B Systems at Building via Gateway

****

NOTE: Provide a Points Schedule drawing for the legacy system.

****

When integrating a non-EIA 709.1B Legacy system using a EIA 709.1B Gateway the Contractor shall perform the following tasks:

a. Install and configure the EIA 709.1B Gateway, including adding the gateway to the LNS database and network drawing. The gateway shall be configured such that the required data (points) as shown from the Legacy system can be read as SNVTs on the EIA 709.1B side of the gateway and that required commands as shown on the legacy side of the gateway can be written as SNVTs on the EIA 709.1B side of the gateway.

b. When the Gateway performs protocol translation to EIA 709.1B, an EIA 709.1B TP/FT-10 to IP Router shall be installed on configured to connect the gateway to the UMCS IP Network.

c. Establish network variable bindings for all alarms as shown.

d. Configure M&C functionality as specified in paragraph Integration of EIA 709.1B (per Section 15951) Systems.

3.5.4 Integration of Legacy non-EIA 709.1B Systems at M&C Server via Protocol Driver

****

NOTE: Provide a Points Schedule drawing for the legacy system.

****

When integrating non-EIA 709.1B legacy systems at the M&C Server the

Contractor shall:

a. Extend the legacy system network to the M&C Server

b. Configure the M&C software protocol driver to provide read and write access to required legacy system data as shown.

c. Configure M&C functionality as specified in paragraph Integration of EIA 709.1B (per 15951) Systems

3.6 START-UP AND START-UP TESTING

Contractor shall test all equipment and perform all other tests necessary to ensure the system is installed and functioning as specified. Contractor shall prepare a Start-Up and Start-Up Testing Report documenting all tests performed and their results and certifying that the system meets the requirements specified in the contract documents.

3.7 PERFORMANCE VERIFICATION TEST (PVT)

****

NOTE: A set of Field Test Procedures are being developed by an A/E under contract with Huntsville Center. Once complete, these Test Procedures will be

included or referenced here.

Brief interim guidance is provided here.

****

3.7.1 PVT Phase I Procedures

PVT Procedures shall include:

a. Network bandwidth usage and available bandwidth (throughput)measurements. Network bandwidth usage shall reference the normal usage network Bandwidth Calculations.

b. Test System Reaction during PVT: Under system normal heavy load {as defined in paragraph Bandwidth Usage Calculation), no more than 10 seconds shall lapse from the time an alarm is generated at a node until the M&C software provides notification and the alarm is displayed. The total system response time from initiation of a control action command from the workstation, to display of the resulting status change on the workstation shall not exceed 20 seconds under system normal heavy load conditions assuming a zero response time for operation of the node's control device.

c. Verification of IP Connectivity.

d. Verification of configuration of M&C Software functionality.

3.7.2 PVT Phase I

The Contractor shall demonstrate compliance of the control system with the contract documents. Using test plans and procedures previouslyapproved by the

Government, the Contractor shall demonstrate all physical and functional requirements of the project. Upon completion of PVT Phase I and as specified the Contractor shall prepare and submit the PVT Phase I Report documenting all tests performed during the PVT and their results. The PVT report shall include all tests in the PVT Procedures and any other testing performed during the PVT. Failures and repairs shall be documented with test results.

3.7.3 PVT Phase II

PVT Phase II shall consist of Basic Operator Training. Failures or deficiencies of the UMCS during Basic Operator Training shall be considered PVT failures. Upon completion of PVT Phase II and as specified the Contractor shall prepare and submit the PVT Phase II Report documenting any failures which occurred and repairs performed during PVT Phase II

3.8 TRAINING

**********NOTE: Training duration and content should be modified to fit the requirements of the specific job. For example, if this specification is to be used to add to an existing UMCS or to replace a portion of an existing UMCS the training requirements should be relaxed.
****

The Contractor shall conduct training courses for designated personnel in

the maintenance, service, and operation of the system as specified, including specified hardware and software. The training shall be oriented to the specific system provided under this contract. The Contractor is responsible for providing audiovisual equipment and other training material and supplies. When training is conducted at Government facilities, the Government reserves the right to videotape the training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor should assume that attendees will be tradesmen such as electricians or boiler operators. Approval of the Contractor's training schedule shall be obtained from the Government at least [30][___] days prior to the first day of training.

3.8.1 Training Documentation

The Contractor shall prepare training documentation for each course. Basic Operator Training Documentation, Advanced Operator Training Documentation, and Operator Refresher Training Documentation shall each consist of:

a. Course attendance list: A list of course attendees shall be developed in coordination with and signed by the [Controls][HVAC][Electrical] shop supervisor.

b. Training Manuals: Training manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Where the Contractor presents portions of the course material by audiovisuals, copies of those audiovisuals shall be

delivered to the Government as a part of the printed training manuals.

3.8.2 Basic Operator Training

The Basic Operator Training course shall be taught at the project site on the installed system for a period of no less than [5][___] training days during Phase 2 of the PVT. A maximum of [ten][___] personnel will attend this course. This training shall be targeted towards training personnel in the day-to-day operation and basic maintenance of the system. Upon completion of this course, each student, using appropriate documentation, should be able to start the system, operate the system, recover the system after a failure, perform routine maintenance and describe the specific hardware architecture and operation of the system. This course shall at a minimum include:

a. General system architecture.

b. Functional operation of the system, including workstations and system navigation.

c. System start-up procedures.

d. Failure recovery procedures.

e. Schedule configuration.

f. Trend configuration.

g. Perform point overrides and override release.

h. Reports generation.

h. Alarm reporting and acknowledgements.

j. Diagnostics.

k. Historical files.

l. Maintenance procedures:

(1) Physical layout of each piece of hardware.

(2) Troubleshooting and diagnostic procedures.

(3) Preventive maintenance procedures and schedules.

3.8.3 Advanced Operator Training

**********NOTE: Coordinate with the project site to select the location of the Advanced Operator Training (or leave it up to the Contractor). Select the duration of the training and the number of attendees.**********

The advanced operator course shall be taught [at the project site][off-site

or at the project site] for a period of not less then [five][___] days. A maximum of [ten][___] personnel will attend this course. The course shall consist of "hands-on" training under the constant monitoring of the instructor. The instructor shall be responsible for determining the appropriate password to be issued to the student commensurate with each student's acquired skills at the beginning of each of these individual training sessions. Advanced Operator Training shall include training on the M&C Software and the EIA 709.1B Network Configuration Tool. Upon completion of this course, the students should be fully proficient in the operation and management of all system operations. The Contractor shall report the skill level of each student at the end of this course. This course shall at minimum include:

a. A review of all topics in Basic Operator Training

b. EIA 709.1B1 Network Management

c. M&C Software Graphic Generation

d. M&C Software Application Programming (M&C Software Programming Language)

e. System Administrator including Operating System maintenance, passwords, networking, firewalls and anti-virus software

3.8.4 Operator Refresher Training

**********NOTE: Operator Refresher Training should be timed to take place near the end of the 1-year warranty period. If the UMCS is contracted out via an IDIQ process, it may be desirable to repeat the operator refresher training periodically.**********

The refresher course shall be taught at the project site for a period of [two][___] training days when approved by the Government and as specified in paragraph PROJECT SEQUENCING. A maximum of [ten][___] personnel will attend the course. The course shall be structured to address specific topics that the students need to discuss and to answer questions concerning the operation of the system. Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed UMCS.

Any system failures discovered during the Operator Refresher Training shall be corrected by the Contractor at no cost to the Government.

APPENDIX A

QC CHECKLIST

This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. This checklist is for (check

one:) Pre-Construction QC Checklist Submittal (Items 1-3) |____| Post-Construction QC Checklist Submittal (Items 1-6) |____|

Close-out QC Checklist Submittal (Items 1-14) |____|

Initial each item in the space provided (|____|) verifying that requirement has been met.

Items verified for Pre-Construction, Post-Construction and Closeout QC Checklists Submittal:

1 Network bandwidth calculations have been performed and |____| indicate that the UMCS will meet network bandwidth requirements.

2 Contractor Design Drawing Riser Diagram includes location |____| and types of Building Point Of Connection (BPOC) Hardware.

3 M&C Software is LonWorks Network Services (LNS) based and |____| uses LNS for interfacing to EIA 709.1B networks.

Items verified for Post-Construction and Closeout QC Checklist Submittal:

4 Connections between the UMCS IP network and EIA 709.1B |____| building networks are through EIA 709.1B TP/FT-10 to IP Routers, IP Routers or Ethernet Switches

5 Computer workstations and servers are installed as shown |____| on the UMCS Riser Diagram.

6 Training schedule and course attendee lists have been |____| developed and coordinated with shops and submitted.

Items verified for Closeout QC Checklists Submittal:

7 LNS Database is up-to-date and accurately represents the |____| final installed system

8 All software has been licensed to the Government |____|

9 M&C software monitoring displays have been created for all |____| building systems, including all override and display points indicated on Points Schedule drawings.

10 Final As-built Drawings accurately represent the final installed system. |____|

QC CHECKLIST

11 Default trends have been set up (per Points Schedule drawings) |____|

12 M&C Software schedules have been set up (per Occupancy Schedule drawing). |____|

13 O&M Instructions have been completed and submitted. |____|

14 Basic Operator and Advanced Operator Training courses have been completed |____|

(QC Representative Signature) (Date)

-- End of Section -

****
****
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Preparing Activity: NASA

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are NOT in agreement with UMRL
References will be in agreement at next scheduled update of UMRL
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SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16003S

GENERAL ELECTRICAL PROVISIONS

12/05

PART 1 GENERAL

1.1 REFERENCES

1.2 SUBMITTALS

1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

1.4 CODES AND STANDARDS

1.5 COORDINATION

1.6 APPROVAL REQUIREMENTS

1.7 PREVENTION OF CORROSION

1.8 HAZARDOUS AREA

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

2.2 WARNING SIGNS

2.3 ANCHOR BOLTS

2.4 SEISMIC ANCHORAGE

2.5 PAINTING

PART 3 EXECUTION

3.1 INSTALLATION

3.2 PAINTING APPLICATION

3.3 IDENTIFICATION PLATE INSTALLATION

3.4 EQUIPMENT PADS

3.5 CUTTING AND PATCHING

3.6 DAMAGE TO WORK

3.7 CLEANING

3.8 FIELD TESTING AND TEST EQUIPMENT

-- End of Section Table of Contents -

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****
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References will be in agreement at next scheduled update of UMRL
****

SECTION 16003S

GENERAL ELECTRICAL PROVISIONS

**********N
OTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers requirements common to all electrical sections and should be included in all project specifications which contain any sections of Division 16, "Electrical," with the exception of Section 16050S BASIC ELECTRICAL MATERIALS AND METHODS which stands alone: Accordingly, this section should be tailored carefully to suit project conditions and to meet project requirements and must be checked with Division 1 to avoid conflicts or repetition.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
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 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.

****

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 NATIONAL STANDARDS INSTITUTE

(ANSI)ANSI Z535.1 (2002) Safety Color CodeASTM

INTERNATIONAL (ASTM)ASTM A 123/A 123M (2002)

Standard Specification for Zinc (Hot-Dip

Galvanized) Coatings on Iron and Steel

ProductsINSTITUTE OF ELECTRICAL AND

ELECTRONICS ENGINEERS (IEEE)IEEE C2 (2002)

National Electrical Safety CodeNATIONAL FIRE

PROTECTION ASSOCIATION (NFPA)NFPA 70 (2005)

National Electrical Code 2005 Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MS MIL-T-704 (Rev K) Treatment and Painting of

Material

UNDERWRITERS LABORATORIES (UL)

UL Elec Const Dir	(2003) Electrical Construction Equipment Directory

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS A-A-59214	(2004) Junction Box: Extension, Junction Box; Cover, Junction Box (Steel, Coated With Corrosion-Resistant Finish)

1.2 SUBMITTALS

Not Used

1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to

provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements that may be required for proper installation of the work. Such work shall be verified at the site. Additional bends and offsets, and conduit as required by vertical and

horizontal equipment locations or other job conditions, shall be provided to complete the work at no additional cost to the Government.

Except where shown in dimensional detail, the locations of switches, receptacles, lights, motors, outlets, and other equipment shown on plans are approximate. Such items shall be placed to eliminate interference with ducts, piping, and equipment. Exact locations shall be determined in the field. Door swings shall be verified to ensure that light switches are properly located.

Equipment sizes indicated are minimum. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and shall install wire, conduit, disconnect switches, motor starters, heaters, circuit breakers, and other items of the correct size for the equipment actually installed. Wire and conduit sizes shown on the drawings shall be taken as a minimum and shall not be reduced without written approval.

1.4 CODES AND STANDARDS

Equipment design, fabrication, testing, performance, and installation shall, unless shown or specified otherwise, comply with the applicable requirements of NFPA 70 and IEEE C2 to the extent indicated by the references.

1.5 COORDINATION

Installation of the electrical work shall be coordinated with the work of other trades.

1.6 APPROVAL REQUIREMENTS

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories (UL), the label of, or listing with re-examination, in UL Elec Const Dir will be acceptable as sufficient evidence that the items conform to the requirements.

Where materials or equipment are specified to be constructed or tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized standards, a manufacturer's certificate of compliance indicating complete compliance of each item with the applicable NEMA, ANSI, ASTM, or other commercial standards specified will be acceptable as proof of compliance.

1.7 PREVENTION OF CORROSION

****

NOTE: For all outdoor applications and all indoor applications in a harsh environment refer to Section 09960 HIGH-PERFORMANCE COATINGS. High performance coatings are specified for all outdoor applications because ultraviolet radiation will break down most standard coatings, causing a phenomena known as chalking, which is the first stage of the corrosion process. For additional information contact The Coatings Industry Alliance, specific suppliers such as Keeler and Long and PPG, and NACE International (NACE).

****

Metallic materials shall be protected against corrosion. Equipment

enclosures shall be given a rust-inhibiting treatment and the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09960 HIGH-PERFORMANCE COATINGS. Aluminum shall not be used in contact with earth or concrete. Dissimilar metals in intimate contact shall be protected by approved fittings, barrier material, and treatment. Ferrous metals such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123/A 123M for exterior locations and cadmium-plated in conformance with FS A-A-59214 for interior locations.

1.8 HAZARDOUS AREA

Electrical work within any hazardous location shall meet the applicable requirements of NFPA 70, Chapter 5, Articles 500 through 517. The following definitions apply:

Explosionproof: A receptacle, fixture, device, or equipment enclosure that is designed to withstand explosion of a specified liquid, gas, vapor, or dust within the enclosure and to prevent the ignition of a specified gas, vapor, or dust surrounding the enclosure by sparks, flashes, or explosions of the specified liquid, gas, vapor, or dust that may occur within the enclosure. Enclosure shall be capable of operating at an external temperature that will not ignite a surrounding
flammable atmosphere.

Hazardous location: An area where ignitable vapors or dust may cause a fire or explosion created by energy emitted from lighting or other electrical equipment or by electrostatic generation.

NFPA 70, Article 500-2 lists chemical atmospheres by groups A, B, C, and D. In addition, although not defined as a hazardous material by the NEC, oxygen concentrations (liquid and gaseous) are considered to provide a hazard because of the increased flammability of materials exposed to oxygen. Therefore, oxygen concentrations shall be classified under Group D.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

Identification plates shall be [3-layer white-black-white] [2-layer black-white], engraved to show black letters on a white background. Letters shall be uppercase. Identification plates 40 millimeter 1-1/2 inches

40 millimeter high and smaller shall be 2 millimeter 1/16-inch thick with
engraved lettering 3 millimeter 1/8-inch high. Identification plates larger than 40 millimeter 1-1/2 inches high shall be 3 millimeter 1/8-inch
thick with engraved lettering not less than 5 millimeter 3/16-inch high. Identification plates having edges of 40 millimeter 1-1/2 inches high and larger shall be beveled.

2.2 WARNING SIGNS

Each item of electrical equipment operating at 480 volts and above shall be
provided with conspicuously located warning signs conforming to the requirements of Occupational Safety and Health Agency (OSHA) standards.

Any equipment with externally powered wiring shall be marked with a laminated plastic nameplate having 5 millimeter 3/16-inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

Safety color coding for identification of warning signs shall conform to

ANSI Z535.1.

2.3 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or slabs.

2.4 SEISMIC ANCHORAGE

****
NOTE: Retain this part only in areas of seismic activity.

****

Electrical equipment, except communications, emergency, and standby equipment, shall be anchored to withstand a lateral force of 0.3 times the

weight of the equipment.

Communications, emergency, and standby equipment shall be anchored to withstand a lateral force of 0.6 times the weight of the equipment.

The following standard anchoring should be adequate for equipment not classified as communications, emergency, or standby:

Dry transformers - floor-mounted with four anchor bolts

BOLT DIAMETER

Under 150 kVA -M10 3/8 150 to 500 kVA -M14 1/2 Over 500 kVA -M16 5/8

Panels - floor-mounted with four M14 1/2-inch diameter anchor bolts

2.5 PAINTING

Enclosures of the following listed items shall be cleaned, primed, and factory-painted inside and outside in accordance with MS MIL-T-704 and the equipment sections of this specification. [Refer to Section 09960 HIGH-PERFORMANCE COATINGS, for requirement for outdoors or in harsh environments.]

ITEM FINISH COLOR Circuit Breakers ANSI

No. 61 gray Substations ANSI No. 61 gray

Switchgear ANSI No. 61 gray Transformers ANSI

No. 61 gray

ITEM FINISH COLOR

Safety Switches Manufacturer's standard

Panelboards Manufacturer's standard

Electric Heaters Manufacturer's standard

Motors Manufacturer's standard

Limit Switches Manufacturer's standard

Control Components Manufacturer's standard

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations.

3.2 PAINTING APPLICATION

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks, if not factory painted, shall be thoroughly cleaned and painted as specified in [Section 09920S ARCHITECTURAL PAINTING] [the equipment sections in this specification] unless otherwise noted. Work shall be left in a neat and clean condition at final completion of the contract.

Emergency equipment, such as fire-alarm boxes, shall be cleaned, primed, and painted red.

3.3 IDENTIFICATION PLATE INSTALLATION

Identification plates shall be fastened by means of corrosion-resistant steel or nonferrous metal screws. Hand lettering, marking, or embossed self-adhesive tapes are not acceptable.

3.4 EQUIPMENT PADS

Equipment pads shall be constructed with a minimum 100 millimeter 4-inch margin around the equipment and supports.

3.5 CUTTING AND PATCHING

Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching on the building structure.

Holes in or through existing masonry walls and floors in exposed locations shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved.

3.6 DAMAGE TO WORK

Required repairs and replacement of damaged work shall be done as directed by and subject to the approval of the Contracting Officer, and at no additional cost to the Government.

3.7 CLEANING

Exposed surfaces of wireways, conduit systems, and equipment that have

become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish or painting or are enclosed within the building structure.

Before final acceptance, electrical equipment, including lighting fixtures and glass, shall be clean and free from dirt, grease, and fingermarks.

3.8 FIELD TESTING AND TEST EQUIPMENT

All Field testing specified in Divisions 16 electrical specification shall be made with test equipment specially designed and calibrated for the purpose. Test equipment used shall be calibrated and certified by an approved testing laboratory. Date of last calibration and certification shall not be more than 90 calendar days old at the time of field testing.

-- End of Section -

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****
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SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16050S

BASIC ELECTRICAL MATERIALS AND METHODS

12/05

PART 1 GENERAL

1.1 REFERENCES

1.2 SUBMITTALS

1.3 PREVENTION OF CORROSION

1.4 GENERAL REQUIREMENTS

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Rigid Steel Conduit

2.1.2 Electrical Metallic Tubing (EMT)

2.1.3 Flexible Metallic Conduit

2.1.4 Intermediate Metal Conduit

2.1.5 Rigid Nonmetallic Conduit

2.1.6 Wireways and Auxiliary Gutters

2.1.7 Surface Raceways and Assemblies

2.1.8 Cable Trays

2.2 WIRE AND CABLE

2.3 SPLICES AND CONNECTORS

2.4 SWITCHES

2.4.1 Safety Switches

2.4.2 Toggle Switches

2.5 RECEPTACLES

2.6 OUTLETS, OUTLET BOXES, AND PULL BOXES

2.7 PANELBOARDS

2.8 CIRCUIT BREAKERS

2.9 LAMPS AND LIGHTING FIXTURES

2.10 DRY-TYPE DISTRIBUTION TRANSFORMERS

PART 3 EXECUTION

3.1 CONDUITS, RACEWAYS AND FITTINGS

3.1.1 Rigid Steel Conduit

3.1.2 Electrical Metallic Tubing (EMT)

3.1.3 Flexible Metallic Conduit

3.1.4 Intermediate Conduit

3.1.5 Rigid Nonmetallic Conduit

3.1.6 Wireway and Auxiliary Gutter

3.1.7 Surface Raceways and Assemblies

3.1.8 Cable Trays

3.2 WIRING

3.3 SAFETY SWITCHES

3.4 WIRING DEVICES

3.4.1 Wall Switches and Receptacles

3.4.2 Device Plates

3.5 BOXES AND FITTINGS

3.6 LAMPS AND LIGHTING FIXTURES

3.7 PANELBOARDS

3.8 DRY-TYPE DISTRIBUTION TRANSFORMERS

3.9 IDENTIFICATION PLATES AND WARNINGS

3.10 PAINTING

3.11 FIELD TESTING

-- End of Section Table of Contents -

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****

SECTION 16050S

BASIC ELECTRICAL MATERIALS AND METHODS

12/05

**********NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This broadscope section covers requirements common to all electrical sections.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

****

PART 1 GENERAL

1.1 REFERENCES

****

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.

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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.

****

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 NATIONAL STANDARDS INSTITUTE

(ANSI)ANSI Z535.1 (2002) Safety Color CodeELECTRONIC INDUSTRIES ALLIANCE (EIA)EIA 480 (1981) Toggle SwitchesINTERNATIONAL CODE COUNCIL (ICC)ICC A117.1 (1998) American National Standards for Accessible and Usable Buildings and FacilitiesNATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)NEMA 250

(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)NEMA FB 1 (2001) Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable AssembliesNEMA KS 1 (2001) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)NEMA OS 1 (1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box SupportsNEMA OS 2 (1996) Nonmetallic Outlet Boxes, Device

Boxes, Covers and Box Supports

NEMA PB 1 (2000) Panelboards

NEMA RN 1 (1998) Polyvinyl-Chloride (PVC)

Externally

Coated Galvanized Rigid Steel Conduit and Intermediate Metal ConduitNEMA TC 13 (2000) Electrical Nonmetallic Tubing (ENT)NEMA VE 1 (2002) Metallic Cable Tray SystemsNEMA WD 1 (1999) General Requirements for Wiring DevicesNEMA WD 6 (2002) Wiring Devices - Dimensional RequirementsNATIONAL FIRE PROTECTION ASSOCIATION (NFPA)NFPA 70 (2005) National Electrical Code 2005 Edition

UNDERWRITERS LABORATORIES (UL)

UL 1	(2004) UL Standard for Safety - Flexible Metal Conduit
UL 1242	(2003) UL Standard for Safety - Intermediate Metal Conduit
UL 489	(2003; Bulletin Feb 11, 1992; Bulletin Mar 16, 1992) UL Standard for Safety Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
UL 506	(2004) Standard for Specialty Transformers

UL 6	(2003) UL Standard for Safety for Electrical Rigid Metal Conduit-Steel
UL 797	(2003) UL Standard for Safety - Electrical Metallic Tubing
UL 870	(2002) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings

1.2 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for the following:

Conduits, Raceway sand Fittings
Wire and Cable
Splices and Connectors
Switches
Receptacles
Outlets, Outlet Boxes, and Pull Boxes
Circuit Breakers
Panelboards
Lamps and Lighting Fixtures
Dry-Type Distribution Transformers

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Conduits, Raceway sand Fittings
Wire and Cable
Splices and Connectors
Switches
Receptacles
Outlets, Outlet Boxes, and Pull Boxes
Circuit Breakers
Panelboards
Lamps and Lighting Fixtures
Dry-Type Distribution Transformers
Spare Parts

SD-06 Test Reports

Continuity and Insulation Resistance Test
Phase-Rotation Tests
Insulation Resistance Test

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted.

1.3 PREVENTION OF CORROSION

****
NOTE: For all outdoor applications and all indoor applications in a harsh environment refer to Section 09960 HIGH-PERFORMANCE COATINGS. High performance coatings are specified for all outdoor applications because ultraviolet radiation will break down most

standard coatings, causing a phenomena known as

chalking, which is the first stage of the corrosion process. For additional information contact The Coatings Industry Alliance, specific suppliers such as Keeler and Long and PPG, and NACE International (NACE).

****

Metallic materials shall be protected against corrosion. Equipment enclosures shall have the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09960 HIGH-PERFORMANCE COATINGS. Aluminum shall not be used in contact with earth or concrete and, where connected to dissimilar metal, shall be protected by approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

1.4 GENERAL REQUIREMENTS

Material, Equipment, and Fixture Lists shall be submitted for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Manufacturer's Instructions shall be submitted including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products.

2.1.1 Rigid Steel Conduit

Rigid steel conduit shall be in accordance with UL 6 and shall be galvanized by the hot-dip process. Where underground and in corrosive areas, rigid steel conduit shall be polyvinylchloride (PVC) coated in accordance with NEMA RN 1 or shall be painted with bitumastic.

Fittings for rigid steel conduit shall be threaded.

Gaskets shall be solid. Conduit fittings with blank covers shall have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Covers shall have captive screws and shall be accessible after the work has been completed.

2.1.2 Electrical Metallic Tubing (EMT)

EMT shall be in accordance with UL 797 and shall be zinc coated steel. Couplings and connectors shall be zinc-coated, raintight, gland compression

with insulation throat. Crimp, spring, or setscrew type fittings shall not be acceptable.

2.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall be in accordance with UL 1 and shall be galvanized steel.

Fittings for flexible metallic conduit shall be specifically designed for such conduit.

Liquidtight flexible metallic conduit shall be provided with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Fittings for liquidtight flexible metallic conduit shall be specifically designed for such conduit.

2.1.4 Intermediate Metal Conduit

Intermediate metal conduit shall be in accordance with UL 1242 and shall be galvanized.

2.1.5 Rigid Nonmetallic Conduit

Rigid nonmetallic conduit shall be in accordance with NEMA TC 13 and shall be PVC with wall thickness not less than Schedule 40.

2.1.6 Wireways and Auxiliary Gutters

Wireway and auxiliary gutters shall be a minimum 100 by 100 millimeter 4-by 4 inch trade size conforming to UL 870.

2.1.7 Surface Raceways and Assemblies

Surface metal raceways and multi-outlet assemblies shall conform to NFPA 70.
Receptacles shall conform to NEMA WD 1, Type [5-15R] [5-20R].

2.1.8 Cable Trays

Cable trays shall be ladder type conforming to NEMA VE

1.

2.2 WIRE AND CABLE

Conductors installed in conduit shall be copper 600-volt type [THHN] [THWN] [XHHW]. All conductors 3.15 millimeter diameter (AWG No. 8) AWG No. 8 and larger, shall be stranded. All conductors smaller than 3.15 millimeter diameter (AWG No. 8) AWG No. 8 shall be [stranded] [solid].

Flexible cable shall be Type SO and shall contain a grounding conductor with green insulation.

Conductors installed in plenums shall be marked plenum rated.

2.3 SPLICES AND CONNECTORS

Splices in 3.15 millimeter diameter (AWG No. 8) AWG No. 8 and smaller shall
be made with approved [insulated electrical type] [indentor crimp-type connectors and compression tools].

Splices in 4.1 millimeter diameter (AWG No. 6) AWG No. 6 and larger shall be made with [indentor crimp-type connectors and compression tools] [bolted clamp-type connectors]. Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

2.4 SWITCHES

2.4.1 Safety Switches

Safety switches shall be in accordance with NEMA KS 1, and shall be the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, with the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and shall be so constructed that an external tool must be used to open the cover. Provisions shall be made to lock the handle in the "OFF" position, but the switch shall not be capable of being locked in the "ON" position.

Switches shall be of the quick-make, quick-break type. Terminal lugs shall be approved for use with copper conductors.

Safety color coding for identification of safety switches shall conform to ANSI Z535.1.

2.4.2 Toggle Switches

Toggle switches shall be in accordance with EIA 480, and shall control incandescent, mercury, and fluorescent lighting fixtures and shall be of the heavy duty, general purpose, noninterchangeable flush-type.

Toggle switches shall be commercial grade toggle type, [single] [double]-pole, [three] [four]-way two-position devices rated 20 amperes at 277 volts, 60 hertz alternating current (ac) only.

All toggle switches shall be products of the same manufacturer.

2.5 RECEPTACLES

Receptacles shall be commercial grade, 20A, 125 VAC, 2-pole, 3-wire duplex conforming to NEMA WD 6, NEMA 5-20R.

2.6 OUTLETS, OUTLET BOXES, AND PULL BOXES

Outlet boxes for use with conduit systems shall be in accordance with NEMA FB 1 and [NEMA OS 1] [NEMA OS 2] and shall be not less than 40 millimeter 1-1/2 inches deep. Pull and junction boxes shall be furnished with screw-fastened covers.

2.7 PANELBOARDS

Lighting and appliance branch circuit panelboards shall be the circuit-breaker type in accordance with NEMA PB 1. Circuit breakers shall be bolted to the bus. Plug-in circuit breakers shall not be acceptable. Buses shall be copper of the rating indicated, with main lugs or main circuit breaker as indicated. Panelboards for use on grounded ac systems shall be provided with a full-capacity isolated neutral bus and a separate grounding bus bonded to the panelboard enclosure. Panelboard enclosures shall be NEMA 250, Type 1, in accordance with NEMA PB 1. Enclosure fronts shall have latchable hinged doors.

2.8 CIRCUIT BREAKERS

Circuit-breaker interrupting rating shall be not less than those indicated and in no event less than [10,000] [20,000] amperes root-mean-square (rms) symmetrical at [208] [240] volts, respectively. Multipole circuit breakers shall be the common-trip type with a single handle. Molded case circuit

breakers shall be bolt-on type conforming to UL 489.

2.9 LAMPS AND LIGHTING FIXTURES

Manufacturers and catalog numbers shown are indicative of the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, will be acceptable. Lamps of the proper type and wattage shall be provided for each fixture.

Ballasts shall be high power factor and be energy efficient. Ballasts shall have a Class P terminal protective device for [120] [277]-volt operation as indicated and shall be rapid-start fluorescent. Ballasts shall be "A" sound rated. Fluorescent lamps shall be standard reduced wattage type.

High intensity discharge (HID) lighting fixtures shall have prewired integral ballasts and cast aluminum housings complete with tempered glass lenses suitable for installation in damp or wet locations. Fixtures and lamps shall be provided.

2.10 DRY-TYPE DISTRIBUTION TRANSFORMERS

General purpose dry-type transformers with windings 600 volts or less shall be two-winding, 60 hertz, self-cooled in accordance with UL 506. Windings shall have a minimum of two 2-1/2-percent taps above and below nominal voltage.

PART 3 EXECUTION

3.1 CONDUITS, RACEWAYS AND FITTINGS

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall contain not more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Crushed or deformed conduit shall not be installed. Trapped conduit runs shall be avoided where possible. Care shall be taken to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clogged conduit shall be cleared of obstructions or shall be replaced.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 1470 millimeter 5 feet or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

3.1.1 Rigid Steel Conduit

Field-made bends and offsets shall be made with approved hickey or conduit bending machine. Conduit elbows larger than 65 millimeter 2-1/2 inches shall be long radius.

Conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, shall be provided with a flush coupling when the floor slab is of sufficient thickness. Otherwise, a floor box shall be provided and set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

3.1.2 Electrical Metallic Tubing (EMT)

EMT shall be grounded in accordance with NFPA 70, using pressure grounding connectors especially designed for EMT.

3.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall be used to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

Bonding wires shall be used in flexible conduit as specified in NFPA 70, for all circuits. Flexible conduit shall not be considered a ground conductor.

Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit.

Liquidtight flexible metallic conduit shall be used in wet and oily locations and to complete the connection to motor-driven equipment.

3.1.4 Intermediate Conduit

Field-made bends and offsets shall be made with approved hickey or conduit bending machine. Intermediate metal conduit shall be used only for indoor installations.

3.1.5 Rigid Nonmetallic Conduit

Rigid PVC conduit shall be direct buried.

A green insulated copper grounding conductor shall be in conduit with conductors and shall be solidly connected to ground at each end. Grounding wires shall be sized in accordance with NFPA 70.

3.1.6 Wireway and Auxiliary Gutter

Straight sections and fittings shall be bolted together to provide a rigid, mechanical connection and electrical continuity. Dead ends of wireways and

auxiliary gutters shall be closed. Unused conduit openings shall be plugged.

Wireways for overhead distribution and control circuits shall be supported at maximum [_____] [1500] millimeter [5]-foot intervals.

Auxiliary gutters used to supplement wiring spaces for equipment not

contained in a single enclosure shall contain no switches, overcurrent devices, appliances, or apparatus and shall be not more than [_____] [9000] millimeter [30] feet long.

3.1.7 Surface Raceways and Assemblies

Surface raceways shall be mounted plumb and level, with the base and cover secured. Minimum circuit run shall be three-wire with one wire designated as ground.

3.1.8 Cable Trays

Cable trays shall be supported from ceiling hangers, equipment bays, or floor or wall supports. Cable trays may be mounted on equipment racks. Support shall be provided when the free end extends beyond [_____] [900] millimeter [3] feet. Maximum support spacing shall be [_____] [1800] millimeter [6] feet. Trays 250 millimeter 10-inches wide or less shall be supported by [one] [_____] hanger. Trays greater than 250 millimeter 10-inches wide shall be supported by [two] [_____] hangers. Cable trays shall be bonded at splices.

3.2 WIRING

Feeder and branch circuit conductors shall be color coded as follows:

CONDUCTOR COLOR AC

Phase A [_____]

Phase B [_____]

Phase C [_____]

Neutral [White] [Natural Gray]

Equipment Grounds [Green] [Green with Yellow Stripe] [Bare]

Conductors up to and including 6.5 millimeter diameter (AWG No. 2) AWG No. 2shall be manufactured with colored insulating materials. Conductors larger than 6.5 millimeter diameter (AWG No. 2) AWG No. 2 shall have ends

identified with color plastic tape in outlet, pull, or junction boxes.

Splices shall be in accordance with the NFPA 70. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Terminal and conductor identification shall match as indicated.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation.

3.3 SAFETY SWITCHES

Switches shall be securely fastened to the supporting structure or wall, utilizing a minimum of [four] [_____] 6 millimeter 1/4 inch bolts. Sheet metal screws and small machine screws shall not be used for mounting. Switches shall not be mounted in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be [_____] [1500] millimeter [5] feet above floor level, when possible.

3.4 WIRING DEVICES

3.4.1 Wall Switches and Receptacles

Wall switches and receptacles shall be so installed that when device plates are applied, the plates will be aligned vertically to within [_____] [2] millimeter [1/16] inch.

Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper when used with dry wall type construction.

3.4.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably engraved with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets shall be suitably marked, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Required marking shall consist of a self-adhesive label having [_____] [6] millimeter [1/4] inch embossed letters.

Device plates for convenience outlets shall be similarly marked indicating the supply panel and circuit number.

3.5 BOXES AND FITTINGS

Pullboxes shall be furnished and installed where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than

[_____] [30] meter [100] feet or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Boxes and enclosures shall be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be in accordance with ICC A117.1 and as follows:

LOCATION	MOUNTING HEIGHT
Receptacles in offices	450 millimeter18 inches
Receptacles in corridors	450 millimeter18 inches
Receptacles in shops & laboratories	1200 millimeter48 inches
Receptacles in rest rooms	1200 millimeter48 inches
Switches for light control	1200 millimeter48 inches

3.6 LAMPS AND LIGHTING FIXTURES

New lamps of the proper type and wattage shall be installed in each fixture. Fixtures and supports shall be securely fastened to structural members and shall be installed parallel and perpendicular to major axes of structures.

3.7 PANELBOARDS

****
**********NOTE: Ability to remove access covers is required for maintenance activities. In addition, access may be required to inspect this device while circuits are energized (for example, using infrared imaging). Minimum distances to energized circuits is specified in OSHA Standards Part 1910.333 (Electrical -Safety-Related work practices). OSHA Standards are available on the internet.
****
****

Panelboards shall be securely mounted so that the top operating handle does not exceed [_____] [1800] millimeter [72]-inches above the finished floor.

No equipment shall be mounted within 914 millimeter 36 inches of the front
of the panel.Directory card information shall be complete and legible.

3.8 DRY-TYPE DISTRIBUTION TRANSFORMERS

Dry-type transformers shall be connected with flexible metallic conduit.

[All dry-type transformers shall be mounted on vibration isolators in
accordance with Section 15072S VIBRATION ISOLATION FOR AIR CONDITIONING
SYSTEMS.]

3.9 IDENTIFICATION PLATES AND WARNINGS

Identification plates shall be furnished for lighting and power
panelboards, motor control centers, all line voltage heating and
ventilating control panels, fire detector and sprinkler alarms, door bells,
pilot lights, disconnect switches, manual starting switches, and magnetic
starters. Process control devices and pilot lights shall have identification plates.

Identification plates shall be furnished for all line voltage enclosed
circuit breakers, identifying the equipment served, voltage, phase(s) and
power source. Circuits 480 volts and above shall have conspicuously
located warning signs in accordance with OSHA requirements.

3.10 PAINTING

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks shall
be thoroughly cleaned and painted as specified in Section 09920S
ARCHITECTURAL PAINTING or Section 09960 HIGH-PERFORMANCE COATINGS.

3.11 FIELD TESTING

After the installation is complete wire and cable shall be given a continuity and insulation resistance test. Insulation resistance test shall be with a [250][500][1000] - volt insulation test set. Readings shall be recorded after a minimum of 3 minutes and until the reading is constant for 1 minute. Resistance between phase conductors and ground shall be no less than 25 megohms.

Phase-rotation tests shall be conducted on three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical connections to connected equipment shall be A, B, C left to right, or top to bottom facing the equipment.

Transformers shall be given an insulation resistance test. Resistance between each phase and ground shall be not less than 25 megohms.

Final acceptance will depend upon the satisfactory performance of the equipment under test. No conductor or circuit shall be energized until the installation has been approved by the Contracting Officer. Final test data shall be provided to the Contracting Officer. Data shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Data - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section -

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Preparing Activity: NASA

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NASA-16121 (June 2004)

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SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16121S

FIBER OPTIC CABLE

12/05

PART 1 GENERAL

1.1 REFERENCES

1.2 GENERAL REQUIREMENTS

1.3 SUBMITTALS

1.4 QUALIFICATIONS

1.5 QUALITY ASSURANCE PLAN

1.6 STORAGE AND HANDLING

PART 2 PRODUCTS

2.1 FIBER OPTIC CABLE DESIGN

2.1.1 Cable Length

2.1.2 Materials and Construction
2.1.2.1 Central Core Member
2.1.2.2 Optical Fibers
2.1.2.3 Fiber Primary Protective Coating
2.1.2.4 Optical Fiber Color-Code Coating
2.1.2.5 Loose Tube Buffering
2.1.2.6 Colorants
2.1.2.7 Number of Fibers Per Tube Per Cable
2.1.2.8 Inner Jacket
2.1.2.9 Filling Compound
2.1.2.10 Pulling Strength Member
2.1.2.11 Cable Outer Jacket
2.1.2.12 Metallic Armor
2.2 CABLE IDENTIFICATION SYMBOL
2.3 REPLACEMENT CABLE
2.4 SPLICE ORGANIZERS
2.5 PRE-CONNECTED CABLE ASSEMBLY
2.6 OPTICAL PATCH PANEL ASSEMBLIES
2.7 FIBER OPTIC TERMINAL CABINETS
2.8 FACTORY TEST CERTIFICATES
2.8.1 Optical Performance
2.8.1.1 Multi-Mode Fibers in the Cable
2.8.1.2 Single-Mode Fibers in the Cable
2.8.2 Mechanical Performance
2.8.2.1 Minimum Bend Radius
2.8.2.2 Tensile Strength
2.8.2.3 Flexing or Bending Cycles
2.8.2.4 Crush Resistance
2.8.2.5 Impact Resistance

2.8.2.6 Gel Filling Compound Drip Test
2.8.2.7 Fluid Penetration
2.9 TEMPERATURE ENVIRONMENT
2.10 SPLICE COMPATIBILITY TEST
PART 3 EXECUTION
3.1 FIBER SPLICES
3.2 BURIED CABLE INSTALLATION
3.2.1 Location
3.2.2 Field Staking
3.2.3 Method of Cable Placement
3.2.3.1 Open Trench Method
3.2.3.2 Direct Plow Method
3.2.4 Compaction
3.3 UNDERGROUND CABLE INSTALLATION
3.3.1 Securing Cable
3.3.2 Bending
3.3.3 Pulling
3.3.4 Lubricant
3.3.5 Damage and Defects
3.3.6 Seal
3.4 CABLE INSTALLATION IN CABLE TRAYS
3.5 CABLE DELIVERY
3.6 GROUNDING SYSTEMS
3.7 TESTING
3.8 TEST REQUIREMENTS
3.8.1 Single and Multi-mode OTDR Test
3.8.2 End-to-End Attenuation Tests

3.8.3 End-to-End Bandwidth Tests

-- End of Section Table of Contents -

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USACE / NAVFAC / AFCESA / NASA NASA-16121S
(December 2005)

Preparing Activity: NASA

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40
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SECTION 16121S

FIBER OPTIC CABLE

12/05

****
NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers requirements for fiber optic cable systems.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.
****

PART 1 GENERAL

1.1 REFERENCES

****
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 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.

****
*

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.

ASTM INTERNATIONAL (ASTM)

ASTM C 338	(1993; R 2003) Softening Point of Glass
ASTM D 4976	(2002) Standard Specification for Polyethylene Plastics Molding and Extrusion Materials

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 455-104A	(2000) FOTP-104 Fiber Optic Cable Cyclic Flexing Test
EIA 455-164A	(1991) FOTP-164 Single-Mode Fiber, Measurement of Mode Field Diameter by Far-Field Scanning
EIA 455-165	(1993) FOTP-165 Single-Mode Fiber, Measurement of Mode Field Diameter by Near-Field Scanning
EIA 455-167A	(1992; R 2000) FOTP-167 Mode Field Diameter Measurement Variable Aperture Method in the Farfield

EIA 455-168A	(1992) FOTP-168 Chromatic Dispersion Measurement of Multimode Graded-Index and Single-Mode Optical Fibers by Spectral Group Delay Measurement in the Time Domain
EIA 455-169A	(2001) FOTP-169 Chromatic Dispersion Measurement of Optical Fibers by the Phase-Shift Method
EIA 455-25C	(1996) FOTP-25 Repeated Impact Testing of Single-Mode Fiber Optic Cables and Cable Assemblies
EIA 455-30B	(1991) Frequency Domain Measurement of Multitude Optical Fiber Information Transmission Capacity
EIA 455-33A	(1988) FOTP-33 Fiber Optic Cable Tensile Loading and Bending Test
EIA 455-41	(1993) FOTP-41 Compressive Loading Resistance of Fiber Optic Cables
EIA 455-46A	(1990) FOTP-46 Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers
EIA 455-47B	(1992) FOTP-47 Output For Field Radiation Pattern Measurement
EIA 455-51A	(2001) FOTP-51 Pulse Distortion Measurement of Mulitmode Glass Optical Fiber Information Transmission Capacity
EIA 455-53A	(2001) FOTP-53 Attenuation by Substitution Measurement for Multimode Graded-Index

	Optical Fibers or Fiber Assemblies Used in Long Length Communications Systems
EIA 455-78B	(2002) Optical Fibres - Part 1-40: Measurement Methods and Text Procedures - Attenuation
EIA 455-80B	(1996) FOTP-80 Cutoff Wavelength of Uncabled Single-Mode Fiber by Transmitted Power
EIA 455-81B	(2000) FOTP-81 Compound Flow (Drip) Test for Filled Fiber Optic Cable
EIA 455-82B	(1991) FOTP-82 Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD 595	(1994b) Colors Used in Government Procurement

1.2 GENERAL REQUIREMENTS

****
NOTE: If Section 16003S GENERAL ELECTRICAL PROVISIONS is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.
****

Section 16003S GENERAL ELECTRICAL PROVISIONS applies to work specified in

this section.

Fiber optic cable shall consist of optical fibers, strength

member[s], and jacketing. Associated components shall include optical fiber connectors, optical patch panels, terminal bay cabinets, and splice closures as indicated. Fiber optic cables shall be installed in inner duct in the existing cable duct and manhole system and/or directly buried to the facility. Fiber optic terminal shall be located in existing facility buildings.

References in this section to cable shall refer to fiber optic cable.

1.3 SUBMITTALS

****
**********NOTE: Review Submittal Description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force
and NASA projects, or choose the second bracketed
item for Army projects.

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****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

The following preconstruction submittals shall be submitted to the
Contracting Officer for approval and approved [30] [_____]
calendar days prior to installation.

Qualifications
Quality Assurance Plan

SD-03 Product Data

Manufacturer's product data shall be submitted for the following
items. Data shall include a complete list of parts, special
tools, and supplies with current unit prices and source of supply.

Optical Fibers
Fiber Optic Cable Design
Splice Organizers
Pre-Connected Cable Assembly
Fiber Optic Terminal Cabinets
Optical Patch Panel Assemblies

SD-06 Test Reports

Contractor test reports shall be submitted for approval to the
Technical Representative not later than [14] [_____] calendar days
after the completion of each test.

Factory Test Certificates
Single and Multi-mode OTDR Test
End-to-End Attenuation Tests
End-to-End Bandwidth Tests

1.4 QUALIFICATIONS

Cable construction work shall be performed by construction personnel who have had at least [3] [_____] years experience in placing cables in conduit, cable trays, and underground duct systems.

Fiber optic cable splices, terminations and testing shall be made by journeymen cable splicers who have had a minimum of [1] [_____] year experience in splicing and terminating fiber optic cables. Personnel working pursuant to this section, may at the Contracting Officer's option, be required to demonstrate technical competence by performing sample work [and/or by displaying their state qualifications/certificates], at no additional cost to the Government.

Each person who is to perform fiber optic cable splicing shall perform a minimum of one acceptable sample splice and termination. Sample splices and terminations shall not be incorporated in the job.

A Quality Assurance Plan shall be submitted for fiber optic cable systems consisting of detailed procedures defining methods to ensure compliance to contract drawings and specifications by drawing control, inspection and procurement records, test plan showing when and how each system will be tested, material testing, and certification records. Test plan shall be submitted to the Technical Representative for approval at least [30] [_____] calendar days prior to the start of testing.

1.5 QUALITY ASSURANCE PLAN

Contractor shall prepare a quality assurance plan which provides a detailed outline of all testing to be accomplished. Quality assurance plan shall address whether cladding modes have been stripped prior to testing, source wavelength (peak), spectral width full width/half maximum (FWHM), mode structure, fiber end preparation, and bandwidth measurements of fiber links both greater and less than 1 kilometer. Quality assurance plan shall include, as a

minimum, a schedule of when tests will be performed relative to installation milestones, specific test procedure that will be used, a list of test equipment that will be used including manufacturer, model number, range, resolution accuracy and shall conform to the specified requirements.

1.6 STORAGE AND HANDLING

Care shall be exercised in handling materials during construction.
Contractor shall ensure that the buried cable is fed through the plow into
the ground at zero tension. Tension shall not be allowed to develop in the
cable.

Whenever the plow is stopped, sufficient cable shall be unreeled to guard
against sudden jerks when the plow is started.

Caution shall be exercised to ensure that the plow is not backed up while the blade is in the ground. Cable can be severely damaged by the plow backing up even a slight amount. During the plowing operation, the plow may strike a buried object or rock that would stop the equipment and necessitate removal of the plow from the ground. When this occurs, the plow shall be removed carefully without backing up. When it is necessary to back the plow, the cable shall be uncovered a sufficient distance back from the plow for inspection by the Contracting Officer to determine if there is any damage. Any damage shall be immediately reported to the Contracting Officer. Damages shall be repaired or replaced as directed by the Contracting Officer.

PART 2 PRODUCTS

2.1 FIBER OPTIC CABLE DESIGN

2.1.1 Cable Length

Cable shall be manufactured continuous with no factory splices.

2.1.2 Materials and Construction

Materials used within a given cable shall be compatible with all other materials used in the same cable when such materials come into intimate contact. All cable components used shall have no adverse affect on optical transmission or on the mechanical integrity characteristics of the fiber

placed in the cable. All materials used shall be non-toxic, non-corrosive, and shall present no dermal hazard.

Minimum required material components applied to fiber optic cable construction shall be central core member, color-coded optical fiber, color-coded loose tube buffer with gel-filling, gel-filling around loose tube, inner jacket, pulling strength members, and outer jacket. Variations in sequence and construction structural components will be considered when necessary.

2.1.2.1 Central Core Member

A central core member shall be included to serve as a cable core foundation to reduce strain on the fibers but not to serve as a pulling strength member. Material of the central core member shall be non-metallic.

2.1.2.2 Optical Fibers

Two types of optical fibers, single-mode fiber and multi-mode fiber, shall be contained in the cable and shall be as follows:

Single-Mode (SM) fiber must be the equivalent [step] [graded] index optical glass. Core diameter of the fiber shall be approximately 8.7 micrometer. Cladding diameter shall be 125 plus or minus 3 micrometer. Core cladding offset shall be less than 1 micrometer. Minimum tensile strength of the fiber after primary protective coating shall be greater than 350,000 kilopascal 50,000 psi . Softening point of the clad material of the optical fiber shall be 1630 degrees C plus or minus 50 degrees C in accordance with ASTM C 338, or the optical fiber shall meet the requirements in paragraph entitled, "Splice Compatibility Test."

Multi-Mode (MM) fiber shall be the [graded] [step] index optical glass.

Core diameter of the fiber shall be [50] [62.5] plus or minus 3 micrometer. Cladding diameter shall be 125 plus or minus 3 micrometer. Core-cladding offset shall be less than 3 micrometer. Minimum tensile strength of the fiber after primary protective coating shall be greater than 350,000 kilopascal 50,000 psi. Softening point of the

clad material of the optical fiber shall be 1630 degrees C plus or minus 50 degrees C in accordance with ASTM C 338, or the optical fiber shall meet the requirements in paragraph entitled, "Splice Compatibility Test."

2.1.2.3 Fiber Primary Protective Coating

Optical fiber shall be coated with suitable material to preserve the intrinsic high tensile strength of the glass fiber. Outside diameter of the coated optical fiber shall be 250 plus or minus 15 micrometer. Coating material shall be readily removable, mechanically or chemically, without damaging the optical fibers when the removal is desired.

2.1.2.4 Optical Fiber Color-Code Coating

Primary protective coated SM and MM fibers shall be coated with a color-code coating for individual fiber identification. Maximum outside diameter of color-code coated fiber shall be less than 300 micrometer.

2.1.2.5 Loose Tube Buffering

Color-code coated fiber[s] shall be surrounded with a loose tube buffering for protection from external mechanical and environmental influences. Interior of the tube shall be filled with a suitable gel-fitting compound to prevent water migration. Loose tube buffering shall be color coded for the tube identification. Material of the buffering tube shall be [PVC] [mylar] [nylon] [_____].

2.1.2.6 Colorants

Color concentrates or inks used to color code the optical fibers and the loose buffer tube shall not be susceptible to migration and chemical reaction with gel filling compound.

2.1.2.7 Number of Fibers Per Tube Per Cable

36-fiber cable and 72-fiber cable are required and shall be as follows:

36-fiber cable shall contain multimode and single mode fibers. Cable core configuration shall be comprised of six loose buffer tubes, each containing six fibers. Six fibers in each loose buffer tube shall be color coded

using the first colors of the standard Munsell color code, Blue, Orange, Green, Brown, Slate, and White. Loose buffer tubes shall be color coded using the standard Munsell color code, Blue, Orange, Green, Brown and Slate. Sixth buffer tube shall be Pink. Single mode fibers shall be considered last in configuration.

72-fiber cable shall contain multimode and single mode fibers. Cable core configuration shall be comprised of 12 loose buffer tubes, each containing six fibers. Six fibers in each loose buffer tube shall be color coded using the first colors of the standard Munsell color code, Blue, Orange, Green, Brown, Slate and White. Loose buffer tubes shall be color coded using the standard Munsell color code, Blue, Orange, Green, Brown, Slate, Red, Black, Yellow, and Violet. Eleventh and twelfth buffer tubes shall be Blue/White and Orange/White, respectively. Single mode fibers shall be considered last in configuration.

2.1.2.8 Inner Jacket

Buffer tubes shall be located concentrically around the cable central core member and covered with a polyethylene inner jacket. Polyethylene inner jacket shall be [high] [medium] density polyethylene in accordance with ASTM D 4976. Space between the buffer tubes and inner jacket shall be filled with a gel compound to prevent air, moisture, or water intrusion in the inner jacket.

2.1.2.9 Filling Compound

Inner jacket interior and loose tube buffer cavity shall contain a gel-type filling compound. Filling compound shall be of suitable viscosity so that it will protect the optical fibers against the ingress of water and/or soluble chemicals and shall not flow at the temperature of up to 65 degrees

C. Gel filling compound shall be electrically non-conducting, inert gel-type, waterproof compound, non-toxic, with no dermal hazards, and compatible chemically and mechanically with all cable components and associated splice hardware materials to which it may make contact. Gel filling compound shall be removable, as required, using commercially available products under field-type conditions.

2.1.2.10 Pulling Strength Member

Aramid type material shall be used as pulling strength members in the cable to provide pulling strength of at least [1800] [_____] newton [400] [_____] pounds for the cable during installation.

2.1.2.11 Cable Outer Jacket

Black [high] [medium] density, high-molecular weight, polyethylene materials in accordance with ASTM D 4976 shall be applied longitudinally over all the inner jacket and sheathing strength member to form the cable outer jacket. Outer jacket shall be smooth, concentric, non-nutrient to fungus, and free from holes, splits, blisters, or other imperfections. Overall outside cable diameter shall not exceed [19] [_____] millimeter

[0.75] [_____] inch.

2.1.2.12 Metallic Armor

A metallic armor shield for direct buried cable shall be provided for additional tensile strength, rodent protection, and high crush and moisture resistance. Material of the metallic armoring shall be metallic tube or steel corrugation-coated with anti-corrosion material, sealed at the longitudinal overlap.

2.2 CABLE IDENTIFICATION SYMBOL

First of three lines on the ID symbol employ 5 characters.

First and second characters, from left to right, shall denote the number of active optical fibers in the cable.

Third character shall be a slash.

Fourth and fifth characters shall denote optical transmission windows which
the optical fiber can support. These windows are defined herein as follows:

Fourth character shall be an "A" or an "O." The "A" denotes a window at a wavelength of 850 nanometers (nm) with an attenuation of 4 dB/kilometer (km) and a bandwidth of 800 MHz-km. Character shall be an "O" if these requirements are not met.

Fifth character shall be a "B" or an "O." The "B" denotes a window at a wavelength of 1,300 nanometer (nm) with an attenuation of 1.0 dB/km and a bandwidth of 1,000 MHz-km. Character shall be an "O" if these requirements are not met.

Two lower lines of the cable ID symbol indicate multi-mode or single mode
fibers, the cable number and the fiber count:

Example: 72/OB	Identifies the number of optical fibers (72) and the optical transmission window (OB - See preceding paragraph).
FM05 : 61-120	Identifies Multi-Mode Fiber Cable 05 with MM Fibers 61 through 120.
and FS05 : 13-24	Identifies Single Mode Fiber Cable 05 with SM Fibers 13 through 24.

2.3 REPLACEMENT CABLE

In addition to the cable sections indicated, a reel of each size and type
of the manufacturer's furnished cable, not less than 0.5 kilometers shall
be provided.

2.4 SPLICE ORGANIZERS

Single mode or multi-mode fibers shall be fusion spliced with a protective
sleeve covering and stored in an organizer with a minimum of

450 millimeter
18 inches spare coiled buffer tubing. Single mode fibers shall be spliced
last in the splice tray.

A [72] [_____] fiber splice shall be completed in an outer closure.
Organizer assembly, with one tray containing [12] [_____] fusion splices
each requires [five] [_____] extra trays, to form the section complete in
the inner closure.

Space between the inner and outer closures shall be filled with
encapsulating fluid. End plates shall be factory drilled to fit the
cable(s) outer diameter.

2.5 PRE-CONNECTED CABLE ASSEMBLY

Contractor shall supply factory assembled pre-connectorized cable assembly
to interface with the patch panel bulkhead feed-through receptacle.
Contractor shall supply and install dust caps for all terminated fibers.

Multi-mode fiber optic cable assembly shall be comprised of a single fiber
connector, terminated on [three (3)] [_____] meter length of single fiber,
multi-mode cable. Single fiber cable shall contain a buffered optical
fiber and shall be the same as that provided in the multi-fiber cable.

Single fiber optic cable assembly shall be comprised of a single fiber connector terminated on the [three (3)] [_____] meter length of single fiber, single mode cable. Single fiber cable shall contain a buffered optical fiber and shall be the same as that provided in the multi-fiber cable. Return loss for single mode connectors shall be a minimum of [minus 30dB] [_____].

Connector/cable interface on both the single and multi-mode cable
assemblies shall be able to withstand a tensile force of [110] [_____]
newton [25] [_____] pounds without detrimental affects on the connector
loss characteristics.

Each connectorized cable assembly shall have a loss of less than or equal
to [0.5 dB] [_____].

2.6 OPTICAL PATCH PANEL ASSEMBLIES

All cable terminations shall be made in optical patch panel assemblies.
Patch panel assemblies shall be of the pre-assembled chassis type with
associated rack-mounting hardware.

To facilitate the transition between outside plant cable and the preconnectorized cable assemblies, the fibers shall be [fusion] [mechanical] spliced and housed in a splice tray. Splice tray shall be positioned in the optical patch panel assembly as indicated. Splice attenuation shall not exceed [0.2] [_____] db. Splice shall be covered with a protective sleeve.

2.7 FIBER OPTIC TERMINAL CABINETS

FOT cabinets shall be front recess only. Cabinet's frame shall consist of vertical and horizontal tubular aluminum extrusions with a minimum wall thickness of [3.81] [_____] millimeter [.150] [_____] inches. Front to rear aluminum extruded corners shall be at least [3.18] [_____] millimeter [.125] [_____] inches thick. Rear door, top panel, and side panels shall be a minimum of [1.3] [_____] millimeter [18] [_____]-gage steel. Cabinet shall be provided with [1.9] [_____] millimeter [14] [_____] gage steel,
[7.14] [_____] millimeter [.281] [_____] inches punched panel/chassis mounting rails permitting recessed installation of equipment. Cable entry and exit holes shall be placed as indicated. Dimensions of cabinet and associated cabinet hardware shall be as indicated.

Cabinet shall be gray in color in accordance with FED-STD 595.

2.8 FACTORY TEST CERTIFICATES

Fiber optical cable shall comply with the following optical and mechanical
test requirements.

2.8.1 Optical Performance

2.8.1.1 Multi-Mode Fibers in the Cable

Optical attenuation of each optical fiber in the cable (reeled) shall be no greater than 1.0 dB/Km at 1300 plus or minus 50 nm optical spectrum window. Attenuation shall be measured on completed cable reel length, and normalized linearly to 1 Km. Measurement method shall be in accordance with [EIA 455-46A] [EIA 455-53A] at central wavelength 1300 nm nominal.

Bandwidth at minus 3 dB optical power of each optical fiber in the cable (reeled) shall be a bandwidth length product, gamma equals 1, greater than 1 GHz-Km at 1300 plus or minus 50 nm optical spectrum window. Bandwidth measurement shall be in accordance with [EIA 455-30B, frequency domain] [EIA 455-51A time domain] at central wavelength 1300 nm nominal.

Numerical aperture of each optical fiber shall be 0.2 plus or minus 0.015 at 1300 nm optical spectrum window. Method of numerical aperture measurement shall be in accordance with EIA 455-47B, at central wavelength 1300 nm nominal. When this requirement is not met, the fusion splice compatibility test shall be applied.

2.8.1.2 Single-Mode Fibers in the Cable

Optical attenuation of each optical fiber in the cable (reeled) shall be no greater than 0.5 dB/Km at 1300 plus or minus 50 nm optical spectrum window. Attenuation shall be measured on completed cable reel length, and normalized linearly to 1 Km. Measurement method shall be in accordance with EIA 455-78B, at central wavelength 1300 nm nominal.

Pulse dispersion of each optical fiber in the cable (reeled) shall be no greater than 3.5 picosecond/nm-Km within the emissive region of 1285-1330 nm. Measurement method shall be in accordance with [EIA 455-168A] [EIA 455-169A].

Mode field diameter at 1300 nm optical spectrum window shall

be within 10 plus or minus 1 micrometer. Measurement method shall be in accordance with [EIA 455-164A] [EIA 455-165] [EIA 455-167A] at central wavelength 1300 nm nominal. When this requirement is not met, the fusion splice compatibility test shall be applied.

Cut-off wavelength for 1300 nm optical spectrum window shall be within 1200
plus or minus 70 nm. Measurement method shall be in accordance with EIA
455-80B.

2.8.2 Mechanical Performance

2.8.2.1 Minimum Bend Radius

Cable shall be able to withstand bending to a minimum radius of [10]
[_____] times the cable outer diameter without tensile load applied, and of

[20] [_____] times the cable outer diameter with maximum tensile load
applied (during installation), without damage to cable components or
degradation of the optical fiber performance at room temperature.

2.8.2.2 Tensile Strength

Fiber optical cable shall withstand a pull force of at least [1800] newtons
[(400 pounds)] [_____] to be applied to the pulling strength member during
the installation, and a tensile load of at least [300]
[_____] newtons
during operation without incurring any damage or detriment to fiber optical
cable and optical performance. Tensile strength test shall be in
accordance with EIA 455-33A.

2.8.2.3 Flexing or Bending Cycles

Fiber optical cable shall withstand at least [20] [_____] bending cycles at
minimum bend radius without damage to the fiber optic cable components or

degrading optical performance. Cyclic flexing test shall be

in accordance
with EIA 455-104A.

2.8.2.4 Crush Resistance

Minimum crush resistance of the fiber optical cable shall be greater than
650 newton/centimeter (cm) without damage to cable components or degrading
optical performance. Crush resistance test shall be in accordance with EIA
455-41.

2.8.2.5 Impact Resistance

Fiber optical cable shall be capable of withstanding [20] [_____] impacts,
at five newton-meters force, without damage to cable components, or
degradation of optical performance. Impact resistance test shall be in
accordance with EIA 455-25C.

2.8.2.6 Gel Filling Compound Drip Test

Optical cable shall be tested for the ability of the gel filling compound
in the interior of the inner jacket and loose tube buffer to resist flow at
the temperature range of minus 40 degrees C to 60 degrees C in accordance
with EIA 455-81B.

2.8.2.7 Fluid Penetration

Optical cable shall be capable of preventing the entry and axial migration
of pressurized water when subjected to fluid penetration testing in
accordance with EIA 455-82B.

2.9 TEMPERATURE ENVIRONMENT

Fiber optical cable shall comply with the mechanical performance requirements herein while used in duct applications where the temperature varies from minus 8 degrees C to plus 38 degrees C. Optical performance degradation shall be less than [five] [_____] percent of the

optical performance requirements in the temperature range of minus 20 degrees C to plus 60 degrees C. Fiber optical cable shall not be damaged in storage where the temperature may vary from minus 40 degrees C to plus 65 degrees C.

2.10 SPLICE COMPATIBILITY TEST

When the material of the optic fiber is different from Cornings' Class Code No. 1517 for multi-mode graded index fiber and No. 1528 for single-mode fiber, the Splice Compatibility Test shall be performed and documented as follows:

Vendor shall select fiber samples from a minimum of [3] [_____]

different production lots of the fiber type proposed for the job.

Vendor shall fabricate and measure a minimum of [10] [_____] fusion splices using fiber from the different production lots and a sample of Corning fiber, Class Code No. 1517 and No. 1528, supplied by the Government.

Fusion splices shall be measured using an Optical Time Domain Reflectometer (OTDR) operating in the region of 1250 through 1350 nm. The insertion loss of the fusion splice shall be the average of two OTDR measurements, one taken with the OTDR installed on the Corning

fiber, and the other with the OTDR installed on the vendor's fiber. Vendor's fiber and the Corning fiber shall each be a minimum of 1 Km in length throughout the testing.

Vendor's fiber shall be considered compatible with the Corning fiber if the maximum splice insertion loss of each of [10] [_____] fusion splices tested measures less than 0.2 dB.

Vendor shall be allowed a maximum of three retries on any

one splice to
obtain a loss of 0.2 dB or less.

These tests shall be performed under Government supervision.

PART 3 EXECUTION

3.1 FIBER SPLICES

Outside plant fiber splices shall be [fusion] [mechanical] type and made along the fiber route. Splices shall exhibit an insertion loss not greater than 0.2 dB. All splice measurements shall be made at 1300 nm, plus or minus 5 nm. All splices shall be mounted in trays. Number of splices shall not be increased.

Completed splice shall be covered with a protective sleeve heat shrink type
to restore the protective properties of the fiber coating and buffering.
Deviations to the splice, location and pulling plan will be permitted, upon
approval by the Contracting Officer, and shall be provided at no additional
cost to the Government.

All fiber colors shall be continuous from end to end. No switching or staggering of color scheme within the cable at splice points shall be allowed. Fibers shall be spliced in order with multi-mode fibers identified first and single mode fibers at the end.

Cables shall be brought out of the manhole in a controlled environment to perform the fiber fusion splice operation. Splice shall be completed by returning the cable to the manhole such that the excess cable does not impede future entrance and utilization. Cable shall be secured at regular intervals.

3.2 BURIED CABLE INSTALLATION

3.2.1 Location

****
**********NOTE: Buried cable installation refers to the placement of cables directly in the ground without protection other than their own outer coverage (jackets). The overall buried cable installation may include manholes and hand holes, for splicing, terminating and pull-through purposes.

****
****

Location of the cable splice overlaps shall be as indicated. Contractor
shall ensure that all cable ends are sufficiently long before cutting.

3.2.2 Field Staking

When staking the cable plow or trench line, stakes shall be placed at least

every 30 meter 100 feet in level country and more frequently in rolling country or in dense vegetation, so that the construction force can sight at least two successive stakes at all times. Stakes should be placed at changes in direction, the beginning and end of all turns should be staked clearly. Where existing buried cable is encountered within [600] [_____] millimeter [2] [_____] feet of the proposed line, the distance between stakes shall be decreased to a minimum of [3] [_____] meter [10] [_____] feet. When possible, stakes should project above the vegetation along the line. When a road or other crossings are involved, stakes should be placed at both extremes of the right-of-way.

A stake, with the appropriate number or explanation noted on it, should be
used to show the location of each caution point, such as underground
utility crossings and culverts; miscellaneous points, such as physical
cable protection; and buried cable warning sign locations.

3.2.3 Method of Cable Placement

****
**********NOTE: Method used in placing the cable will depend on the exact location of the route, obstructions encountered, soil conditions, and topography of the route. Method which best suits the local conditions and which produces the least amount of disturbance or damage to existing utilities and surrounding areas should be used. Under certain conditions, combinations of placing methods may be advantageous.
****
****

All direct buried cable shall have a warning tape placed above it as

indicated.

Depth of buried cable in soil measured from the top of the cable to the
surface of the ground shall be a minimum of [800] [_____] millimeter [30]
[_____] inches, when existing utilities are crossed, hand excavation shall
be used at a distance of no less than [1.3] [_____] meter [four] [_____]
feet on each side of the utility.

3.2.3.1 Open Trench Method

Contractor shall observe the following when placing cable by the open

trench method:

Trench shall be free of all rock and debris.

Cable shall be pulled from cable reel truck or dolly and shall be

placed in the trench by hand.

Cable shall be placed in trench as soon as practical and backfilled

immediately to avoid cave-in, and ensure safe operational conditions.

An inspector shall walk closely behind the cable reel dolly and ensure
that the cable lies flat on the trench bottom, and is placed at the
required minimum depth.

Cable shall be pulled by hand on each end simultaneously, to remove
excess slack, prior to backfilling.

Trench shall be backfilled in [150] [_____] millimeter [six] [_____]

inch lifts to ensure proper fill. Each backfill lift shall be compacted with hand tamp tools. First lift shall

be hand tamped prior to placing the cable.

3.2.3.2 Direct Plow Method

Contractor shall observe the following when placing cable by the direct

plow method:

Plow shall be clear of any obstruction which may damage cable and
ensure that all rollers on the tractor and on the plow turn freely and
are properly located.

Cable shall be hand fed off the reel at all times to ensure that no
damage is done to the cable due to excess tension.

An inspector shall walk closely behind the plow and inspect the cable
for any blemish or damage, and ensure a free and continuous flow of the
cable from the reel to the plow. Inspector shall ensure that the cable
is plowed at the minimum required depth.

3.2.4 Compaction

****
**********NOTE: The following method of compaction is recommended: Run the tractor track or tire along and immediately adjacent to both sides of the plow slot; fill in any ground depressions which may develop with earth to form a mound over the center of the plow slot; and then run the tractor tire over the center slot. Different soil conditions may warrant that other methods of compaction be employed.
****
****

Plow slot shall be compacted following the plowing in or trenching of wire
or cable.

3.3 UNDERGROUND CABLE INSTALLATION

Inner duct assignment of individual cables shall be as

indicated. Cables

shall not be placed in ducts other than those specified.

Adequate care shall be exercised when handling and storing reels of cable to prevent damage to the cable. Cable with dents, flat spots, or other sheath distortions shall not be installed.

3.3.1 Securing Cable

Immediately after cable placement, a permanent identification tag as indicated shall be attached to visible cable sections. Cables shall be checked to ensure that the markings are intact.

Cables and equipment shall be supported and secured as indicated. Where the specific method of support is not shown, supports and fasteners shall be used to secure cables and equipment in position. Metallic supports and fasteners shall have a corrosion resistant finish. All cables shall be routed along the interior sides of manholes.

Two or more cable hooks shall be required per manhole.

Clamps and straps shall be used as necessary to properly secure the cable.

3.3.2 Bending

Caution shall be used when bending cable to avoid kinks or other damage to the sheath. Bend radius shall be as large as possible with a minimum of

[250] [_____] millimeter [10] [_____] inches. Minimum radius shall be increased when necessary to meet cable manufacturer's recommendation. Cables shall not rest against any sharp edges.

Cable shall be pulled and spliced in the manner and at the locations shown.

3.3.3 Pulling

Pulling lines shall be attached to both cable ends when cable

is destined
for bi-directional pull, and fitted with factory-installed pulling eyes.
Cables not equipped with a pulling eye shall have the pulling line attached
to the cable end by means of a cable grip. Core hitches shall not be used.

Cable reels shall be located and aligned so that the cable is paid out from
the top of the reel into the duct or conduit in a long, smooth bend without
twisting. Cable shall not be pulled from the bottom of the reel. A cable
feeder guide of proper dimensions shall be used at the mouth to guide the
cable into the duct or conduit.

Rigging shall be set up at the pulling end so that the pulling line and cable exit on a line parallel with the duct or conduit to prevent either from rubbing against the edge or mouth. Cable ends shall not be pulled around sheave wheels. When the sheave or pulley cannot be positioned to obtain sufficient cable end slack for proper racking and splicing with the pulling line attached to the end of the cable, a split cable grip may be used to obtain the necessary slack.

3.3.4 Lubricant

Pulling lubricant, shall be used to minimize pulling tension and prevent sheath damage when pulling cables into ducts and conduits. Lubricant shall be applied to the cable sheath with a lubricator. When pulling has been completed, the exposed cable ends shall be wiped clean of lubricant.

Lubricants shall be compatible with and intended for use with plastic-sheathed cables. Soap and grease type lubricants shall not be
allowed.

All equipment and the pulling set shall be checked to minimize interruptions once pulling begins. Cable shall be pulled without stopping until the required amount of the cable has been placed. When the pulling operation is halted before the pull is completed, the tension of the pulling line shall not be released. When pulling is resumed, the inertia of the cable shall be overcome by increasing the tension in small steps a few seconds apart until the cable is in motion. Cable shall be paid from the top of the reel by rotating the reel in the feed direction at the rate of pull. Cable shall not be stripped off the reel by pulling.

3.3.5 Damage and Defects

Contractor shall use a tension monitoring device to ensure that the maximum pulling tension that may be applied to the cable to be pulled into a

conduit section is not exceeded. Any damage to the cable due to exceeding the maximum tension will require a new cable furnished by the Contractor.

Cable shall be carefully inspected for sheath defects or other irregularities as it is paid out form the reel. When defects are detected, pulling shall stop immediately and the cable section shall be repaired or replaced at the discretion of the Contracting Officer. A system of communications shall be maintained between pulling and feed locations so that pulling can be stopped instantly, when required.

Cable shall be hand guided through intermediate manholes and into the next duct section when making pull-throughs. Proper rigging shall be used in the intermediate manhole to keep the pulling line and cable aligned with the exit duct to prevent the line or cable from rubbing against the edge of the duct. Cables in pull-through manholes shall be set up and racked before the cable ends in adjacent manholes are set up and racked.

Cable ends pulled into manholes, vaults, or terminal locations that are not to be racked or otherwise permanently positioned immediately shall be tied in fixed positions to prevent damage to the cables and provide adequate working space.

3.3.6 Seal

Ducts or innerduct in which cable is placed shall be sealed with urethane foam duct seal. This material shall be inserted between the cable and the duct or innerduct of which it is in, between the innerduct and the duct, and in all unused innerduct, in order to prevent damage to the cable sheath and to prevent the entrance of dirt or water into the manhole or vault.

Cables shall be provided in continuous lengths as required to accomplish

the required installation without splices from termination to termination,
except where field splices are specifically shown.

3.4 CABLE INSTALLATION IN CABLE TRAYS

Communication cables shall not be installed in the same cable tray with ac
power cables.

Cables placed in cable trays shall be installed in a neat and orderly
manner and shall not cross or interlace other cables except at breakout
points.

Cables in vertical trays shall be individually retained with straps at a
maximum of [1800] [_____] millimeter [6] [_____] feet on center.

3.5 CABLE DELIVERY

Replacement cable reels shall be delivered to the Government as directed by
the Contracting Officer.

3.6 GROUNDING SYSTEMS

Cables shall be grounded at each termination point or as indicated.

3.7 TESTING

As a minimum, the Contractor shall test each fiber cable before and after
installation for any faults or attenuations using an Optical Time Domain

Reflectometer (OTDR). End-to-end attenuation tests shall also be conducted
after complete installation.

All test equipment, test procedures, and testing techniques shall be specified in the quality assurance plan and will require approval prior to execution. Tests shall be conducted by the Contractor in accordance with the approved Quality

Assurance Plan. Field tests shall be witnessed by the Contracting Officer. Contracting Officer shall be given at least [20] [_____] calendar days notice prior to performing each test.

Each test sheet shall have a sign-off blank for the Contractor as well as the Contracting Officer. Copies of the completed test forms and test results shall be delivered as indicated.

Sequential cable markings along the cable, prior to and after each end of splice point, shall be recorded on the sequential cable form and submitted for approval.

Test results shall be submitted on all installed fiber cabling before and after each pre-connectorized cable assembly splice is completed.

Contractor shall maintain an accurate test record during all field tests.

3.8 TEST REQUIREMENTS

Test equipment used for verifying installation testing shall be calibrated by a certified testing company within [3] [_____] weeks of use.

3.8.1 Single and Multi-mode OTDR Test

The Optical Time Domain Reflectometer (OTDR) shall conform to the following minimum requirements:

Operating wavelengths: [1,300] [_____] plus or minus 20 nanometers

Attenuation Range (one way): minimum [15] [_____] dB at 1,300 nm

Attenuation Resolution: [0.01] [_____] dB

Accuracy: plus [0.5] [_____] dB.

OTDRs shall have digital readout capability and shall have a means of
providing a permanent record in the form of a [strip chart] [photograph]
[_____].

3.8.2 End-to-End Attenuation Tests

An attenuation measurement test set shall consist of an optical power meter and an optical power source. Attenuation measurement test set shall be in accordance with the applicable National Bureau of Standards (NBS) standards for a stable optical source. Meter may be analog or digital. End-to-end attentuation test reading shall be included on the test reference loss. Measurement test set shall conform to the following minimum requirements:

Operating wavelengths: [1,300] [_____] plus or minus 10 nanometers

Attenuation Range: at least [30] [_____] dB at 1,300 nm

Attenuation Resolution: [0.01] [_____] dB

Accuracy: The accuracy of the attenuation measurement test set shall
be plus or minus [5] [_____] percent.

Optical source shall be capable of coupling sufficient power into the fiber
so that the light received at the meter is within the meter delectability
limits.

3.8.3 End-to-End Bandwidth Tests

Bandwidth test shall conform to the following minimum

requirements:Operating wavelengths: [1,300] [_____] plus

or minus 10 nanometersBandwidth range: minimum [1000]

[_____] megahertzBandwidth Resolution: [1] [_____]

megahertzAccuracy: plus or minus [0.5] [_____]

megahertzMeasurement Method: [Swept Frequency] [_____]

-- End of Section -

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USACE / NAVFAC / AFCESA / NASA UFGS-16262N (February 2004)

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

Latest change indicated by CHG tags.
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SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16262N

INSTALLATION OF UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

02/04

PART 1 GENERAL

1.1 REFERENCES

1.2 DEFINITIONS

1.2.1 Uninterruptible Power Supply (UPS)

1.2.2 Battery System

1.2.3 Electrolyte

1.3 SUBMITTALS

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Government-Furnished Equipment (GFE)

1.4.2 Pick-Up

1.4.3 Delivery

PART 2 PRODUCTS

2.1 CONTRACTOR FURNISHED MATERIAL AND EQUIPMENT

2.2 GOVERNMENT-FURNISHED MATERIAL

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Control Cable

3.1.2 Grounding Conductor

3.1.3 UPS Output Conductors

3.1.4 DC Power Conductors

3.1.5 Emergency Control Contacts

3.1.6 Cable Lugs

3.1.7 Seismic Protection

3.1.8 Conduit Entries

3.1.9 Battery Rack Assembly

3.1.10 Battery Cabinet

3.1.11 Battery Installation

3.1.11.1 Positioning Cells

3.1.11.2 Connecting Cells

3.1.11.3 Inter-Rack and Inter-Tier Cables

3.1.12 UPS Spare Parts and Manuals

3.2 UPS TECHNICAL REPRESENTATIVE

3.2.1 Contractor Duties

3.2.2 Installation Inspection

3.3 BATTERY FILLING AND CHARGING

3.3.1 General Instructions for Lead Calcium Alloy Battery

3.3.1.1 Hydrogen Gas Safety Instructions

3.3.1.2 Sulfuric Acid Safety Instruction

3.3.1.3 Battery Filling Instruction

3.3.2 General Instructions for Sealed Type, Valve Regulated Battery

3.3.3 Electrical Safety Instructions

3.3.4 Battery Charging Instructions

3.3.5 Battery Refreshing Charge Instructions

3.3.6 Float Charge

3.4 FIELD QUALITY CONTROL

3.4.1 UPS Unit Performance Test

3.4.1.1 Emergency Generator Operation

3.4.2 Battery Performance Test (Constant KW)

3.5 FINAL ADJUSTMENTS

3.6 DISPOSAL

-- End of Section Table of Contents -

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USACE / NAVFAC / AFCESA / NASA UFGS-16262N
(February 2004)

Preparing Activity: NAVFAC MasterFormat™ 2004 - 26 32 33.00 20
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SECTION 16262N

INSTALLATION OF UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

02/04

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NOTE: This guide specification covers the requirements for Installation of Government-furnished\Contractor installed Uninterruptible Power Supply (UPS) System.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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**********N
OTE: This guide specification will be used in the preparation of project documents for installation of Government-furnished UPS systems. (Navy-type UPS).
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NOTE: This section contains Appendix A, "UPS Manufacturer's Installation Drawings" and Appendix B, "Battery Manufacturer's Rack Assembly and Battery Installation Instructions."

Appendices must be obtained from NFESC ECDET, Code 65, BLDG 218, 901 M Street SE, Washington Navy Yard, Washington, DC 20374-5063, Telephone: (202) 433-2515, DSN 288-2515, Fax (202) 433-6379.

All plans/specifications having uninterruptible power supply systems, which were procured as Government-furnished/Contractor installed equipment,
must be reviewed and concurred by NFESC ECDET,

Code

65.
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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 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.

****

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.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2005) National Electrical Code

1.2 DEFINITIONS

1.2.1 Uninterruptible Power Supply (UPS)

The uninterruptible power supply system described herein shall denote a solid state power system which will provide continuous regulated single

phase or three phase AC power at its output terminals, while operating from
either an AC power source or from a battery system.

1.2.2 Battery System

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**NOTE: Sealed battery or valve regulated is more commonly known as maintenance free battery. The term maintenance free is a misnomer, since all battery systems require maintenance. The term "maintenance free" signify that no water may be added to the cell.
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The battery is an electrochemical device that stores energy at one time for
use at another. The energy is stored in chemical form and converted to electrical form during discharge, in the event of AC power failure. Battery
system may be lead calcium alloy type, water must be added in the cells, or
sealed type, (valve regulated), water cannot be added in the cells.

1.2.3 Electrolyte

The acid solution surrounding the plates of a battery cell, usually

consisting of 1.250 specific gravity sulfuric acid.

1.3 SUBMITTALS

****
**NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A “G” following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a “G”. Only delete an existing “G” if the submittal item is not complex and can be reviewed through the Contractor’s Quality Control system. Only add a “G” if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force
and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

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NOTE: Typical installation and module arrangement

shall be based in accordance with manufacturer's installation drawings. Installation drawings may be
obtained from NFESC ECDet, Code 65.

****

Overall dimensions, front view, and sectional view; G

Typical installation and module arrangement; G

Ventilation and exhaust system; G

Submit drawings for [UPS] and [battery] installation.

SD-03 Product Data

Inter-rack and inter-tier cables; G

Control cable; G

Cable lugs; G

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Government-Furnished Equipment (GFE)

The Government will furnish various components and equipment listed in article entitled "GOVERNMENT-FURNISHED MATERIAL" for installation by the
Contractor.

[1.4.2 Pick-Up

The GFE will be available on [_____]. Contractor shall pickup, transport form [_____], unload, unpack and install all GFE. The Contractor shall notify Contracting Officer [_____] calendar days in advance of the date the GFE is required for installation. The GFE shall be unpacked by Contractor in the presence of Contracting Officer to determine damage or missing parts. Contractor shall be responsible for damages sustained by the materials and equipment after this inspection. UPS equipment is heavy and easily damaged. Do not bump or bounce equipment at any time. When lifting, do not tip beyond 0.087 radians 5 degrees.

][1.4.3 Delivery

Activity will receive, store and deliver the GFE to jobsite. Contractor shall unload, unpack, and install GFE. Notify Contracting Officer [_____] calendar days prior to when delivery on the site is required. GFE shall be unpacked in the presence of Contracting Officer to determine damage or missing parts. Contractor shall be responsible for damage sustained by the materials and equipment after this inspection. UPS equipment is heavy and easily damaged. Do not bump or bounce equipment at any time. When lifting, do not tip beyond 0.087 radians 5 degrees.

]PART 2 PRODUCTS

2.1 CONTRACTOR FURNISHED MATERIAL AND EQUIPMENT

Materials, equipment, and devices not specifically indicated or specified
to be Government Furnished-Contractor Installed, shall be Contractor Furnished-Contractor Installed (CFCI). Such equipment required to provide

the completely operable UPS installation includes, but is not necessarily
limited to, conduit, conduit fittings, insulated conductors, compression
lugs, cable trays, supports, fasteners, and other such items.

2.2 GOVERNMENT-FURNISHED MATERIAL

The Government will furnish the following components of the UPS system:

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NOTE: This information may be obtained from NFESC
ECDet, Code 65.

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a. [_____][One]-[_____] KVA - [_____] (Volts) UPS Systems. Type: [Non-Redundant] [Parallel Redundant].

b. [_____][One]-[Maintenance Bypass Cabinets] [System Control Cabinet(s)]

c. [_____][One]-Remote Monitor Panels

d. [_____][One]-3 Pole Motor Operated Battery Circuit Breakers

e. [_____][One] Battery system(s) each consisting of [182] [192]

[210] [240] [_____] cells, inter-cell connecting hardware, terminal connectors, connector bolt package, solderless lugs, cell identification decals, and miscellaneous hardware. This does not include tier-to-tier or rack-to-rack cables specified in paragraph entitled "Inter-Rack and Inter-Tier Cables." The battery cells are as follows:

Cell type: [_____]

Cell dimensions: [_____]

Cell weight (dry): [_____]

Electrolyte per cell: [_____]

f. [_____](Each)-[_____] foot battery rack(s) [standard], [shock protected], [seismic] type, each weighing [_____] kg [_____] lbs.

g. [_____](Each) battery cabinets each weighing [_____] kg [_____] lbs.

h. [_____](Each) 56.83 liters 15 gallon DOT 37P-2U poly-lined steel
drums of electrolyte. Each drum of electrolyte weighs
approximately 77 kg 170 pounds.

PART 3 EXECUTION

3.1 INSTALLATION

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NOTE: Manufacturer's installation drawing, wiring
diagrams, battery, racks and cabinets' information

shall be obtained from NFESC ECDet, Code 65. Appropriate information and data will form an integral part of these specifications.

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Conform to the requirements for electrical equipment installations specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM, to the requirements specified herein, and in strict accordance with NFPA 70, and manufacturer's installation drawings and wiring diagrams to include overall dimensions, front view, and sectional view, typical installation and module arrangement, and ventilation and exhaust system. During and after installation, until the system is accepted by the Contracting Officer, Contractor shall protect UPS equipment, including batteries, from moisture, dust, and contamination. Upon completion of the UPS system installation, Contracting Officer and UPS manufacturer's technical representative will inspect the installation for contract compliance. Contractor shall correct installation deficiencies as directed.

3.1.1 Control Cable

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**NOTE: UPS sizes 200 KVA and above are shipped in sections. Control wiring between module sections will be connected by the UPS manufacturer's technical representative.
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UPS control wiring shall be stranded type and must be installed in individual separate rigid steel conduits. Tag control wires with numeric identification tags corresponding to the terminal strip location to where the wires are connected. In addition to manufacturer's requirements, provide four additional spare conductors between UPS module and remote alarm panel in same conduit. When routing control cables inside UPS module, maintain a minimum 155 mm 6 inches separation from power cables.

3.1.2 Grounding Conductor

Provide an insulated equipment grounding conductor in feeder and branch circuits. Conductor shall be separate from the electrical system neutral conductor. Ground battery racks and battery breaker cabinets with a separate equipment grounding conductor to the UPS cabinet.

3.1.3 UPS Output Conductors

Isolate the UPS output conductors from the UPS cabinet to the critical load
panels and from other conductors by installing in separate conduit. Isolation shall prevent inductive coupling from other conductors.

3.1.4 DC Power Conductors

When installed in conduits, place DC power conductors from the UPS

cabinet
to the battery circuit breaker such that each conduit contains an equal number of positive and negative conductors, for example, two positive and
two negative conductors in each conduit.

3.1.5 Emergency Control Contacts

Provide normally open contacts for each UPS system to signal when power is
supplied to the UPS from emergency engine generators. Installation shall conform to manufacturer's installation drawings.

3.1.6 Cable Lugs

Provide appropriate compression type lugs on all AC and DC power connections to the UPS system and battery as required. Aluminum or bare
copper cable lugs are not suitable.

3.1.7 Seismic Protection

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**NOTE: If zone is not considered to be seismic, text below shall be deleted. If seismic zone, applicable local regulations shall be referenced.
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For UPS installations within Seismic zones [1] [2] [3] [4], provide equipment anchor to protect against seismic shock in accordance with applicable local regulations.

3.1.8 Conduit Entries

Provide conduits using the available conduit areas shown on manufacturer's
installation drawings. Conduit entries shall not be made through the front, side or rear panels of the UPS or [Maintenance Bypass Cabinets] [System Control Cabinet].

[3.1.9 Battery Rack Assembly

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NOTE: Choose this paragraph or the one below entitled "Battery Cabinet".

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Battery racks are shipped dismantled in separate rail, frame, and brace packages. Ensure that necessary assembly hardware is included in the frame packages. Installation of battery racks shall conform to the manufacturer's instructions provided as Attachment B to this section.

][3.1.10 Battery Cabinet

Battery cabinets are factory assembled and are suitable for 25, 50 and 100
KVA UPS systems.

]3.1.11 Battery Installation

Installation of battery shall conform to the manufacturer's instructions
provided in Attachment B.

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**NOTE: Appendix B provides information on the type of battery used in the UPS application. This information will include battery and racks data, mounting information, charging instruction, etc. It is the Contractors responsibility to familiarize himself with this information prior to the start of work.
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3.1.11.1 Positioning Cells

Use lifting belt and spreader when lifting the cells with mechanical equipment such as a crane or hoist. Install cells on racks in accordance with manufacturer's instructions. Ensure each hydrometer tube is located on aisle side of each cell.

3.1.11.2 Connecting Cells

Cleaning contact surfaces, application of no-oxide grease, and connection
of cells shall be in accordance with the manufacturer's instructions. No-oxide grease is applied only on connection surfaces.

3.1.11.3 Inter-Rack and Inter-Tier Cables

Provide flexible, welding type cable for all inter-rack and inter-tier connections. Number and size shall be as indicated. Battery cables shall have a long bending radius to avoid excessive stress at the point of termination.

3.1.12 UPS Spare Parts and Manuals

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**NOTE: Three (3) volumes of UPS maintenance manuals are provided as part of the UPS package. These manuals are not commercially available and contain proprietary information. Additional manuals must be procured by NFESC ECDet, Code 65.
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Three volumes of the UPS maintenance manuals and one package of spare parts
are shipped with the UPS equipment. Perform inventory and store these items until notified by the Contracting Officer.

3.2 UPS TECHNICAL REPRESENTATIVE

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**NOTE: The UPS manufacturer's technical representative will inspect the completed UPS and battery installation as part of the UPS procurement package, and at no additional cost to the activity. The representative's visit to the site must be scheduled by NFESC ECDet, Code 65. If the station or Contractor requests UPS technical representative's services without notifying Code 65, they may incur additional expenses.
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Contractor shall notify Contracting Officer in writing at least 45 calendar days prior to completion of the UPS system installation. At this time the Contracting Officer, via NFESC ECDet, Code 65, will schedule the UPS manufacturer's technical representative to inspect the completed installation. The UPS technical representative will provide 15 days of service including five days of instruction for activity personnel. The following items shall be completely installed by the Contractor and be operational prior to the arrival of the UPS representative for inspection, unit start-up and testing:

a. Ventilation equipment in the UPS and battery rooms.

b. Battery [racks][cabinets] and cells. Cells shall not be filled with electrolyte until directed by the Contracting Officer. This is not applicable for maintenance free battery.

c. Battery connections including cell-to-cell, tier-to-tier, and rack-to-rack connections, with correct polarity;

d. DC power and control connections between UPS and battery circuit
breaker, with correct polarity;

e. DC power connection between battery circuit breaker and battery,
with correct polarity;

f. Clockwise phase rotation of AC power connections;

g. AC power to rectifier input bus;

h. AC power to UPS bypass input bus;

i. AC power to UPS maintenance bypass circuit breaker;

j. AC power from UPS output to UPS maintenance bypass output circuit breaker;

k. Remote monitors and control wiring;

l. UPS system and battery system properly grounded;

m. Emergency shower and eye wash;

n. Control connections between UPS and emergency engine generator signal contacts;

o. Control connections between UPS modules and [UPS maintenance bypass cabinet][system control cabinet]; and

p. Clean and vacuum UPS and battery room floors, battery cells, and UPS equipment, both inside and outside.

3.2.1 Contractor Duties

Prior to the arrival of the UPS technical representative, Contractor shall furnish the following for testing:

a. Load bank with temporary jumper cables, unless provided as CFCI equipment in the contract, and

b. Calibrated digital voltmeter with 0.01 volt resolution.

3.2.2 Installation Inspection

The UPS technical representative and the Contracting Officer, in the presence of the Contractor, will inspect the completed installation. The Contractor shall correct construction or installation deficiencies as directed.

3.3 BATTERY FILLING AND CHARGING

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NOTE: Battery system provided is either lead calcium alloy type or sealed (valve regulated) type.

Use appropriate instructions.
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Inspection of the battery installation, filling, charging and testing shall be supervised by an authorized representative of the battery manufacturer. Representative shall supervise and instruct the Contractor as to the proper installation, charging, and testing procedures described herein for the battery system. Contractor shall be responsible for arranging and paying costs of the battery manufacturer's representative. The following instructions shall be read completely before commencing

work on the battery:

[3.3.1 General Instructions for Lead Calcium Alloy Battery

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NOTE: Delete paragraph and subparagraph if sealed
(valve regulated) battery is used.

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a. Only authorized personnel who have been thoroughly familiarized with battery installation, charging, and maintenance procedures will be permitted access to the battery room.

b. During initial activation, monitor the battery continuously for electrolyte level, specific gravity, temperature, voltage, and current. Record measurements every hour.

c. Use only distilled water in the battery cells.

d. During the activation charging cycle it may be necessary to provide additional ventilation to maintain a low ambient temperature in the area of the charging cells. This is to prevent a possible heat induced boil-over of the cell's electrolyte.

e. During the activation charging cycle, Contractor shall provide a
chemical agent, such as soda ash or baking soda, capable of neutralizing electrolytic fluid, in sufficient quantity to safely neutralize any spill or boil-over of electrolyte.

f. At all times while in the battery room, personnel shall wear the proper safety items as deemed necessary by their task. This shall include, but not be limited to, face shield, impermeable apron, and acid resistant boots and gloves. Contractor shall provide one extra set of safety equipment for Contracting Officer.

[3.3.1.1 Hydrogen Gas Safety Instructions

a. During activation and operation of the battery, hydrogen gas is formed. Hydrogen gas is extremely explosive when ignited. Contractor shall ensure sufficient ventilation is provided to prevent the hydrogen level from exceeding a one percent concentration by volume of the space in the battery room.

b. An essentially fully charged battery will generate a maximum of 0.00045 cubic meter 0.016 cubic feet of hydrogen (measured at 25

degrees C and 760 mm Hg absolute pressure) per hour from each cell
for each ampere of charging current. When necessary, additional ventilation may be required during activation charging cycle.

c. Never bring burning material such as lit matches, cigarettes, lighters, or any type of spark producing material or devices into
the battery room or adjacent to any cell.

][3.3.1.2 Sulfuric Acid Safety Instruction

a. During handling of the electrolytic fluid, personnel shall wear the appropriate safety clothes, as previously specified.

b. Exercise the utmost caution to avoid spilling electrolyte. When acid comes in contact with the eyes or skin, immediately flush and rinse with water and consult a physician. Bicarbonate of soda solution (one pound per gallon of water) will neutralize acid spilled on clothing or material. Apply the solution until bubbling stops, then rinse with clear water. In the event of acid spill or accident, notify the Contracting Officer as soon as practical.

c. Utilize only approved hydrometers and thermometers for monitoring the cells. Automotive hydrometers are not acceptable. Contractor shall provide sufficient quantities of both instruments so as to provide time efficient and accurate specific gravity and temperature measurements.

][3.3.1.3 Battery Filling Instruction

After the UPS technical representative has inspected the UPS and demonstrated proper operation of the UPS rectifier, Contracting Officer will instruct Contractor to perform battery filling and charging in accordance with the following instructions:

a. Clean each cell thoroughly with a cloth dampened in clear water and wipe dry with a clean cloth prior to filling the cells with electrolyte.

b. Ensure battery connections are properly torqued to manufacturer's specifications. Torque values are given in mN-m inch-lbs. Take and record, for cell-to-cell and terminal connections, detailed micro-ohm resistance readings before placing battery in service. Remake connections having a resistance of more than 10 percent above the average. Test equipment and procedure must be approved by the Contracting Officer.

c. Electrolyte in the containers may have stratified. Contractor shall ensure the specific gravity is between 1.205 and 1.220 by agitating each electrolyte container until the specific gravity is within the required range.

d. Once a specific gravity between 1.205 and 1.220 is measured, and the UPS rectifier is fully operational, remove the shipment vent plug from each cell and fill cells with electrolyte. Use the screw-in plastic shut-off nozzles provided with the electrolyte containers. Contractor shall provide all hoses necessary for filling the cells. Equipment used for filling the cells shall be free of any metal to prevent electrolyte contamination.

e. The filling height of the electrolyte shall not be higher than 6 mm 1/4 inch below the bottom of the low level line.

f. Install a flame-arrestor vent in each cell immediately after filling the cell. Lock in place with a one-quarter turn in a clockwise direction. Then install a dust cover cap on the top of each flame arrestor. CAUTION: Do not remove the flame arrestor vents after initial filling.

g. Allow the battery to stand open circuit a minimum of four hours after filling the last cell. Add acid through the funnel of the

flame arrestor or the electrolyte sampling tube to again bring the electrolyte level to 6 mm 1/4 inch below the bottom of the low level line.

h. Commence charging after the required stand period but no later than 12 hours after the filling of the first cell.

]][3.3.2 General Instructions for Sealed Type, Valve Regulated Battery

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**
NOTE: Delete paragraph if lead calcium alloy battery is used.

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a. Only authorized personnel who have been familiarized with battery installation, charging, and maintenance procedures will be permitted access to the battery room.

b. At all times while in the battery room, personnel shall wear the proper safety items as deemed necessary by their task. This shall include, but not be limited to, face shield, impermeable apron, and acid resistant boots and gloves. Contractor shall provide one spare set of safety equipment for Contracting Officer.

c. These cells are sealed and do not present an acid danger. However if the container is damaged, exposure to acid could occur.

d. Sealed batteries will vent potentially explosive gases, particularly in the event of a charger malfunction. Never bring any burning material such as lit matches, cigarettes, lighters, or any type of spark producing material or devices into the battery room or adjacent to any cell.

e. Cells connected in series have high voltages that could produce a shock hazard. Do not ground the DC system. If a ground is placed at one end of the battery, an increased shock hazard exists between the opposite end of the battery and ground. Also, if another ground should develop within the system, it may create a short circuit which could start a fire.

f. Ensure that bolted battery connections are torqued to the recommended values. Loose connections can cause excessive resistance between cells.

g. Do not lift cell by its terminal posts as this can damage the battery. Under no circumstance attempt to remove the pressure relief valves, vents or vent covers as this will prevent proper

function of the battery.

]3.3.3 Electrical Safety Instructions

a. Cells connected in series have high voltage potentials that produce shock hazards.

b. Discharge static electricity from the body before touching cell terminal posts by first touching a grounded surface such as the grounded battery racks.

c. Only insulated tools shall be used when working on the battery cells during and after activation charging has begun. Never place metal tool on the top of cell.

d. Only approved digital voltmeters shall be used in monitoring the cells. Digital volt meters shall provide a minimum of .01 volt resolution.

[3.3.4 Battery Charging Instructions

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**NOTE: This paragraph is applicable to the lead calcium alloy type battery. Delete if sealed (valve regulated) battery is used.
****
*

Contracting Officer will coordinate the battery charging process with Contractor and UPS technical representative. UPS technical representative will instruct the Contractor on adjusting the rectifier voltage as required by the procedure. Battery charging is the Contractor's responsibility. Contractor shall provide the manpower, including an authorized representative of the battery manufacturer, and equipment necessary to continuously monitor and control the battery charging process.

a. The minimum charge required by each cell is [_____] Ampere-Hours.

The maximum charge current is [_____] Amps.

Therefore, the absolute minimum charging time is [_____] Continuous Hours.

<u>Overtime will be required!</u>

b. Provide temporary cables required for charging. This cable shall be the same size as used for the tier-to-tier and rack-to-rack connections. Coordinate the charging configuration of the battery with the battery manufacturer's representative and UPS technical representative.

c. Prior to the actual start of the activation charge, pilot cells shall be designated by the Battery manufacturer's representative.

Pilot cells will be designated to obtain an average mean of the battery. A minimum of 19 cells within the battery will be designated as pilot cells. If, by feeling cell jars during charging, warmer cells are noted, they shall be made pilot cells also.

d. Technical direction on the actual activation charging cycle will

(2) Specific gravity.

(3) Temperature.

k. Upon completion of the activation charge, Contractor shall return
the battery to its normal operating configuration.

be provided by the UPS and Battery manufacturer's representatives. This direction includes but is not limited to analysis of individual and pilot cell data, adjusting the UPS rectifier output voltage and current, the removal of electrolyte and addition of distilled water for the adjustment of the cell specific gravity and ensuring the battery is charged to the minimum ampere hour-rating. The UPS technical representative will also provide the Contractor with a phone number where he can be contacted after regular working hours should there by any problems with the UPS during the charging period.

e. Immediately before starting the activation charge, measure and record the following:

(1) Voltage of each cell.

(2) Specific gravity of each cell.

(3) Temperature of each cell.

f. Measure and record the open circuit voltage of the parallel connection. Turn-on the rectifier and adjust the voltage control to the open-circuit voltage reading. Close the battery circuit breaker and adjust the rectifier voltage control until charging current is at maximum limit specified herein. Continue charging at maximum rate (unless temperature limits are exceeded) for minimum ampere-hours specified herein.

g. At the start of the activation charge the following measurements shall be taken and recorded :

(1) Time at start of charge.

(2) Current at start of charge.

(3) Voltage at start of charge taken at the battery terminals.

h. The following measurements shall be taken and recorded on an hourly basis until the end of charge:

(1) Battery voltage taken at the battery terminals.

(2) Charging current.

(3) Cell voltage, specific gravity and temperature of each pilot cell.

i. Do not permit cell temperatures to exceed 43 degrees C 110 degrees F. If temperature is exceeded, interrupt the charge until the cells cool down to 38 degrees C 100 degrees F. Then resume charging. Record times of interruptions. Ensure batteries are charged for the full number of minimum ampere-hours required.

j. At the completion of the activation charge, as determined by the Battery manufacturers' representative, the following measurements of ALL cells shall be taken and recorded:

(1) Cell voltage.

][3.3.5 Battery Refreshing Charge Instructions

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**********NOTE: This paragraph is applicable to sealed (valve regulated) battery. Delete if lead calcium alloy battery is used.
****
****

****
**********NOTE: Recommended refreshing charge values are applicable to cell temperatures between 15 degrees to 32 degrees C 60 degrees to 90 degrees F. For cell temperatures 4 to 15 degrees C 40 degrees to 59 degrees F use twice the number of hours. For cell temperatures 4 degrees C 39 degrees F and below, use four times the number of hours.
****
****

Contracting Officer shall coordinate the battery refreshing charge process with Contractor and UPS technical representative. The only acceptable method of giving a refreshing charge is constant voltage. UPS technical representative will instruct Contractor on adjusting the rectifier voltage as required by this process. Battery refreshing charge is Contractor's responsibility. Contractor shall provide the manpower, including an authorized representative of the battery manufacturer, and all necessary equipment to monitor the refreshing charge process.

a. The refreshing charge shall be determined by the

maximum voltage
that the connected equipment can tolerate, and of
that which the
charger can deliver.

Divide the voltage by the number of cells in the battery, and charge at
that voltage; provided it does not exceed 2.40 volts per cell 25 degrees C
77 degrees F. After the charge current has tapered and stabilized for 24
hours, continue the charge for the number hours as follows:

Refreshing Charge

CELL VOLTS	MIN. HOURS TO CHARGE
2.22	[_____]
2.27	[_____]
2.30	[_____]
2.35	[_____]
2.40	[_____]

DO NOT EXCEED 2.40 VOLTS PER CELL 25 DEGREES C 77 DEGREES F.

]3.3.6 Float Charge

a. The UPS technical representative will adjust UPS for float
operation.

b. Allow battery to float for a minimum of 72 hours to permit cell
voltages to stabilize.

c. Measure and record voltage, specific gravity and temperature of
each cell.

d. Should the float voltage of any cell read below 2.08 volts DC or
the specific gravity read less than 1.190 corrected to 25 degrees C

77 degrees F, remove cell from battery and connect the two adjacent cells with a short length of cable to maintain series connection of remaining cells. Discharge performance test may be conducted with one or more cells missing; however, discharge time will be reduced accordingly. NOTE: The rectifier output voltage to battery on float shall be reduced by 2.25 volts for each cell removed from battery. Additionally, when battery is on equalize, rectifier output voltage must be reduced by 2.33 volts for each cell removed. UPS alarms shall be adjusted as necessary. Notify Contracting Officer immediately if it becomes necessary to remove any cell. Defective cells should be replaced as soon as possible. Contractor, via Contracting Officer, shall contact NFESC ECDet,
Code 65 for assistance.

3.4 FIELD QUALITY CONTROL

Contractor shall be on-site during UPS system testing. Provide equipment, test instruments, power, load bank, materials and labor required for tests. Contracting Officer will witness all tests and the tests shall be subject to his approval. Defects resulting from improper handling or installation shall be corrected by the Contractor and retested at no additional cost to the Government. Defects resulting from non-Contractor furnished equipment failure shall be repaired by equipment manufacturer. Contracting Officer will make final decisions as to whether a failure was due to improper installation or defective non-Contractor furnished equipment.

3.4.1 UPS Unit Performance Test

Upon completion of battery activation procedures and as directed by
Contracting Officer, Contractor shall connect load bank to UPS output.
Load bank required shall be determined by the following:

UPS KVA RATING X 0.8 = KW of LOAD BANK

Performance test is to be run under the supervision of the UPS technical representative. UPS unit shall be operated under full load for a minimum of one hour. Contractor shall be required to operate feeder and bypass power feeder breakers during testing of the UPS.

[3.4.1.1 Emergency Generator Operation

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NOTE: Delete this paragraph if an emergency generator is not required.

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Test UPS to observe operation with emergency generator service. UPS technical representative shall verify UPS battery current limiting feature functions properly.

]3.4.2 Battery Performance Test (Constant KW)

Furnish all labor, material and test equipment necessary to conduct performance test under the direction of UPS technical representative. The following shall be accomplished:

a. Install a calibrated voltmeter across the battery terminals to measure voltage, and install a calibrated voltmeter across the UPS DC shunt to read charging current. UPS technical representative will advise connection to DC shunt.

b. Record temperature of pilot cells in battery immediately prior to start of discharge performance test.

c. Read and record total battery voltage and battery current at start of discharge and every minute during discharge test.

d. Record minutes and seconds when battery voltage drops below minimum discharge voltage of 291 volts DC. On initial discharge test, a battery may be expected to deliver 95 percent of its rated capacity. This will increase to 100 percent after several complete discharge cycles or after 12 months of float charge service.

e. Should battery fail to meet the requirements of the first discharge performance test, open the inverted output breaker. Then put battery on equalizing charge, with rectifier adjusted to normal equalizing voltage of [424] [_____] volts DC. Equalize for a minimum of [100] [_____] hours. Measure and record time and battery voltage. Run a second discharge performance test.

3.5 FINAL ADJUSTMENTS

a. Remove load bank and reconnect system for normal operation.

b. Equalize battery at [424] [_____] volts for a period of [72] [_____] hours.

****
NOTE: Delete this test if battery is sealed (valve regulated) type.

****

c. Bring electrolyte level of all cells up to the bottom of the high level line by adding original filling gravity electrolyte.

d. Resume charging battery at normal float voltage of [411] [_____] volts DC.

e. Check battery connections are properly torqued to manufacturer's specifications. Take and record, for cell-to-cell and terminal connections, detailed micro-ohm resistance readings. Remake connections having a resistance of more than 10 percent above the average.

f. All manufacturer's data and operation manuals, which are an integral part of, and shipped with UPS, shall be delivered to Contracting Officer.

3.6 DISPOSAL

Upon completion of UPS installation and testing, Contractor shall remove and dispose of empty, partially full and excess acid drums, including shipping containers, obsolete batteries, and obsolete UPS modules. Removal shall be accomplished off-base and in conformance with local laws and regulations regarding disposal of hazardous material.

-- End of Section -

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USACE / NAVFAC / AFCESA / NASA UFGS-16713N (February 2003)

Preparing Activity: NAVFAC MasterFormat™ 2004 - 40 95 33.23 20
Superseding
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

Latest change indicated by CHG tags.
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SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16713N

FIBER OPTIC (FO) OUTSIDE PLANT (OSP) MEDIA

02/03

PART 1 GENERAL

1.1 REFERENCES

1.2 RELATED REQUIREMENTS

1.3 SUBMITTALS

1.4 QUALITY ASSURANCE

1.4.1 Fiber Optic System

1.4.2 Fiber Optic Cable Installer and Splicer Qualifications

1.4.3 Fiber Optic System Instructions

1.4.4 Manufacturer's Qualifications

1.4.5 Fiber Optic Factory Test Plan

1.4.6 Fiber Optic Field Tests Plan

1.5 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Fiber Optic Media Types

2.1.1.1 Multi Mode Fiber Media

2.1.1.2 Single Mode Fiber Media.

2.2 FIBER OPTIC SPLICES

2.3 FIBER OPTIC ENCLOSURES

2.4 FIBER OPTIC TERMINATIONS AND CONNECTORS

2.5 FIBER OPTIC PATHWAY SYSTEM

2.5.1 Conduit

2.6 FACTORY FO QUALITY CONTROL

2.7 PREPARATION FOR DELIVERY

2.8 FACTORY REEL TEST

2.9 MISCELLANEOUS ITEMS

2.9.1 FO Media Tags

2.9.2 Buried Warning and Identification Tape

2.9.3 Grounding Braid

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Contractor Damage

3.1.2 Direct Burial System

3.1.2.1 Media Placement

3.1.2.2 Identification Slabs (Markers)

3.1.3 Underground Duct

3.1.3.1 Connections to Existing Maintenance Holes [and Handholes]

3.1.3.2 Connections to Concrete Pads
3.1.3.3 Connections to Existing Ducts

3.1.4 Reconditioning of Surfaces

3.1.4.1 Unpaved Surface Treatment

3.1.4.2 Paving Repairs

3.1.5 Cable Pulling

3.1.5.1 FO Media Tensions

3.1.5.2 Pulling Eyes

3.1.5.3 Installation of Media in Maintenance Manholes, Handholes, and Vaults

3.1.6 Aerial Media Installation

3.1.6.1 Aerial FO Media

3.1.7 Grounding

3.1.8 Housekeeping

3.2 FIELD QUALITY CONTROL

3.2.1 Field Reel Tests

3.2.1.1 Reel Test Results

3.2.2 Final Acceptance Tests

3.2.2.1 Test Results

-- End of Section Table of Contents -

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SECTION 16713N

FIBER OPTIC (FO) OUTSIDE PLANT (OSP) MEDIA

02/03

****
NOTE: This guide specification covers the requirements for exterior cabling requirements for fiber optic (FO) media and pathway systems to support Navy communications systems at Navy shore installations including piers and permanently constructed buildings.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.
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**********N
OTE: This specification covers outside plant (OSP) campus media for supporting Information Technology Transfer systems to include voice, data, video, imaging, security, and audio systems used by various Navy platforms. Navy designs shall provide a minimum of 12 fibers plus 25 percent spare capacity service to each facility. Pier projects shall provide a minimum of 16 fibers plus 25 percent spare capacity to pier enclosures. Shore to ship media may be government furnished umbilical assemblies with pre-installed connectors to mate with shore receptacle stations. Navy systems for interconnection to Defense Information Systems Agency (DISA) networks must be compatible with

MIL-STD-188-176. This guide specification is to be used in the preparation of project construction specifications.

****

PART 1 GENERAL

1.1 REFERENCES

****
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 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.

****

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.

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA EIA/TIA-455-59	(1989) Measurement of Fiber Point Defects Using an OTDR
EIA EIA/TIA-455-78A	(1990; R 1998) Spectral-Attenuation Cutback Measurement for Single-Mode Optical Fibers
EIA TIA-758	(1999) Customer-owned Outside Plant Telecommunications Cabling Standard, including Addendum No. 1
EIA TIA/EIA-455-107A	(1999) Component Reflectance or Link/System Return Loss using a Loss Test Set
EIA TIA/EIA-455-B	(1998) Test Procedures for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and

other Fiber Optic Components (ANSI)

EIA TIA/EIA-472D000-A (1993) Fiber Optic Communications Cable for Outside Plant Use

EIA TIA/EIA-472DAAA (1993) Detail Specification for All Dielectric Fiber Optic Communications Cable for Outside Plant Use Containing Class 1a 62.5 Um Core Diameter/125 um Cladding Diameter/250 um Coating Diameter Fiber(s).

EIA TIA/EIA-4750000-C (1996) Generic Specifications for Fiber Optic Connectors (ANSI)

EIA TIA/EIA-526-14A (1998) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant (ANSI/TIA/EIA-526-14A)

EIA TIA/EIA-526-7 (1998) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant (ANSI/TIA/EIA-526-7)

EIA TIA/EIA-568-B.1 (2001; Addendum 2001) Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements (ANSI/TIA/EIA-568-B.1)

EIA TIA/EIA-568-B.3 (2000; Addendum 2002) Optical Fiber Cabling Components Standard (ANSI/TIA/EIA-568-B.3)

EIA TIA/EIA-569-A (1998; Addenda 2000, 2001) Commercial Building Standards for Telecommunications Pathways and Spaces (ANSI/TIA/EIA-569-A)

EIA TIA/EIA-590-A (1997) Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant

EIA TIA/EIA-598-B (2001) Optical Fiber Cable Color Coding

EIA TIA/EIA-604-3A (2000) FOCIS 3 Fiber Optic Connector Intermateability Standard - Standard Type SC

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)IEEE C2 (2002) National Electrical Safety CodeINSULATED CABLE ENGINEERS ASSOCIATION (ICEA)ICEA S-87-640 (1999) Fiber Optic Outside Plant Communications CableNATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA RN 1 (1998) Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

NEMA TC 2 (2003) Electrical Polyvinyl Chloride (PVC) Tubing and Conduit

NEMA TC 3 (2004) Polyvinyl Chloride PVC Fittings for Use with Rigid PVC Conduit and Tubing

NEMA TC 6 & 8 (2003) Polyvinyl Chloride PVC Plastic Utilities Duct for Underground Installations

NEMA TC 9 (2004) Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2005) National Electrical Code

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 7CFR 1755.900 (2000) Filled Fiber Optic Cables (REA)

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-188-176 (Basic, Notice 1) Standardized Profile for Asynchronous Transfer Mode (ATM)

MIL-STD-2042 (Rev B) Fiber Optic Cable Topology Installation Standard Methods for Naval Ships

1.2 RELATED REQUIREMENTS

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NOTE: Coordinate with Sections 16302N UNDERGROUND TRANSMISSION AND DISTRIBUTION, and Section 16145 480 VOLT PIER POWER OUTLET ASSEMBLIES. For LANTNAVFACENGCOM projects, use Section 16303N UNDERGROUND ELECTRICAL WORK in lieu of Section

16302N UNDERGROUND TRANSMISSION AND DISTRIBUTION.
****

Section 16050N BASIC ELECTRICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's

Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the

Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fiber Optic System; G

SD-03 Product Data

Fiber Optic Media Types; G

Fiber Optic Splices Material Data; G

Fiber Optic Terminations and Connectors Material Data; G

Fiber Optic Enclosures; G

SD-06 Test Reports

Fiber Optic Factory Test Plan; G

Fiber Optic Field Tests Plan; G

SD-07 Certificates

Fiber Optic Cable Installer and Splicer Qualifications; G

Manufacturer's qualifications; G

SD-08 Manufacturer's Instructions

Fiber optic system instructions; G

1.4 QUALITY ASSURANCE

1.4.1 Fiber Optic System

Provide drawings for the fiber optic cable and pathway system. Provide single line schematic details of the fiber optic and pathway media, splices, and associated construction materials. Drawings shall be in AUTOCAD.DXF or compatible format. Provide Registered Communications Distribution Designer (RCDD) approved drawings of the fiber optic system. Include drawing details of fiber optic terminations in equipment rooms. System drawings shall show final configuration, including location, fiber pair count, pathway innerduct arrangement, and pathway assignment of outside plant. FO system shall be compatible with MIL-STD-188-176. Pier FO systems shall be designed for

compatibility with MIL-STD-2042 and NAVSEA drawings.

**********Note: Design drawings shall provide physical location details for aerial poles, underground media routes, maintenance holes, handholes, ducts, duct banks, pathways, cable markers, and related hardware. Show telecommunications rooms, closets, and backboards on drawings. Provide a telecommunications media schedule on the drawings with FO pair, counts, media length and pathway length. Designer shall perform pathway fill, (max 40 percent), and media tension calculations for all runs. Materials must be listed as RUS certified for the application (http://www.usda.gov/rus/telecom/materials/material.htm). Design drawings shall provide details for installation of the FO cable in accordance with EIA/TIA-590-A.

****

1.4.2 Fiber Optic Cable Installer and Splicer Qualifications

Technicians installing FO media, splices and performing system tests shall be certified and trained in accordance with an approved manufacturers training program. Technicians shall have a minimum of 3 years FO experience in installing equivalent FO systems. Submit data for approval to the [____] Contracting Officer. Submit FO technician qualifications for approval 30 days before splices are to be made on the cable. Certification shall include the training, and experience of the individual on specific type and classification of FO media to be provided under this contract.

1.4.3 Fiber Optic System Instructions

Provide installation methods and procedures for installing the FO media and pathway system. Include methods and procedures for installing FO media, pathway, splices, and associated hardware. Submit installation procedures and equipment list to the Contracting Officer.

1.4.4 Manufacturer's Qualifications

The FO media manufacturer shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of FO media which comply with RUS 7CFR 1755.900. Manufacturer must provide a list of customers with 3 years of maintenance logs documenting experience with government customers.

1.4.5 Fiber Optic Factory Test Plan

Prepare and provide the government for review a test plan for factory and field tests of the FO media. Provide factory OTDR test data as part of the test report. Provide a list of factory test equipment. Include a FO link performance test plan. Submit the plan at least [30][____] days prior to tests for government approval. Refer to EIA TIA/EIA-569-A for performance measurement criteria. Conduct tests at all operating bandwidths. Provide calculations for optical power budget and bandwidth as required by RUS 7CFR 1755.900 using test method EIA EIA/TIA-455-78A or EIA TIA/EIA-455-B. Submit test plans and reports to the government for review and approval.

1.4.6 Fiber Optic Field Tests Plan

Prepare and provide technicians and test equipment for field tests of FO media. Conduct OTDR reel tests at the job site prior to installation. Perform OTDR and end to end tests of all installed media. Conduct tests on single mode fiber in accordance with EIA TIA/EIA-526-7 for single mode fiber and EIA TIA/EIA-526-14A for multi mode fiber.

1.5 DELIVERY, STORAGE, AND HANDLING

Ship media to job site on factory reels or in factory cartons. Radius of the reel drum shall not be smaller than the minimum bend radius recommended by the manufacturer for the media. Wind cable on the reel so that unwinding can be done without kinking the cable. Two meters of cable at each end of the reel must be readily accessible for testing. Provide a permanent label on each reel showing length, media, identification number, and date of manufacture. Provide water resistant label and ink on the labels. Apply end seals to each end of the media after testing and before terminating to prevent moisture from entering the cable while stored at the job site. Reels with cable shall be suitable for outside storage conditions when temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from zero to 100 percent. Equipment, other than FO media, delivered and placed in storage shall be stored with protection from weather, humidity and temperature variation, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and FO system material shall be the standard products of a manufacturer regularly engaged in the manufacturer of such products and shall be the manufacturer's standard commercially available product.

2.1.1 Fiber Optic Media Types

FO media shall meet all performance requirements of EIA TIA/EIA-568-B.1, EIA TIA/EIA-568-B.3 and the physical requirements of ICEA S-87-640 and EIA TIA/EIA-598-B.

****

Note: Designer shall specify requirements for Fiber Optic media from the following selections:

Fiber Optic Media Type:
(single mode) (multi mode) (hybrid)

Fiber Count: [12][24][48][ ][216]

Media Optic Characteristics:
Fiber core diameter: [50]mmf [62.5]mmf or [ ]smf
Bandwidth 850nm mHz/km: [500]50µm [160] 62.5µm
Bandwidth 1300nm mHz/km: [500]50µm [500]62.5µm
Attenuation 850nm dB: [2.5]50µm [3.0]62.5µm
Attenuation 1300nm dB: [0.8]50µm [0.7]62.5µm

Bending Radius mm: [30]50 m [30]62.6 m [30]smf

****

2.1.1.1 Multi Mode Fiber Media

Provide FO media with outer sheath jacket,[strength member,] ripcords, water blocking material,[optional steel shield,] core tube, and core fibers as installed in a permanent underground pathway system as shown on the construction drawings. FO media shall have an all glass, graded index material with a nominal core diameter of [62.5][____] microns. Provide a cladding material for the fiber which is compatible with the core. Media transmission window shall be centered at 850 and 1300 nanometer wavelengths, attenuation at 1300 nanometers shall be less than [2.0][___] dB per kilometer. Minimum bandwidth shall be 500 mHz-Km.

**********NOTE: The designer shall specify the number of fiber strands. The minimum number of fiber to a facility or building shall be 12 plus 25 percent spare capacity. Designer shall specify loose tube or tight tube design. In general gelatin filled media should be used unless tight tube is required to interface with customer terminal equipment. The loose tube construction is more appropriate where media is subject to numerous bends along the cable route. This includes aerial and long distance runs (over one Km). Tight tube design may be used for exterior direct burial in ducts below the frost line. For Navy projects the preferred underground installation is within a pathway system compliant with EIA/TIA-569. Direct burial installations shall comply with EIA/TIA-590. Media for Defense Information System Agency (DISA) equipment connection shall comply with Mil-Std-188-176.
****

2.1.1.2 Single Mode Fiber Media.

Provide FO single mode media with outer sheath jacket,[strength member,] ripcords, water blocking material,[optional steel shield,] core tube, and core fibers as installed in a permanent underground pathway system as shown on the construction drawings. Media shall have all glass, dual window, graded index material with a core diameter of [____][8.7] microns. Fiber shall be coated with a cladding material which is concentric with the core. Fiber cladding diameter shall be nominal 125 microns. Media shall have a transmission window centered at 1300 and 1550 nanometer wavelengths, attenuation at 1550 nanometers shall be less than 0.5 dB per kilometer. FO media shall comply with EIA TIA/EIA-472DAAA,and EIA TIA-758.

**********NOTE: Designer shall specify splice materials and enclosures for fiber optic splices. The number of fiber splices must be minimized to preserve the transmission system signal. RUS 7CFR part 1753.f401 provides information on fiber optic splices.
****

2.2 FIBER OPTIC SPLICES

Provide FO splices and splicing materials for [fusion][or][mechanical]

methods at locations shown on the construction drawings. The splice insertion loss shall be less than 0.1 dB mean, (0.3 dB max) when measured in accordance with EIA EIA/TIA-455-59 using an Optical Time Domain Reflectometer (OTDR). Splices shall be designed for a return loss of 40.0 db max for single mode fiber when tested in accordance with EIA TIA/EIA-455-107A.

2.3 FIBER OPTIC ENCLOSURES

Provide metallic enclosures for fiber optic data transmission equipment. NEMA 250, type 4 enclosure. Enclosures shall protect the spliced fibers from moisture and physical damage. Splice closure shall provide strain relief for the cable and the fibers at splice points. Provide full documentation citing conformance to structural parameters.

2.4 FIBER OPTIC TERMINATIONS AND CONNECTORS

FO connectors shall comply with EIA TIA/EIA-4750000-C and EIA TIA/EIA-604-3A.

2.5 FIBER OPTIC PATHWAY SYSTEM

Provide an FO pathway system including raceway conduit, duct system, and maintenance manholes and handholes as shown on the drawings. Pathway materials shall comply with EIA TIA/EIA-569-A, and the following commercial
standards for construction materials, NEMA RN 1 (PVC), NEMA TC 2 (PVC), NEMA TC 3 (PVC), NEMA TC 6 & 8, and NEMA TC 9.

2.5.1 Conduit

Conduit as specified in Section 16302N, "Underground Transmission and

Distribution."

2.6 FACTORY FO QUALITY CONTROL

Conduct factory quality tests of FO media as required by EIA

TIA/EIA-472D000-A.

2.7 PREPARATION FOR DELIVERY

Ship media on reels in [____] ft [____] m lengths. Provide 2 meters 6 1/2 feet pigtails on each end of media accessible for testing. Reel drum shall comply with manufacturers recommended bend radius for the media. Wind media on reel so that unreeling can be done without kinking the media. Attach a permanent waterproof label with indelible text on reel showing the length, media type, bandwidth, attenuation, and date of manufacture.

2.8 FACTORY REEL TEST

Test 100 percent OTDR test of FO media at the factory prior to shipment in accordance with EIA TIA/EIA-568-B.1 and EIA TIA/EIA-568-B.3. Use EIA TIA/EIA-526-7 for single mode fiber and EIA TIA/EIA-526-14A Method B for multi mode fiber measurements. Calibrate OTDR to show anomalies of 0.2 dB minimum. Provide digitized or photographic traces to the Contracting Officer.

2.9 MISCELLANEOUS ITEMS

2.9.1 FO Media Tags

Provide stainless steel, 41.25 mm 1 5/8 inches in diameter 1.58 mm 1/16 inch thick, and circular in shape.

2.9.2 Buried Warning and Identification Tape

Provide color, type and depth of tape as specified in paragraph "Buried Warning and Identification Tape" in Section 02300 EARTHWORK, FO media must be marked and protected as required by EIA TIA/EIA-590-A.

2.9.3 Grounding Braid

Grounding braid shall provide low electrical impedance connections for dependable shield bonding. Braid shall be made from flat tin-plated copper.

PART 3 EXECUTION

3.1 INSTALLATION

Install and test the FO media in accordance with contract drawings, specifications, IEEE C2, NFPA 70, and EIA TIA/EIA-590-A. Provide all necessary power, utility services, technicians, test equipment, calibration equipment as required to perform reel and final acceptance tests of the media. All media which fail the factory or reel tests or final acceptance field tests shall be replaced and re-tested at the contractors expense. Splices are not permitted unless shown on the construction drawings. Field test splices within 24 hours after splice installation. Splices shall be tested to demonstrate a maximum 0.2 dB loss. Provide a splice box for each field splice. Provide a minimum of 2 meters for routing and testing media. Protect media ends of unspliced FO media during splicing operations.

3.1.1 Contractor Damage

Promptly repair indicated utility and communications lines or systems damaged during site preparation and construction. Damage to lines or systems not indicated, which are caused by contractor operations, shall 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 shall 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 damage.

3.1.2 Direct Burial System

****
NOTE: Designer must specify the depth of media placement. Designer may specify air blown fiber installed in new or existing underground duct pending the approval of the media manufacturer. Air blown fiber installation and construction materials must be approved by the contracting officer.

****

Installation shall be in accordance with EIA TIA/EIA-590-A. Under railroad tracks, 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 610 mm 24 inches below finished grade. Trenches shall be not less than 155 mm 6 inches wide and in straight lines between cable markers. Do not use cable plows. Bends in trenches shall have a radius of not less than [915][____] mm [36][____] inches. Where two or more cables are laid parallel in the same trench, space laterally at least 75 mm 3 inches apart. When rock is encountered, remove it to a depth of at least 75 mm 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 6 mm 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 Section 02300 EARTHWORK.

3.1.2.1 Media Placement

a. Separate FO media crossing other cables or metal piping from the other cables or pipe by not less than [75][____] mm [3][____] inches of well tamped earth. Do not install FO media under or above traffic signal loops.

b. Media shall be in one continuous length without splices except where splices are shown on the drawings.

c. Do not allow bends in media which exceed the manufacturers minimum recommended radii. Do not bend media to a radius less than 10 times the outside diameter of the media.

d. Leave a horizontal slack of approximately 915 mm 3 feet in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought above ground. Where cable is brought above ground, leave additional slack to make necessary connections.

3.1.2.2 Identification Slabs (Markers)

Provide a marker at each change of direction of the cable, over the ends of ducts or conduits which are installed under paved areas and roadways and over each splice. Identification markers shall be of concrete, approximately500 mm 20 inches square by 150 mm 6 inches thick and stake mounted warnings meeting the requirements of REA.

3.1.3 Underground Duct

Construct underground duct as specified in Section 16302N UNDERGROUND TRANSMISSION AND DISTRIBUTION. Encase in concrete any ducts under roads, paved areas, or railroad tracks.

3.1.3.1 Connections to Existing Maintenance Holes [and Handholes]

For duct line connections to existing structures, break the structure wall out to the dimensions required and preserve the steel in the structure wall. Cut the steel and the duct line envelope.

3.1.3.2 Connections to Concrete Pads

For duct line connections to concrete pads, break an opening in the pad out to the dimensions required and preserve the steel in the pad. Cut the steel and extend it out to tie into the reinforcing of the duct line envelope. Chip out the opening in the pad to form a key for the duct line envelope.

3.1.3.3 Connections to Existing Ducts

Where connections to existing duct lines are indicated, excavate the lines to the maximum depth required. Cut off lines and remove loose concrete from the conduits before new concrete encased ducts are installed. Provide reinforced concrete collar, poured monolithically with the new duct line to take the shear at the joint of the duct lines.

3.1.4 Reconditioning of Surfaces

3.1.4.1 Unpaved Surface Treatment

Restore unpaved surfaces disturbed during the installation of duct or direct burial cable to their original elevation and condition. Carefully preserve existing sod and topsoil and replace after the back-filling is completed. Replace damaged sod with sod of quality equal to that removed. Where 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.

3.1.4.2 Paving Repairs

****
NOTE: Choose one of the following options.

****

[a. Where trenches, pits, or other excavations are made in existing roadways and in other areas of pavement where surface treatment of any kind exists, restore such surface treatment or pavement to the same thickness and to the same kind as previously existed. Surface treatment or pavement shall also match and tie into the adjacent and surrounding existing surfaces.]

****
NOTE: Insert appropriate Section number and title
in the blank below using format per UFC 1-300-02.

****

[b. Make paving repairs as specified in [_____].]

3.1.5 Cable Pulling

Test duct lines with a mandrel and swab out to remove foreign material before the pulling of FO media. Avoid damage to cables in setting up pulling apparatus or in placing tools or hardware. Do not step on media when entering or leaving the maintenance holes. Do not place media 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 media reels on the same side of the maintenance hole as the pathway section in which the media is to be placed. Level the reel and bring into proper alignment with the pathway section so that the media pays off from the top of the reel in a long smooth bend into the duct without twisting. Under no circumstances shall the media be paid off from the bottom of the reel. Check the equipment set up prior to beginning the media cable pulling to avoid an interruption once pulling has started. Use a cable feeder guide of suitable dimensions between media reel and face of duct to protect media and guide cable into the duct as it is paid off the reel. As media is paid off the reel, lubricate and inspect media for sheath defects. When defects are noticed, stop pulling operations and notify the Contracting Officer to determine required corrective action. Stop media pulling if reel binds or does not pay off freely. Rectify cause of binding before resuming pulling operations. Provide media lubricants recommended by the cable manufacturer. Provide 1 meter 3.3 feet of spare media in all manholes and enclosures for final termination and testing.

3.1.5.1 FO Media Tensions

Install FO media as shown on construction drawings. Provide devices to monitor media tension during installation. Do not exceed manufacturers recommended maximum FO tensions and bending radii during installation.

3.1.5.2 Pulling Eyes

Equip media 30 mm 1- 1/4 inchesin diameter and larger with cable manufacturer's factory installed pulling-in eyes. Provide media with diameter smaller than 30 mm 1-1/4 inches with heat shrinkable type end caps or seals on cable ends when using cable pulling grips. Rings to prevent grip from slipping shall not be beaten into the cable sheath. Use a swivel grip of19 mm 3/4 inch links between pulling-in eyes or grips and pulling strand.

3.1.5.3 Installation of Media in Maintenance Manholes, Handholes, and Vaults

Do not install media utilizing 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 media on brackets and cable insulators at a maximum

of1220 mm 4 feet. In existing maintenance manholes, handholes, and vaults where new ducts are to be terminated, or where new media are to be installed, modify the existing installation of media, cable supports, and grounding as required with cables arranged and supported as specified for new media.

3.1.6 Aerial Media Installation

****
NOTE: Include tensioning and sag data on drawings in tabular form.
****

Pole installation shall be as specified in Section 16301N 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. Wire shall be sagged in accordance with the data shown.

3.1.6.1 Aerial FO Media

Keep media ends sealed at all times using cable end caps. Take media from reel only as it is placed. During placing operations, do not bend in a radius less than 10 times the outside diameter of media. Place temporary supports sufficiently close together, and properly tension the media where necessary, to prevent excessive bending. In those instances where spiraling of media is involved, accomplish mounting of enclosures for purposes of loading, splicing, and distribution after the spiraling operation has been completed.

3.1.7 Grounding

**********N
OTE: Designer should verify the existence of grounding facilities. It is essential that all grounding facilities, new and existing, conform with IEEE C2, NFPA 70, MIL-HDBK-419, and MIL-STD-188-124.
****

Ground exposed non current carrying metallic parts of telephone equipment, media sheaths, media splices, and terminals.

3.1.8 Housekeeping

The Contractor shall be responsible for cleaning up work area and

maintaining the work area in orderly condition.

3.2 FIELD QUALITY CONTROL

Provide the Contracting Officer [10][_____] working days notice prior to [each][____] reel and final acceptance test. Provide labor, equipment, and incidentals required for testing. 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.

3.2.1 Field Reel Tests

Perform the following tests on FO media at the job site before it is removed from the cable reel. For cables with factory installed pulling eyes, these tests shall be performed at the factory and certified test results shall accompany the media. Perform OTDR tests with media on reels and compare factory and field test data.

****
NOTE: The purpose of this test is to assure the Government and the installation contractor that the media was not damaged during shipment.

****

3.2.1.1 Reel Test Results

Provide results of reel tests to the Contracting Officer at least [5][____] working days before installation is to commence. Results shall indicate

reel number of the media, manufacturer, type and number of fiber tested, and recorded readings. When reel tests indicate that the media does not comply with factory reel test results remove the media from the job site and replace with compliant media.

3.2.2 Final Acceptance Tests

Perform end-to-end tests including power meter light source and OTDR tests.

Perform OTDR measurements as required by EIA TIA/EIA-568-B.1 and EIA TIA/EIA-568-B.3. Single mode fiber shall be tested in accordance with EIA TIA/EIA-526-7 (Optical Power Loss). Multi mode fiber shall be tested in accordance with EIA TIA/EIA-526-14A (Optical Power Loss).

3.2.2.1 Test Results

Provide results of final acceptance tests (attenuation tests, OTDR traces, etc.), to the Contracting Officer at least [5][____] working days after completion of tests.

****
NOTE: Suggestions for improvement of this

specification will be welcomed using the Navy "Change Request Forms" subdirectory located in SPECSINTACT in Jobs or Masters under "Forms/Documents" director or DD Form 1426. Suggestions should be forwarded to:

Naval Facilities Engineering Command
Engineering Innovation and Criteria Office,
1510 Gilbert Street
Norfolk, VA 23511-2699
Fax: (757-322-4416) DSN 262-4416

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-- End of Section -

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SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16768A

FIBER OPTIC DATA TRANSMISSION SYSTEM

04/04

PART 1 GENERAL

1.1 REFERENCES

1.2 SUBMITTALS

1.3 SYSTEM DESCRIPTION

1.3.1 General

1.3.2 Environmental Requirements

1.3.3 Hazardous Environment

1.3.4 Electrical Requirements

1.3.5 Input Line Surge Protection

1.3.6 Power Line Surge Protection

1.3.7 Spare Parts

1.4 DELIVERY OF TECHNICAL DATA

1.4.1 Group I Technical Data Package

1.4.1.1 System Drawings

1.4.1.2 Equipment Data

1.4.1.3 Data Transmission System Description and Analyses

1.4.1.4 System Overall Reliability Calculations

1.4.1.5 Certifications

1.4.1.6 Key Control Plan

1.4.2 Group II Technical Data Package

1.4.3 Group III Technical Data Package

1.4.4 Group IV Technical Data Package

1.4.4.1 Performance Verification and Endurance Testing Data

1.4.4.2 Operation and Maintenance Data

1.4.4.3 Training Data

1.4.5 Group V Technical Data Package

1.4.5.1 Functional Design Manual

1.4.5.2 Hardware Manual

1.4.5.3 Maintenance Manual

1.4.5.4 Operator's Manual

1.4.6 Group VI Technical Data Package

PART 2 PRODUCTS

2.1 FO MODEMS

2.1.1 FO Modem Operating Wavelength

2.1.2 FO Modem Inputs and Outputs

2.2 FO TRANSMITTER AND RECEIVER MODULES

2.2.1 Analog FO Transmitter and Receiver Modules

2.2.2 Digital FO Transmitter and Receiver Modules

2.2.3 FO Transmitter Module

2.2.4 FO Receiver Module
2.3 FO DIGITAL REPEATERS
2.4 FO ANALOG REPEATERS
2.5 TRANSCEIVERS FOR VIDEO APPLICATIONS
2.6 TRANSCEIVERS FOR LAN APPLICATIONS
2.7 FO SWITCHES
2.8 FO SPLITTER/COMBINER
2.9 FIBER OPTIC DIGITAL REPEATERS (FODR)
2.10 DATA TRANSMISSION CONVERTER
2.11 ENCLOSURES
2.11.1 Interior
2.11.2 Exterior
2.11.3 Corrosive Environment
2.11.4 Hazardous Environment
2.12 TAMPER AND PHYSICAL PROTECTION PROVISIONS
2.12.1 Enclosure Covers
2.12.2 Conduit-Enclosure Connections
2.12.3 Locks and Key-Lock-Operated Switches
2.12.3.1 Locks
2.12.3.2 Key-Lock-Operated Switches
2.13 SYSTEM REQUIREMENTS
2.13.1 Signal Transmission Format Code
2.13.2 Flux Budget/Gain Margin
2.13.3 Receiver Dynamic Range
2.14 OPTICAL FIBERS
2.14.1 General
2.14.2 50 Micron Multimode Fibers
2.14.3 62.5 Micron Multimode Fibers

2.14.4 8.3 Micron Single-Mode Fibers
2.15 CROSS-CONNECTS
2.15.1 Patch Panels
2.15.2 Patch Cords
2.16 CABLE CONSTRUCTION
2.16.1 General
2.16.2 Exterior Cable
2.16.2.1 Aerial Cable
2.16.2.2 Duct Cable
2.16.2.3 Direct Burial Cable
2.16.3 Interior Cable
2.16.4 Pigtail Cables
2.17 FO CONNECTORS
2.18 MECHANICAL SPLICES
2.19 FUSION SPLICES
2.20 CONDUIT, FITTINGS AND ENCLOSURES
1 FAN-OUT KITS
2 INSTALLATION

PART 3 EXECUTION

3.1.1 Interior Work
3.1.2 Exterior Work, Aerial
3.1.3 Exterior Work Underground
3.1.4 Service Loops
3.1.5 Metallic Sheath Grounding
3.1.6 Splices
3.1.6.1 General
3.1.6.2 Mechanical Splices
3.1.7 Connectors

3.1.8 Identification and Labeling
3.1.9 Enclosure Sizing and Cable
3.1.10 Enclosure Penetrations
3.2 TESTING
3.2.1 General
3.2.2 Contractor's Field Test
3.2.2.1 Optical Time Domain Reflectometer Tests
3.2.2.2 Power Attenuation Test
3.2.2.3 Gain Margin Test
3.2.2.4 Analog Video Signal Test
3.2.2.5 Digital Video Signal Test
3.2.2.6 Performance Verification Test and Endurance Test
3.3 TRAINING
3.3.1 General
3.3.2 System Maintenance Course

-- End of Section Table of Contents -

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SECTION 16768A

FIBER OPTIC DATA TRANSMISSION SYSTEM

****
NOTE: This guide specification covers the requirements for fiber optics data transmission systems.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

****
*

PART 1 GENERAL

****
NOTE: There are two ways the designer can require the submission of data concerning fiber optic equipment. The most common way is through the use of submittals. However, the Federal Acquisition Regulations apply special constraints on some types of technical data that fall under the Data Requirements Clause. Generally, the technical data associated with fiber optic data transmission systems do not fall under the special Data Requirements Clause. However, if other systems such as EMCS, UMCS, IDS, ESS, and CCTV, interconnected by FO systems do fall within the special category, the associated FO technical data should be acquired in the same manner. Therefore, if some systems used with this specification fall under the special Data Requirements Clause, use sub-paragraph a. below for guidance.

a. The acquisition of all technical data, data bases and computer software items that are identified herein will be accomplished strictly in accordance with the Federal Acquisition Regulation (FAR) and the Department of Defense Federal Acquisition Regulation Supplement (DOD FARS). Those regulations,

as well as the Army and Corps of Engineers implementations thereof, should also be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost. Specifically, the Rights in Technical Data Non-commercial, DOD FARS 52.227-7013, and DOD FARS 52.227-7031 [Reserved], as well as any requisite software licensing agreements will be made a part of the CONTRACT CLAUSES or SPECIAL CONTRACT REQUIREMENTS of the contract. In addition, the appropriate DD Form 1423, Contract Data Requirements List, will be filled out for each distinct deliverable item and made a part of the contract. Where necessary, a DD Form 1664, Data Item Description, shall be used to explain and more fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to assure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government. Include with the request for proposals a completed DD Form 1423, Contract Data Requirements List. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly specified, both description and quantity being required.

****
*

1.1 REFERENCES

****

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 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.
****

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.

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 170

EIA ANSI/EIA-310-D

EIA ANSI/EIA-455-171

EIA ANSI/EIA-455-81A-91

EIA ANSI/EIA-455-91

EIA ANSI/EIA/TIA-232-F

EIA ANSI/EIA/TIA-455-170

EIA ANSI/EIA/TIA-455-25C

EIA ANSI/EIA/TIA-455-30B

EIA ANSI/EIA/TIA-455-46A

EIA ANSI/EIA/TIA-455-47B

EIA ANSI/EIA/TIA-455-58B

EIA ANSI/EIA/TIA-455-59A

EIA ANSI/EIA/TIA-455-61A

EIA ANSI/EIA/TIA-455-82B

(1957) Electrical Performance Standards - Monochrome Television Studio Facilities

(1992) Racks, Panels, and Associated Equipment

(1987) FOTP-171 Attenuation by Substitution Measurement for Short-Length Multimode Graded-Index and Single-Mode Optical Fiber Cable Assemblies

(1992) FOTP-81 Compound Flow (Drip) Test for Filled Fiber Optic Cable

(1985; R 1996) FOTP-91 Fiber Optic Cable Twist-Bend Test

(2002) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

(1989) FOTP-170 Cable Cutoff Wavelength of Single-Mode Fiber by Transmitted Power

(2002) FOTP-25 Impact Testing of Optical Fiber Cables

(1991) FOTP-30 Frequency Domain Measurement of Multimode Optical Fiber Information Transmission Capacity

(1990) FOTP-46 Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers

(1992) FOTP-47 Output Far Field Radiation Pattern Measurement

(2001) FOTP-58 Core Diameter Measurement of Graded-Index Optical Fibers

(2000) FOTP-59 Measurement of Fiber Point Discontinuities Using an OTDR

(2000) FOTP-61 Measurement of Fiber or Cable Attenuation Using an OTDR

(1992) FOTP-82 Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable

EIA ANSI/TIA/EIA-455-13A	(2002) FOTP-13 Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies
EIA ANSI/TIA/EIA-455-177A	(1992) FOTP-177 Numerical Aperture Measurement of Graded-Index Optical Fibers
EIA ANSI/TIA/EIA-455-41A	(2001) FOTP-41 Compressive Loading Resistance of Fiber Optic Cables
EIA ANSI/TIA/EIA-485-A	(1998) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint System
EIA ANSI/TIA/EIA-606A	(2002) Administration Standard for the Telecommunications Infrastructure
EIA TIA/EIA-455-104A	(2000) FOTP-104 Fiber Optic Cable Cyclic Flexing Test
EIA-455-88	(2001) FOTP-88 Fiber Optic Cable Bend Test

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2002) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 1666	(2000; Rev thru Jul 2002) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

1.2 SUBMITTALS

****

*NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fiber Optic System[; G][; G, [_____]]
Installation[; G][; G, [_____]]

Detail drawings including a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Detail drawings shall contain complete cabling, wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function with its associated subsystems as well as other systems. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operations. System drawings shall show proposed configuration, including location, type and termination of both interior and exterior fiber optics and showing the location, duct and innerduct arrangement, and fiber assignment. The ac power consumption and heat dissipation shall be shown under both normal and maximum operating conditions.

SD-03 Product Data

Fiber Optic System

Equipment calculations for flux budgets and gain margins.

Spare Parts

Data lists of spare parts, tools, and test equipment, as specified.

Manufacturer's Instructions[; G][; G, [_____]]

Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be submitted prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received and approved.

Test Procedures and Reports[; G][; G, [_____]]

Test plans shall define test procedures and tests required to ensure that the system meets technical, operational, and performance specifications. The test plans shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested.

SD-06 Test Reports

Test Procedures and Reports[; G][; G, [_____]]

Test reports, in booklet form showing field test procedures and field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system.

SD-07 Certificates

Fiber Optic System

Manufacturer's certificate indicating compliance with transmission and reliability requirements. Where equipment or materials are specified to conform to the standards or publications and requirements of CFR, ANSI,IEEE, NEMA, NFPA, EIA, or UL, certificates attesting that the items furnished under this section of the specification conform to the specified requirements.

SD-10 Operation and Maintenance Data

System Maintenance Course

[Six] [_____] copies of operating instructions outlining the step-by-step procedures required for system operation including description of each subsystem in its operating mode. Instructions shall include the manufacturer's name, service manual, parts list, and a brief description of equipment, components, and their basic operating features. [Six] [_____] copies of the maintenance instructions listing regular maintenance procedures, possible system failures, a troubleshooting guide for repairs, and

simplified diagrams for the system as installed. A video describing operating and maintenance instructions may be included.

1.3 SYSTEM DESCRIPTION

1.3.1 General

****

**
NOTE: Show on drawings the data transmission media required between each sub-assembly of the system or systems to be interconnected. Give consideration to compliance with NEC for supports, raceways, etc.

****
*

A fiber optics (FO) data transmission system (DTS) shall be provided. The data transmission system shall consist of fiber optic transmission media, transmitter and receiver modules, modems, transceiver modules, repeaters, cable and power line surge protection, terminal devices (such as connectors, patch panels and breakout boxes) and power supplies for operating active components. The data transmission system shall interconnect system components as shown. Computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class A computing devices and labeled as set forth in 47 CFR 15.

1.3.2 Environmental Requirements

****
**NOTE: Select equipment and cable temperature rating within ambient temperature conditions at project location. State additional requirements when ambient conditions are more extreme than manufacturers' equipment ratings (e.g., conformal coating for 100% relative humidity or condensing atmospheres, enclosure heaters or enclosure coolers.)
****
*

Equipment and cable to be utilized indoors shall be rated for continuous operation under ambient environmental conditions of 0 to 50 degrees C 32 to 122 degrees F dry bulb and 10 to 95 percent relative humidity, non-condensing. Equipment and cables to be used outdoors shall be rated for continuous operation under ambient environmental conditions of [minus 40] [minus [_____]] to plus [75] [_____] degrees C [minus 40] [minus [_____]] to plus [166] [_____] and humidity of up to 100 percent condensing or as normally encountered for the installed location. All equipment and cable shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location. Cables installed in ducts, plenums, and other air-handling spaces shall be installed per NFPA 70. Cables installed in plenums shall be plenum-rated cables listed for the use. Cables installed in risers shall be riser-rated cables listed for the use, unless the installed cable is identified as a permitted substitution for the required riser-rated cable type.

1.3.3 Hazardous Environment

****
**
NOTE: Designer will show hazardous (classified) environment area(s), type of hazard(s), and hazard classification (Class I, II, or III, or

combinations; Divisions 1 or 2; Groups A, B, C, D, E, F, or G or combinations; and operating

temperatures) on the drawings. Whenever possible, avoid placement of the FO DTS equipment and cables within the hazardous location to reduce installation costs, and to simplify maintenance.

****

System components and wiring located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated for Classes, Divisions, Groups and suitable for the operating temperatures and shall be installed according to Chapter 5 of NFPA 70 and as shown.

1.3.4 Electrical Requirements

The equipment shall operate from a voltage source as shown, plus or minus

10 percent, and 60 Hz, plus or minus 2 percent.

1.3.5 Input Line Surge Protection

Inputs and outputs shall be protected against surges induced on wiring and cables including wiring and cables installed outdoors. Surge protection devices shall be selected based on voltages and current ratings of components to be protected. Communications equipment shall be protected against surges induced on any communications circuit. Cables and conductors (except non-conductive fiber optic cables which serve as communications circuits from consoles to field equipment and between field equipment), shall have surge protection circuits installed at each end. Protection shall be furnished at equipment, and additional triple electrode gas surge protectors rated for the application on each conductive wire line and coaxial circuit shall be installed within 1 meter 3 feet of the building cable entrance. Surge protection devices shall be selected based on voltages and current ratings of components to be protected. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

- a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

- b. An 8 microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.3.6 Power Line Surge Protection

Equipment connected to AC circuits shall be protected from power line surges. Surge protection devices shall be selected based on voltages and current ratings of components to be protected. Equipment shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

1.3.7 Spare Parts

The Contractor shall submit spare parts data for each different item of material and equipment specified and furnished, after approval of detail drawings not later than [_____] months prior to the date of beneficial occupancy. The data shall include a list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [1 year] [3 years] of
service.

1.4 DELIVERY OF TECHNICAL DATA

****
**
NOTE: Insert the Section title of the appropriate additional specifications: Section 16751A CLOSED CIRCUIT TELEVISION SYSTEMS; Section 13702N BASIC INTRUSION DETECTION SYSTEMS (IDS); Section 13703N COMMERCIAL INTRUSION DETECTION SYSTEMS (IDS); Section 13720A ELECTRONIC SECURITY SYSTEM; Section 13721A SMALL INTRUSION DETECTION SYSTEM; Section 13801A UTILITY MONITORING AND CONTROL SYSTEMS (UMCS).

For UMCS, IDS, ESS and similar systems requiring head-end computers and software, designer shall use
the paragraph DELIVERY OF TECHNICAL DATA and delete
paragraph SUBMITTALS. In no case will both paragraphs be retained.

****

Computer software and technical data (including technical data which relates to computer software), which are specifically identified in this specification shall be delivered strictly in accordance with the CONTRACT CLAUSES, SPECIAL CONTRACT REQUIREMENTS, and in accordance with the Contract Data Requirements List (CDRL), DD Form 1423, which is attached to and thereby made a part of this contract. All data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. If the DTS is being installed in conjunction with another system such as an intrusion detection system, electronic SECURITY system, closed circuit television system, or utility monitoring and control system, the Technical Data Packages shall be submitted as part of the Technical Data Package for Section [_____]; [_____] hard copies and [_____] electronic copies (DC-ROM or DVD-R) of the Technical Data Package(s) shall be submitted.

1.4.1 Group I Technical Data Package

1.4.1.1 System Drawings

The package shall include the following:

- a. Communications system block diagram.

- b. FO receivers, transmitters, transceivers, multiplexers, and FO modem installation, block diagrams, and wiring and cabling diagrams.

- c. FO receivers, transmitters, transceivers, multiplexers, and FO modem physical layout and schematics.

- d. Details of interfaces with other systems.

- e. Details of connections to power sources, including grounding.

- f. Details of surge protection device installations.

- g. Details of cable splicing and connector installations.

- h. Details of aerial cable and messenger installation on poles, cable entrance to buildings, and termination inside enclosures.

- i. Details of underground cable and duct installation, cable entrance into buildings, and terminations inside enclosures.

Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operations. System drawings shall show proposed configuration, including location, type and termination of both interior and exterior fiber optics and showing the location, duct and innerduct arrangement, and fiber assignment. The ac power consumption and heat dissipation shall be shown under both normal and maximum operating conditions.

1.4.1.2 Equipment Data

A complete data package shall be delivered for all material, including

field and system equipment.

1.4.1.3 Data Transmission System Description and Analyses

The data package shall include complete system description, and analyses and calculations used in sizing equipment required by these specifications.
Descriptions and calculations shall show how the equipment will operate as
a system to meet the specified performance. The data package shall include
the following:

- a. FO receivers, transmitters, transceivers, multiplexers, FO modem transmit and receive levels, and losses in decibels (dB) on each communication link.

- b. Digital transmitter and receiver communication speed and protocol description.

- c. Analog signal transmission method and bandwidth of the transmitter and receiver.

- d. Data transmission system expansion capability and method of implementation.

- e. FO system signal-to-noise ratio calculation for each communication link.

- f. Flux-budget and gain margin calculation for each communication link.

1.4.1.4 System Overall Reliability Calculations

```
*************************************************************************
          **
          NOTE: The designer must insert the section that
          describes the system configuration.

*************************************************************************
*
```

The data package shall include manufacturers' reliability data and calculations required to show compliance with the specified reliability.
The calculations shall be based on the configuration specified in Section
[_____] and as shown.

1.4.1.5 Certifications

Specified manufacturers' certifications shall be included with the data

package.

1.4.1.6 Key Control Plan

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*************************************************************************
          **
          NOTE: The designer will specify the Section in
          which a key control plan is found, when this
          specification is used with IDS, ESS, or CCTV:
          Section 13702N BASIC INTRUSION DETECTION SYSTEMS
          (IDS); Section 13703N COMMERCIAL INTRUSION DETECTION
          SYSTEMS (IDS); Section 13720A ELECTRONIC SECURITY
          SYSTEM; Section 13721A SMALL INTRUSION DETECTION
          SYSTEM; Section 13801A UTILITY MONITORING AND
          CONTROL SYSTEMS (UMCS); Section 16751A CLOSED
          CIRCUIT TELEVISION SYSTEMS.

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1.4.2 Group II Technical Data Package

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NOTE: If the designer has specified site condition investigation in other sections, the first bracketed sentence, with the proper section number inserted, may be substituted in lieu of the second set of bracketed sentences.

****
*

[The Group II technical data package is specified in Section [_____].] [The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall submit a report to the Government documenting changes to the site, or differing conditions that affect performance of the system to be installed. For those changes or conditions which affect system installation or performance, specification sheets shall be provided (with the report), or written functional requirements to support the findings, and a cost estimate to correct the deficiency shall be provided with the report. The Contractor shall not correct any deficiency without written permission from the Government.]

1.4.3 Group III Technical Data Package

****
**
NOTE: Insert section number and title for the UMCS, IDS, ESS or CCTV specifications.

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*

The Contractor shall prepare test procedures and reports for the factory test. A test plan and test procedures shall be prepared in accordance with Section [_____] and this specification. The test procedures shall describe the applicable tests to be performed, and other pertinent information such as specialized test equipment required, length of test, and location of the test. The procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of this specification, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system. The test report shall describe the results of testing to include the date, time, location and system component designations of material and equipment tested. Testing action shall be recorded whether successful or not. Reasons for termination of testing shall be described. Testing work sheets, printouts, strip charts, oscilloscope or optical time domain reflectometer (OTDR)
printouts/photographs, raw and analyzed data, and testing conclusions shall be included in the report. The Contractor shall deliver the factory test procedures to the Government for approval. After receipt by the Contractor of written approval of the test procedures, the Contractor may schedule the factory test. The Contractor shall provide written notice of the test to the Government at least 2 weeks prior to the scheduled start. The final test report shall be delivered within 15 days after completion of the test.

1.4.4 Group IV Technical Data Package

1.4.4.1 Performance Verification and Endurance Testing Data

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**
NOTE: Insert section number and title for the UMCS, IDS, ESS or CCTV specification.

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The Contractor shall prepare procedures and reports for the performance verification test and endurance test. Test procedures shall be prepared in accordance with Section [_____] and this specification. Testing shall be performed on an installed system as approved by the Government. Where required and approved by the Government, the Contractor shall simulate conditions of operation to demonstrate the performance of the system. The test plan shall describe the applicable tests to be performed, other pertinent information such as specialized test equipment required, length of performance verification test and endurance test, and location of the performance verification test and endurance test. The procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of this specification, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system. The test report shall describe the results of testing to include the date, time, location and system component designations of material and equipment tested. Testing action shall be recorded whether successful or not. Reasons for termination of testing for any reason shall be recorded in the report. Testing work sheets, printouts, strip charts, oscilloscope or OTDR printouts/photographs, raw data, analyzed data and testing conclusions shall be included in the report. The Contractor shall deliver the performance verification test and endurance test procedures to the Government for review and approval. After receipt of written approval of test procedures, the Contractor may schedule the performance verification and endurance tests. The Contractor shall provide written notice of the performance verification test and the endurance test to the Government at least 2 weeks prior to the scheduled start of the test. The final performance verification test and endurance test report shall be delivered 30 days after completion of testing.

1.4.4.2 Operation and Maintenance Data

A draft copy of the operation and maintenance data, in manual format, as specified for the Group V technical data package, shall be delivered to the
Government prior to beginning the performance verification test for use during site testing.

1.4.4.3 Training Data

Lesson plans and training manuals, including type of training to be provided, with a list of reference material shall be delivered for approval
by the Government prior to starting any training.

1.4.5 Group V Technical Data Package

****
**NOTE: Specify the correct number of manuals on DD Form 1423.

Adjust the quantities below to fill special local requirements. Coordinate O&M manual requirements with those of the performing district.

Generally, FO systems do not include controls or functions under the control of system operators. Therefore, an operator's manual is not needed. Include an operator's manual if such controls are provided.

****

The Group V package consists of the operation and maintenance data, in manual format. Final copies of the manuals bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subContractor installing equipment and systems, and of the nearest service representative for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. Manuals delivered shall include:

a. Functional Design Manual: [two] [_____] copies [_____] hard copies

- [1] [_____] CD-ROM(s).

- b. Hardware Manual: [two] [_____] copies [_____] hard copies [1] [_____] CD-ROM(s).

- c. Maintenance Manuals: [two] [_____] copies. [_____] hard copies [1] [_____] CD-ROM(s).

- d. Operator's Manual: [six] [_____] copies [_____] hard copies [1] [_____] CD-ROM(s).

1.4.5.1 Functional Design Manual

The functional design manual shall identify the operational requirements for the data transmission system and explain the theory of operation, design philosophy, and specific functions. A description of hardware functions, interfaces, and requirements shall be included for all system operating modes.

1.4.5.2 Hardware Manual

A manual describing all equipment and devices specified and under Part 2 PRODUCTS shall be furnished. The following information shall be included:

- a. General description and specifications.
- b. Installation and checkout procedures.
- c. Equipment electrical schematics and layout drawings.
- d. Data transmission systems schematics.
- e. Alignment and calibration procedures.
- f. Manufacturer's repair parts list indicating sources of supply.
- g. Interface definition.

1.4.5.3 Maintenance Manual

The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.

1.4.5.4 Operator's Manual

The operator's manual shall fully explain procedures and instructions for operation of the system. This shall include an operator's manual for any fiber optic systems in which system operators control any function of the system.

1.4.6 Group VI Technical Data Package

The Group VI Technical Data Package shall consist of the as-built drawings revised to include system revisions and modifications. Copies of the updated as-built drawings shall be delivered to the Government following approval of the PVT and endurance test.

PART 2 PRODUCTS

****
**NOTE: All of the products listed in this section may not be required for every project. Keep the products required and delete the others.
****
*

2.1 FO MODEMS

FO modems shall be selected to meet FO system requirements. The modems shall allow full duplex, asynchronous, point-to-point digital communication
for the system being installed.

2.1.1 FO Modem Operating Wavelength

****
**NOTE: Select the required operating wavelength: Typically 850 and 1300 wavelengths are used with multimode fibers and 1300 and 1550 wavelengths are used with single-mode fibers. Generally, longer wavelengths should be used for cable lengths over 3 km (1.75 miles) because longer wavelengths exhibit less attenuation than shorter wavelengths. Dense Wave Division Multiplexing (DWDM) and Coarse Wave Division Multiplexing (CWDM) transmitters use multiple wavelengths; the flux budget should be based on the wavelength with the greatest attenuation.
****

The operating wavelength shall be centered on [850] [1300] [1550]

nanometers (nm).

2.1.2 FO Modem Inputs and Outputs

****
NOTE: Match the input and output configurations to the equipment to be interconnected. The data rate of the FO modem must exceed the data rate of the devices served.
****
*

FO modems shall accept inputs and provide outputs compatible with [EIA ANSI/EIA/TIA-232-F] [EIA ANSI/TIA/EIA-485-A] [20 mA current loop] [T1] [10
Base-F]. Digital data rates through each link shall be [9.6 KBPS] [19.2 KBPS] [38.4 KBPS] [1.54 MBPS] [10 MBPS].

2.2 FO TRANSMITTER AND RECEIVER MODULES

****
NOTE: There are several ways fiber optic transmitters and receivers can be implemented such as:

- a. The transmitter and receiver can be mounted on a logic board. The transmitter and receiver are then an integral part of the system at the logic level.

- b. The transmitter and receiver can be individual modules which are mounted external to the logic boards. They can be powered by their own power supplies and can communicate with the serial data

ports of the logic boards at logic levels.

• c. The fiber optics transmitter and receiver can be combined with interface and control logic to form a fiber optic modem. The system field equipment can thus communicate with the modem over a EIA 232-F serial data port.

The designer must determine where FO communication devices will be located. In many systems, FO transmitters and receivers or modems are located in the field equipment enclosures of the systems being supported by the FO system. Often, these FO devices are physically mounted on circuit cards or modules. In other cases, FO devices will have to be installed in separate enclosures provided with the FO system. This is often the case for FO repeaters and active star units.

****

FO transmitter/receiver pairs shall have signal-to-noise power ratio of 40 dB or better after photo detection at the receiver. Transmitter power output and receiver sensitivity shall not drift more than plus or minus 2 dB over their operational life.

2.2.1 Analog FO Transmitter and Receiver Modules

FO transmitter/receiver pairs used to pass analog video signals shall accept inputs and provide outputs that comply with EIA 170 and shall have a bandwidth of 6 MHz or greater.

2.2.2 Digital FO Transmitter and Receiver Modules

FO transmitter/receiver pairs used to pass digital signals shall accept inputs and provide outputs compatible with [EIA ANSI/EIA/TIA-232-F] [EIA ANSI/TIA/EIA-485-A] [20 mA current loop] [T1] [10 Base-F]. Digital data rates through each link shall be [9.6 KBPS] [19.2 KBPS] [38.4 KBPS] [1.54 MBPS] [10 MBPS]. FO transmitter and receiver modules shall be housed [in field equipment enclosures where possible] [in new enclosures] [as shown]. FO transmitter and receiver modules shall be compatible with each other, the FO cable, and connectors.

2.2.3 FO Transmitter Module

The FO transmitter module shall accept electronic signals and shall modulate a light source. The light source shall be coupled into an FO cable. The operating wavelength shall be centered on [850] [1300] [1550] [850 and 1300] [1300 and 1550] nanometers.

2.2.4 FO Receiver Module

The FO receiver module shall receive light from the FO cable and shall convert this light into an electronic signal identical to the electronic

signal applied to the FO transmitter module. The operating wavelength shall be the same as the transmitter.

2.3 FO DIGITAL REPEATERS

FO digital repeaters shall be used to extend the range of the FO data transmission system when necessary to meet the requirements of paragraph SYSTEM REQUIREMENTS. For simplex circuits, the repeater shall consist of an FO receiver connected to an FO transmitter. For Duplex circuits, the repeater shall consist of a pair of FO receivers that are connected to a pair of FO transmitters. The FO receivers shall receive the optical signal and drive the transmitters. The transmitters shall regenerate the optical signal at the transmission rate specified. The FO repeater shall be mechanically and optically compatible with the remainder of the FO system.

2.4 FO ANALOG REPEATERS

FO analog repeaters shall be used to extend the range of the FO data transmission system when necessary to meet the requirements of the paragraph SYSTEM REQUIREMENTS. For simplex circuits, the repeater shall consist of an FO receiver connected to an FO transmitter. For duplex circuits, the repeater shall consist of a pair of FO receivers that are connected to a pair of FO transmitters. The FO receivers shall receive the optical signal and drive the transmitters. The transmitters shall regenerate the optical signal in compliance with EIA 170. The FO repeater shall be mechanically and optically compatible with the remainder of the FO system.

2.5 TRANSCEIVERS FOR VIDEO APPLICATIONS

FO Transceivers shall allow bi-directional signal transmission on a single

fiber. The operating wavelength in one direction shall be 1300/850 nonometers, while in the opposite direction it shall be 850/1300 nanometers. Crosstalk attenuation between channels shall be 40 dB or greater. FO transceivers shall be selected to match or exceed the highest data rate of attached input devices. The FO transceiver shall be mechanically and optically compatible with the remainder of the FO system.

2.6 TRANSCEIVERS FOR LAN APPLICATIONS

****
**
NOTE: Designer will use the transceivers for ESS or UMCS systems which use a LAN topology for communication.

****
*

Transceivers for FO LAN applications shall be active units, compatible with the LAN cards, modems and repeaters used in the system. Indicators provided shall be for power, collision detection, receive, transmit, and status. Power for transceivers shall be derived from the Attachment Unit

Interface (AUI) port of LAN equipment or from a dedicated power supply. Transceiver loss characteristics shall be less than 1.0 db. Connectors shall be low loss and compatible with LAN equipment. Circuitry shall be included so when a device is disconnected, other devices on the LAN continue to operate without any disruption.

2.7 FO SWITCHES

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**
NOTE: Designer will show FO switches and designate latching or nonlatching on contract drawings.

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FO switches shall be single pole, double throw. Switching speed shall be less than 15 milliseconds. Insertion loss shall be less than 1.5 dB. Crosstalk attenuation between FO outputs shall be 40 dB or greater. FO switches shall be latching or nonlatching as shown.

2.8 FO SPLITTER/COMBINER

FO splitter/combiner units shall provide full-duplex communications in a multi-point configuration. Each unit shall have one input port module and up to four output port modules. FO splitter/combiner units shall be mechanically and optically compatible with the remainder of the FO system. The splitter/combiner shall allow a mixed configuration of port module operating wavelengths and single-mode or multimode FO cables. Each port module shall have a separate FO cable input and output. Port modules shall be connected using an electronic data bus. Port module FO transmitters shall regenerate the optical signal at the transmission rate specified. Port modules shall be rack-mounted in a 483 mm 19 inch rack complying with EIA ANSI/EIA-310-D. The total propagation delay through the splitter/combiner shall be less than 100 nanoseconds.

2.9 FIBER OPTIC DIGITAL REPEATERS (FODR)

FODRs shall combine the features specified for Fiber Optic Digital Repeaters and Local Area Network (LAN) transceivers. FODRs shall regenerate the optical signal at the transmission rate specified. The FODRs shall be mechanically and optically compatible with the remainder of the Fiber Optic System. FODRs shall restore the optical signals amplitude,
timing and waveform. The FODR shall provide an electrical interface to the transmission media. The electrical interface shall be identical to all other network interfaces as specified.

2.10 DATA TRANSMISSION CONVERTER

Data transmission converters shall be used to connect equipment using EIA ANSI/TIA/EIA-485-A data transmission when necessary and as shown. Converters shall operate full duplex and support two wire circuits at speeds up to 2 megabytes per second and have a built in 120 Ohm terminating
resistor. Converters shall be mechanically, electrically, and optically compatible with the system.

2.11 ENCLOSURES

****
**NOTE: If all FO devices will be located in enclosures of other systems, then paragraph ENCLOSURES can be deleted. Otherwise, paragraph ENCLOSURES must remain and enclosure locations must be shown on the drawings.
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Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish.

2.11.1 Interior

Enclosures installed indoors shall meet the requirements of NEMA 250 Type
12 or as shown.

2.11.2 Exterior

****
**NOTE: For exterior applications where corrosive environments exist, Type 4X will be specified. Type 4X metallic enclosures should be used for security applications where physical hardening is required.
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Enclosures installed outdoors shall meet the requirements of NEMA 250 Type
4 unless otherwise specified or shown.

2.11.3 Corrosive Environment

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****
NOTE: Show corrosive locations on the drawings.
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****

Enclosures in a corrosive environment shall meet the requirements of NEMA
250, Type 4X.

2.11.4 Hazardous Environment

Enclosures in a hazardous environment shall be installed and shall meet the
requirements as specified in paragraph ENVIRONMENTAL REQUIREMENTS.

2.12 TAMPER AND PHYSICAL PROTECTION PROVISIONS

****
**NOTE: Tamper and physical protection provisions are only required for FO system applications involving security systems such as IDS, ESS or CCTV. This requirement should be deleted for all other applications. Generally, security screws are preferred over tack welding or brazing because the enclosure surface protection is not damaged.
****
*

Enclosures and fittings of every description having hinged doors or removable covers that contain the FO circuits, connections, splices, or power supplies, shall be provided with cover-operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed. The enclosure and the tamper switch shall function together to not allow direct line of sight to any internal components and tampering with the switch or the circuits before the switch activates. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware concealed so that the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; shall be spring-loaded and held in the closed position by the door cover; and shall be wired so that they break the circuit when the door or cover is disturbed. Tamper switches located in enclosures which must be opened to make routine maintenance adjustments to the system and to service the power supplies shall be push/pull-set, automatic reset type.

2.12.1 Enclosure Covers

Covers of pull and junction boxes provided to facilitate installation of the system need not be provided with tamper switches if they contain no splices, connections or power supplies, but shall be protected by [security screws] [tack welding or brazing] to hold the covers in place. Zinc labels shall be affixed to such boxes indicating they contain no connections. These labels shall not indicate that the box is part of a security system. Any damage to the enclosure or its cover's surface protection shall be cleaned and repaired using the same type of surface protection as the original enclosure. Conduit enclosures constructed of fiberglass shall be secured with tamper proof security servers.

2.12.2 Conduit-Enclosure Connections

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**
NOTE: Tamper and physical protection provisions are only required for FO system applications involving security systems such as IDS, ESS, or CCTV. Delete this requirement for all other applications.

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Conduit-enclosure connections shall be protected by tack welding or brazing the conduit to the enclosure. Tack welding or brazing shall be done in addition to standard conduit-enclosure connection methods as described in NFPA 70. Any damage to the enclosure or its cover's surface protection shall be cleaned and repaired using the same type of surface protection as
the original enclosure. Conduit enclosures constructed of fiberglass shall
be secured with tamper proof security screws.

2.12.3 Locks and Key-Lock-Operated Switches

****
**NOTE: Either round key or conventional key type locks as defined in this specification are acceptable. Selection should be based on hardware availability at the time of design and the requirement for matching locks currently in use at the site. If the locks do not have to be matched to locks in use at the site, and the designer has no preference as to lock type, all brackets may be removed.
****
*

2.12.3.1 Locks

Locks required to be installed on system enclosures for maintenance purposes shall be UL listed, [round key type, with three dual, one mushroom, and three plain pin tumblers] [or] [conventional key type lock having a combination of five cylinder pin and five-point three position side bar]. Keys shall be stamped U.S. GOVT. DO NOT DUP. The locks shall be
so arranged that the key can only be withdrawn when in the locked position.

All maintenance locks shall be keyed alike and only two keys shall be furnished for all of these locks.

2.12.3.2 Key-Lock-Operated Switches

Key-lock-operated switches required to be installed on system components shall be UL listed, [with three dual, one mushroom, and three plain pin tumblers,] [or] [conventional key type lock having a combination of five cylinder pin and five-point three position side bar]. Keys shall be stamped U.S. GOVT. DO NOT DUP. Key-lock-operated switches shall be two position, with the key removable in either position. All key-lock-operated switches shall be keyed differently and only two keys shall be furnished for each key-lock-operated switch.

2.13 SYSTEM REQUIREMENTS

2.13.1 Signal Transmission Format Code

****
**NOTE: Different FO systems may use different modulation methods and codes. For example, the digital signal may turn the light source on or off, it may use frequency shift keying, or it may cause the intensity to shift between two preset levels. Likewise, the code can be the simple NRZ (non-return to zero), or it can be the more complex and efficient RZ (return to zero) code, such as the Manchester code. The modulation method can be important to bandwidth limited systems since some methods required twice the bandwidth of other methods for transmitting the same data.
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FO equipment shall use the same transmission code format from the beginning

of a circuit to the end of that circuit. Different transmission code formats may be used for different circuits as required to interconnect supported equipment.

2.13.2 Flux Budget/Gain Margin

****
**NOTE: The flux budget calculations for each FO link are used to determine if the gain margin designed into the link is large enough to allow for splicing of broken fibers and aging effects. The flux budget is the power difference between the transmitter output power and the receiver input power for a given bit error rate.

This power is usually measured in dBm (i.e. referenced to 1 milliwatt) and is an absolute measurement. LED transmitter output power is typically between -10 and -18 dBm. Positive Intrinsic Negative (PIN) receivers with pre-amplifiers have a power input typically between -24 and -37 dBm. Using the flux budget, the link designer can determine the total losses the system links can have and still work properly.

The flux budget is divided into components. The components are the real losses in the system and the gain margin. The real losses consist of all the system losses such as cable attenuation, coupling and splicing losses. The gain margin is a reserve for future losses, such as aging and future splices.
System losses and the gain margin are usually
measured in dB and are a relative measurement.

The receiver dynamic range is the range of input power that can be successfully detected by the receiver (also referred to as the maximum and

minimum optical input power). The variables that can influence the flux budget include changing the transmitter power output, the receiver sensitivity, the imposed signal wavelength and system losses. Allow 3 dB for aging and 3 dB for each cable repair for a total margin of not less than 6 dB. Different wavelengths exhibit different cable attenuation; thus for links that use DWDM or DWDM, the flux budget should be determined using the cable attenuation and connector losses for the wavelength with greater loss (which is usually the shorter wavelength).

****

FO links shall have a minimum gain margin of 6 dB. The flux budget is the difference between the transmitter output power and the receiver input power required for signal discrimination when both are expressed in dBm. The flux budget shall be equal to the sum of losses (such as insertion losses, connector and splice losses, and transmission losses) plus the gain margin. When a repeater or other signal regenerating device is inserted to extend the length of an FO circuit, both the circuit between the transmitter and the repeater-receiver, and the circuit between the repeater-transmitter and the receiver are considered independent FO links for gain margin calculations.

2.13.3 Receiver Dynamic Range

The dynamic range of receivers shall be large enough to accommodate both the worst-case, minimum receiver flux density and the maximum possible, receiver flux density. The receiver dynamic range shall be at least 15 dB.

Where required, optical attenuators shall be used to force the FO link power to fall within the receiver dynamic range.

2.14 OPTICAL FIBERS

****

**NOTE: FO systems use one or two fibers for each full duplex FO link. In the two-fiber links data flows only in one direction in each fiber. DWM and CWM systems often use one fiber for each full duplex FO link in which differing wavelenghts travel in opposite directions on one fiber. In some cases, such as sending sync and receiving video from long distances, bi-directional transmission on one fiber is desired. Shorter wavelenghts generally have greater attenuation; loss budgets should be based on the wavelength with the greater attenuation.

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2.14.1 General

Optical fibers shall be coated with a suitable material to preserve the intrinsic strength of the glass. The outside diameter of the glass-cladded fiber shall be nominally 125 microns, and shall be concentric with the fiber core. Optical fibers shall meet EIA ANSI/EIA/TIA-455-46A, and EIA ANSI/TIA/EIA-455-177A.

2.14.2 50 Micron Multimode Fibers

Conductors shall be multimode, graded index, solid glass waveguides with a nominal core diameter of 50 microns. The fiber shall have transmission windows centered at 850 and 1300 nanometer wavelengths. The numerical aperture for each fiber shall be a minimum of 0.20. The attenuation at 850 nanometers shall be 3.5 dB/Km or less. The attenuation at 1300 nanometers shall be 1.5 dB/Km or less. The minimum bandwidth shall be 500 MHz-Km at both transmission windows. The fibers shall be certified to meet EIA ANSI/EIA/TIA-455-30B and EIA ANSI/EIA/TIA-455-58B.

2.14.3 62.5 Micron Multimode Fibers

Conductors shall be multimode, graded index, solid glass waveguides with a nominal core diameter of 62.5 microns. The fiber shall have transmission windows centered at 850 and 1300 nanometer wavelengths. The numerical aperture for each fiber shall be a minimum of 0.275. The attenuation at 850 nanometers shall be 3.5 dB/Km or less. The attenuation at 1300 nanometers shall be 1.5 dB/Km or less. The minimum bandwidth shall be 160 MHz-Km at 850 nanometers and 500 MHz-Km at 1300 nanometers. FO cable shall be certified to meet EIA ANSI/EIA/TIA-455-30B and EIA ANSI/EIA/TIA-455-58B.

2.14.4 8.3 Micron Single-Mode Fibers

****
**NOTE: Single-mode FO DTS offer larger bandwidth, and lesser attenuation, usually at greater system cost than multimode FO DTS. Single-mode FO DTS will only be used when the designer determines that large bandwidth or low attenuation links warrant the single-mode FO DTS.
****
*

Conductors shall be single-mode, solid glass waveguides with a nominal core diameter of 8.3 microns. The fiber shall have a transmission windows centered at 1310 and 1550 nanometer wavelengths. The numerical aperture for each optical fiber shall be a minimum of 0.10. The attenuation for inside cable at 1310 and 1550 nanometers shall be 1.0 dB/Km or less. The attenuation for outside cable at 1310 and 1550 nanometers shall be 0.5 dB/Km or less. The fibers shall be certified to meet EIA ANSI/EIA/TIA-455-170.

2.15 CROSS-CONNECTS

2.15.1 Patch Panels

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**
NOTE: Show cross-connect or interconnect configuration on the drawings.

****
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Patch panels shall be a complete system of components by a single manufacturer, and shall provide termination, splice storage, routing, radius limiting, cable fastening, storage, and cross-connection. Patch panel connectors and couplers shall be the same type and configuration as used elsewhere in the system. Patch panels shall be [a 480 mm 19 inch rack mount type] [wall mounted] [as shown].

2.15.2 Patch Cords

Patch cords shall be cable assemblies consisting of factory connector-terminated flexible optical fiber cable with connectors of the same type as used elsewhere in the system. Optical fiber shall be the same type as used elsewhere in the system. Patch cords shall be complete assemblies from manufacturer's standard products.

2.16 CABLE CONSTRUCTION

****
**NOTE: Either tight-buffer or loose-tube cable construction can be used. The loose tube construction is more appropriate where the cable is subject to thermal expansion. This would include outdoor aerial and long distance runs over 1 Km (0.62 mile). In multistory buildings or locations where the cable is installed vertically and will not
experience significant temperature variations, use tight-buffer cables.

****

2.16.1 General

The cable shall contain a minimum of two fiber optic fibers for each link circuit. The number of fibers in each cable shall be [_____] [as shown]. Each fiber shall be protected by a protective tube. Cables shall have a jacketed strength member, and an exterior jacket. Cable and fiber protective covering shall be free from holes, splits, blisters, and other imperfections. All interior cables' insulation and jacketing material shall not contain any poly vinyl chloride (PVC) compounds. The covering shall be flame retardant, moisture resistant, non-nutrient to fungus, ultraviolet light resistant as specified and nontoxic. Mechanical stress present in cable shall not be transmitted to the optical fibers. Strength members shall be non-metallic and shall be an integral part of the cable construction. The combined strength of all the strength members shall be sufficient to support the stress of installation and to protect the cable in service. The exterior cables shall have a minimum storage temperature range of minus 40 to plus 75 degrees C minus 104 to plus 167 degrees F. Interior cables shall have a minimum storage temperature of minus 10 to plus 75 degrees C plus 14 to plus 167 degrees F. All optical fiber cables and all optical fiber

raceways furnished shall meet the requirement of NFPA 70. Fire resistant characteristics of optical fiber cables and optical fiber raceways shall conform to Article 770, Sections 49, 50, and 51. A flooding compound shall be applied into the interior of the fiber tubes, into the interstitial spaces between the tubes, to the core covering, and between the core covering and jacket of all cable to be installed aerially, underground, and in locations susceptible to moisture. Flooded cables shall comply with EIA ANSI/EIA-455-81A-91 and EIA ANSI/EIA/TIA-455-82B. Cables shall be from the same manufacturer, of the same cable type, of the same size, and of the same optical characteristics. Each fiber and protective coverings shall be continuous with no factory splices. Fiber optic cable assemblies, including jacketing and fibers, shall be certified by the manufacturer to have a minimum life of 30 years. Cables shall meet UL 1666. FO cable shall be certified to meet the following: EIA ANSI/TIA/EIA-455-13A, EIA ANSI/EIA/TIA-455-25C, EIA ANSI/TIA/EIA-455-41A, EIA ANSI/EIA/TIA-455-47B, EIA ANSI/EIA/TIA-455-59A, EIA ANSI/EIA/TIA-455-61A, EIA-455-88, EIA ANSI/EIA-455-91, EIA TIA/EIA-455-104A, and EIA ANSI/EIA-455-171.

2.16.2 Exterior Cable

2.16.2.1 Aerial Cable

The optical fibers shall be surrounded by a tube buffer, shall be contained in a channel or otherwise loosely packaged to provide clearance between the fibers and inside of the container, and shall be extruded from a material having a coefficient of friction sufficiently low to allow the fiber free movement.

- a. The cable outer jacket shall be medium density polyethylene material containing at least 2.6 percent carbon black with only black pigment added for additional coloring.

- b. Tensile strength: Cables shall withstand an installation tensile load of not less than 2700 Newtons 608 pounds and not less than 600 Newtons 135 pounds continuous tensile load.

- c. Impact and Crush resistance: The cables shall withstand an impact of 3 Newton-meters 1.7 lbs/in as a minimum, and shall have a crush resistance of 220 Newtons per square centimeter 317 psi as a minimum.

2.16.2.2 Duct Cable

The optical fibers shall be surrounded by a tube buffer, shall be contained in a channel or otherwise loosely packaged to provide clearance between the fibers and inside of the container, and shall be extruded from a material having a coefficient of friction sufficiently low to allow the fiber free movement.

- a. The cable outer jacket shall be medium density polyethylene

material
with orange pigment added for ease of identification.

- b. Tensile strength: Cables shall withstand an installation tensile load of not less than 2700 Newtons 608 pounds and not less than 600 Newtons 135 pounds continuous tensile load.

- c. Impact and Crush resistance: The cables shall withstand an impact of 3 Newton-meters 1.7 lbs/in as a minimum, and shall have a crush resistance of 220 Newtons per square centimeter 317 psi as a minimum.

2.16.2.3 Direct Burial Cable

The optical fibers shall be surrounded by a tube buffer, shall be contained
in a channel or otherwise loosely packaged to provide clearance between the
fibers and inside of the container, and shall be extruded from a material having a coefficient of friction sufficiently low to allow the fiber free movement.

- a. The cable outer jacket shall be medium density polyethylene material
containing at least 2.6 percent carbon black with only black pigment added for additional coloring.

- b. Tensile strength: Cables shall withstand an installation tensile load of not less than 2700 Newtons 608 pounds and not less than 600 Newtons 135 pounds continuous tensile load.

- c. Impact and Crush resistance: The cables shall withstand an impact of 3 Newton-meters 1.7 lbs/in as a minimum, and shall have a crush resistance of 220 Newtons per square centimeter 317 psi as a minimum.

- d. Direct burial cable shall be protected with plastic coated steel armor. The plastic coated steel armor shall be applied longitudinally directly over an inner jacket and have an overlap of 5 mm 0.20 inch minimum. Armoring materials shall provide corrosion protection from local environmental/soil conditions over the projected life of the cable.

2.16.3 Interior Cable

a. Loose buffer tube cable construction shall be such that the optical fibers shall be surrounded by a tube buffer, and shall be contained in a channel or otherwise loosely packaged to provide clearance between the fibers and the inside of the container to allow for thermal expansions without constraining the fiber. The protective container shall be extruded from a material having a coefficient of friction sufficiently low to allow the fiber free movement. The cable outer jacket shall be fluorocopolymer (FCP), which complies with NFPA 70 for optical fiber nonconductive plenum (OFNP) applications. Manufacturers' recommended values for tensile strength, impact resistance, and crush
resistance shall not be exceeded. Interior cables' insulation and jacketing material shall not contain any poly vinyl chloride (PVC)
compounds.

b. Tight buffer tube cable construction shall be extrusion of plastic over each cladded fiber, with an outer jacket of FCP, which complies with NFPA 70 for optical fiber nonconductive riser (OFNR) requirements for riser cables and vertical shaft installations. Optical fibers shall be covered in near contact with an extrusion tube and shall have an intermediate soft buffer to allow for the thermal expansions and minor pressures. Manufacturers' recommended values for tensile strength, impact resistance, and crush resistance shall not be exceeded. Interior cables' insulation and jacketing material shall not contain any poly vinyl chloride (PVC) compounds.

2.16.4 Pigtail Cables

Cable used for connections to equipment shall be flexible fiber pigtail cables having the same physical and operational characteristics as the parent cable. The cable jacket shall be FCP, which complies with NFPA 70 for OFNP applications. Maximum dB loss for pigtail cable shall be 3.5 dB/km at 850 nanometers, and 1.0 dB/km at 1300 nanometers, and [_____] dB/Km at 1550 nanometers.

2.17 FO CONNECTORS

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*
NOTE: Available FO connector types include, but are not limited to, FC, SC, Duplex SE (568SC), ST, Duplex ST, LC, Duplex LC, ESCON, FDDI, and MT-RJ. Equipment manufacturers may offer both a manufacturer's standard termination connector type and also an optional termination connector type or types as available on a specific equipment component, whereas some equipment may only be available with one termination connector type (as an example, one manufacturer offers a choice of either ST, SC, or FC connectors on a specific FO transceiver).

For equipment additions to existing installation, the installed base of legacy systems may suggest use of a certain type of connector be continued and to be used for new equipment. Alternatively, use of hybrid adapters or hybrid cables, will allow the use of cables with different connector types on opposite cable ends to permit the cable connectors to be compatible with the equipment termination connectors. Connectors with a pull-proof feature are preferable, especially for patch cords.

Nominal and maximum connector pair losses vary by connector type, by manufacturer, and by cable type (e.g., multimode or single mode). Nominal connector pair loss of 0.3 dB, and maximum connector pair loss of 0.5 dB are common for older types of FO connectors. Small form factor types and newer connector types may offer lesser nominal and lesser maximum loss value.
****

FO connectors shall be field installable, self-aligning and centering. FO connectors shall match the fiber core and cladding diameters. Provide FO cable connectors at field equipment [of the type to match the field equipment connectors] [of type [_____]] [as shown]. Provide FO connectors at terminal head end equipment [of the type to match terminal head equipment connectors] [of type [_____]] [as shown]. Connector insertion loss shall be nominally 0.3 dB and maximum loss shall be less than 0.7 dB.

2.18 MECHANICAL SPLICES

Mechanical splices shall be suitable for installation in the field. External power sources shall not be required to complete a mechanical splice. Mechanical splices shall be self-aligning for optimum signal coupling. Mechanical splices shall not be used for exterior applications where they may be buried underground or laced to aerial messenger cables. Mechanical splices may be used for interior locations and within enclosures. Splice closures shall protect the spliced fibers from moisture and shall prevent physical damage. The splice closure shall provide strain relief for the cable and the fibers at the splice points.

2.19 FUSION SPLICES

The fusion splicer shall be portable, fully automatic, and compact. It shall be suitable for fusion splicing all types of telecommunication grade optical fibers and individual fibers as well as cables containing multiple optical fibers. The fusion splicer shall be capable of operation under various environmental conditions (e.g., temperature, humidity, altitude, etc.) for all types of optical cable deployments. The fusion splicer shall be craft friendly and operation shall require only minimal training. Automatic splicing software shall be available to remove operator and environmental dependence from the splicing process. The controls of the fusion splicer shall be designed in accordance with ergonomic considerations. The automatic splicing process shall be started by pressing one button and can be interrupted at any time. Alternatively, semi-automatic (step-by-step) or manual splicing shall be available by menu selection. Communication with the fusion splicer shall be conducted through a language unspecific keyboard with universal symbols and the dialogue with the splicer shall be displayed on the device screen.

2.20 CONDUIT, FITTINGS AND ENCLOSURES

Conduit, fittings, and enclosures shall be as specified in Section 16402

INTERIOR DISTRIBUTION SYSTEM, and as shown.

2.21 FAN-OUT KITS

****

**NOTE: Fan-out kits (also referred to as providing buffer tube fan-out kits, or furcating harnesses, or furcation kits, or installing furcating tubes) will be provided for terminating all loose-tube optical fibers (i.e., optical fibers with 250 micron outside diameter) and will additionally incorporate strain relief if the connectorization is not contained within a patch panel. Fan-out kits with furcating tubes are typically not used for tight-buffered (e.g., 900

micron outside diameter) optical fibers
which have the connectorization contained within a
patch panel. Fan-out kits with strain relief
furcating tubes are appropriate for field
connectorization of tight-buffered optical fibers
when the termination is not contained within a
patch
panel.

****

For all loose-tube optical fibers, furnish and install fan-out kits using furcating tubes for connectorization. Loose-tube optical fiber furcating tubes shall incorporate strain relief if the connectorization is not contained within a protective enclosure such as a patch panel. For tight-buffered optical fibers, furnish and install fan-out kits using furcating tubes and which incorporate strain relief, if the connectorization is not contained within a protective enclosure such as a patch panel. Furcating tubes required to incorporate strain relief shall provide increased pullout protection and shall be comprised of an inner tube, surrounded by a layer of nonconductive strength members, then surrounded by an enclosing outer jacket layer. [Fan-out kits shall be color coded to match the industry fiber color scheme.] Length of furcating tube shall be [610] [915] mm [24] [36] inches minimum when installation is complete. Fan-out kits shall be rated for the ambient conditions of the location in which installed as specified in paragraph Environmental Requirements. Provide terminations for each fiber, regardless whether fiber is active or spare.

PART 3 EXECUTION

3.1 INSTALLATION

System components and appurtenances shall be installed in accordance with
the manufacturer's instructions and as shown. Interconnections, services,
and adjustments required for a complete and operable data transmission system shall be provided.

3.1.1 Interior Work

****
**NOTE: DTS cable should not be used for, or routed through, Sensitive Compartmented Information Facilities (SCIFs). The designer will not show any DTS cable routed through a SCIF. The designer should check DCID 1/21 for further direction.
****
*

Conduits, tubing and cable trays for interior FO cable shall be installed as specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM and as shown. Cable installation and applications shall meet the requirements of NFPA 70,
Article 770, Sections 52 and 53. Cables not installed in conduits or wireways shall be properly supported, secured, and neat in appearance,

and
if installed in plenums or other spaces used for environmental air, shall comply with NFPA 70 requirements for this type of installation.

3.1.2 Exterior Work, Aerial

****
**NOTE: Aerial cable should be installed on existing poles where height, clearance, and structure loading allow addition of cables. Where this is not possible, requirements for new poles must be shown on drawings. Installations will comply with IEEE C2 for Grade B construction and NFPA 70. Designer must coordinate with facility personnel for ground clearance and establish clearances to be shown on the drawings.

The designer will verify local electrical installation requirements to determine if new grounding conductors and electrodes are required at each messenger cable ground connection and will select the first, or second, or both bracketed entries as determined to be necessary.

Common lashing machines provide 1 turn per 380 linear mm (1 turn per 15 linear inches) in a single pass, which is acceptable for locations where loading due to weather conditions is moderate. Other locations may require multiple passes with the lashing machine.

Percent values stated below for messenger rated breaking strength are based upon overload factors that apply to Grade B construction. If the aerial electrical distribution system construction is a lesser grade (e.g., Grade C, Grade N, or not graded) differing values will be provided by the designer in accordance with NESC and actual requirements.
****

Except as otherwise specified, poles and associated aerial hardware for an overhead FO cable system shall be installed as specified in Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL, as specified herein, and as shown.

• a. A messenger system meeting the requirements of IEEE C2 to support aerial cables shall be furnished and installed. The messenger system shall include all messenger support and attachment hardware and appurtenances needed to install the messenger. Messenger tension due to combined ice and wind loading on the messenger with supported cables shall not exceed 60 percent of the messenger rated breaking strength. Messenger tension due to extreme wind loading on the messenger with supported cables shall not exceed 80 percent of the messenger rated breaking strength. Messenger support and attachment hardware shall have rated strength not less than the messenger rated breaking strength. All messenger support and attachment hardware and appurtenances shall be sized to exceed the rated breaking strength of the messenger cable. Messenger cables shall be galvanized zinc

coated steel or aluminum clad steel.

- b. The messenger cables shall be grounded at all corners, dead ends, at the entrance to each facility, and at intervals not exceeding 305 meters 1000 feet. [New grounding conductors and electrodes shall be provided at each ground connection.] [Where grounding connections are made in the vicinity of existing grounding conductors and electrodes, the grounding connection may be made by a bolted or welded connection to the existing grounding conductor.]
- c. Aerial FO cables shall meet the horizontal, vertical and climbing space clearances prescribed in IEEE C2 and those of the installation.

- d. Transitions from aerial cable to underground cable shall be as specified in paragraph CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS in Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL and as shown.

- e. Splices in aerial cable shall be within 1 meter 3 feet of a pole and placed inside a watertight enclosure. Drip loops shall be formed at the cable entrance to the enclosure. Lashing clamps shall be placed within 300 mm 12 inches of the enclosure.
- f. Loops shall be formed in the aerial cables at points of connection and at poles to prevent damage from thermal stress and wind loading. The communications cable shall be protected from chafing and physical damage with the use of spiral cut tubing and PVC tape, or plastic sleeves. The ground clearance of installed cabling shall be as shown.

- g. Cable shall be run vertically and when possible shall use gravity to assist in cable pulling. Cable shall be pulled from top of run to bottom of run. Cable shall be hand pull if possible. If machine assistance is required, tension shall be monitored using dynamometers or load-cell instruments and shall not exceed specified cable tension limits. After installation, the vertical tension on the cable shall be relieved at maximum intervals of 30 meters 100 feet using a split support grip.
- h. Lashing wire shall be wound tightly around both the communication cable and the messenger cable by machine methods. The lashing wire shall have a minimum of 1 turn per 380 linear mm1 turn per 15 linear inches and not less than the number of turns per unit length that is recommended by the cable manufacturer for the distance between cable support points and the combined ice and wind loading and extreme wind loading specified or normally encountered loading for the installed location. Lashing clamps shall be placed at all poles and splices.
- i. Ground conductors shall be soft drawn copper, having a current capacity of at least 20 percent of that of the messenger to which it is connected. Ground conductors shall not be smaller than No. 6 AWG. The ground conductor shall be connected to a copper or copper clad steel ground rod not less than 19.1 mm 3/4 inch in diameter, and length shall be as needed to achieve the specified ground resistance. After installation is completed, the top of the ground rod shall be approximately 300 mm 1 foot) below finished grade. The ground conductor shall be protected by half-round wood, plastic, or fiber molding from the ground to a point at least 2.4 m 8 feet above the ground. Ground resistance shall be measured in normally dry conditions, not less than 48 hours after a rainfall, and the total ground resistance shall not exceed [25] [_____] ohms.
- j. Design Parameters

****

NOTE: The designer will include the data listing

the loading conditions, including radial thickness

of ice, horizontal wind pressure, and temperature,

for both combined ice and wind loading and extreme

wind loading encountered at the project site.

****

The ice and wind loading conditions to be encountered at this installation are as follows:

aa. Combined ice and wind loading:

- (1) Radical thickness of ice [_____] mm in
- (2) Horizontal wind pressure [_____] Pa psf
- (3) Temperature [_____] degrees C degrees F
- (4) Constant to be added to the resultant [_____] N/m lb/ft

bb. Extreme wind loading:

- (1) Velocity pressure exposure coefficient, wire [_____]
- (2) Basic wind speed [_____] m/s mi/h
- (3) Temperature 15 degrees C 60 degrees F
- (4) Gust response factor, wire [1.0] [_____]
- (5) Importance factor [1.0] [_____]
- (6) Shape factor [1.0] [_____]

3.1.3 Exterior Work Underground

****
**
NOTE: For UMCS ESS or IDS projects, the designer will provide transition details in the drawings based on the details shown in UMCS/EMCS or IDS Typical Drawings and/or Standards installation Details.

****
*

Except as otherwise specified, conduits, ducts, and manholes for underground FO cable systems shall be installed as specified in Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and as shown.

- a. Minimum burial depth for cable shall be 760 mm 30 inches, but not less than the depth of the frost line. Burial depth specified shall take precedence over any requirements specified elsewhere.

- b. Where direct burial cable will pass under sidewalks, roads, or other paved areas, the cable shall be placed in a 25 mm 1 inch zinc-coated rigid coated conduit or larger as required to limit conduit fill to 80 percent or less. Conduit may be installed by jacking or trenching, as approved.

• c. Buried cables shall be placed below a plastic warning tape buried in the same trench or slot. The warning tape shall be 300 mm 12 inches above the cable. The warning tape shall be continuously imprinted with the words "WARNING - COMMUNICATIONS CABLE BELOW" at not more than 1.2 m 48 inch intervals. The warning tape shall be acid and alkali resistant polyethylene film, 76.2 mm 3 inches wide with a minimum thickness of

0.1 mm 0.004 inch. Warning tape shall have a minimum strength of 12066
kPa 1750 psi lengthwise and 10342 kPa 1500 psi crosswise.

• d. Transitions from underground cable to aerial cable shall be as specified in paragraph CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS in Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL and as shown.

• e. For cables installed in ducts and conduit, a cable lubricant compatible with the cable sheathing material shall be used on all

cables pulled. Pulling fixtures shall be attached to the cable strength members. If indirect attachments are used, the grip diameter and length shall be matched to the cable diameter and characteristics. If an indirect attachment is used on cables having only central strength members, the pulling forces shall be reduced to ensure that the fibers are not damaged from forces being transmitted to the strength member. During pulling the cable pull line tension shall be continuously monitored using dynamometers or load-cell instruments, and shall not exceed the maximum tension specified by the cable manufacturer. The mechanical stress placed upon the cable during installation shall be such that the cable is not twisted or stretched. A cable feeder guide shall be used between the cable reel and the face of the duct or conduit to protect the cable and guide it into the duct or conduit as it is unspooled from the reel. As the cable is unspooled from the reel, it shall be inspected for jacket defects or damage. The cable shall not be kinked or crushed and the minimum bend radius of the cable shall not be exceeded during installation. Cable shall be hand fed and guided through each manhole and additional lubricant shall be applied at all intermediate manholes. When practicable, the center pulling technique shall be used to lower pulling tension. That is, the cable shall be pulled from the center point of the cable run towards the end termination points. The method may require the cable to be pulled in successive pulls. If the cable is pulled out of a junction box or manhole the cable shall be protected from dirt and moisture by laying the cable on a ground covering.

3.1.4 Service Loops

Each fiber optic cable shall have service loops of not less than 3 meters

9.8 feet in length at each end. The service loops shall be housed in a service loop enclosure.

3.1.5 Metallic Sheath Grounding

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NOTE: Direct burial cables with metallic sheath will not be installed when transmission of electromagnetic interference (EMI) or radio frequency interference (RFI) through the metallic sheath is a consideration.

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*

Fiber optic cable with metallic sheath that enter buildings shall be grounded at a point as close as practical to the building point of entrance. Fiber optic cable with metallic sheath routed in the trench with
a power cable shall have the metallic sheath grounded at the cable termination points.

3.1.6 Splices

****
**
NOTE: Maximum splice loss values per ANSI/TIA/EIA-568B are 0.3 dB for fusion splices, and

0.3 dB for mechanical splices. These maximum loss values are considered larger loss values than can be provided by many manufacturers and installers. The designer will specify lesser loss values when the design and link loss budget require lesser values.
****

3.1.6.1 General

No splices will be permitted unless the length of cable being installed exceeds the maximum standard cable length available from a manufacturer or unless fiber optic pigtails are used to connect transmitters, receivers, or other system components for terminations to the fiber. Splices shall be made using the method recommended by the cable manufacturer. Splices shall be housed in a splice enclosure and shall be encapsulated with an epoxy, ultraviolet light cured splice encapsulant or otherwise protected against infiltration of moisture or contaminants. FO splices shall be field tested at the time of splicing. Fusion splices shall have nominal splice loss of
[0.15] [_____] dB for multimode and for single mode cable fusion splices
and shall have maximum fusion splice loss not more than 0.3 dB loss.

3.1.6.2 Mechanical Splices

Mechanical splices shall have nominal splice loss of [0.15] [_____] for multimode fiber mechanical splices and [0.2] [_____] dB for single mode fiber mechanical splices and shall have maximum mechanical splice loss not more than [0.3] [_____] dB loss for multimode and for single mode fiber mechanical splices. There shall be no more than 1 splice per km 0.62 mile in any of the FO cables excluding terminations. Field splices shall be located in cable boxes. Sufficient cable shall be provided in

each splicing location to properly rack and splice the cables, and to provide extra cable for additional splices. Cable ends shall be protected with end caps except during actual splicing. During the splicing operations, means shall be provided to protect the unspliced portions of the cable and its fibers from the intrusion of moisture and other foreign matter.

3.1.7 Connectors

****
**NOTE: Maximum connector pair losses per ANSI/TIA/EIA-568B are provided in the first bracketed entry and are considered larger than connector pair losses that can be achieved by many manufacturers and installers. The designer will specify lesser loss values when the design and link loss budget requires lesser values. The designer will confirm with two manufacturers minimum, that the lesser connector pair loss value can be achieved for the connector type and fiber (i.e., multimode or single mode) type.
****
*

Prior to and during installation of connectors, appropriate cleaning should be performed to ensure that any contaminant particulates larger than 0.06 micron in size are removed. Connectors shall be as specified in paragraph FO CONNECTORS. Connectors or splices which leave residue on the connector ferrule or optical connector "lens", are not permitted. Fibers at each end of the cable shall have jumpers or pigtails installed of not less than 1 meter 3 feet in length. Fibers at both ends of the cable shall have connectors installed on the jumpers. The mated connector pair loss shall not exceed [0.75] [_____] dB. The pull strength between the connector and the attached fiber shall not be less than 22.7 kg 50 pounds.

3.1.8 Identification and Labeling

Identification tags or labels shall be provided for each cable. Markers, tags and labels shall use indelible ink or etching which will not fade in sunlight, or in buried or underground applications. Markers, tags, and labels shall not become brittle or deteriorate for a period of 20 years due to moisture, sunlight, soil minerals, chemicals or other environmental elements. Label all termination blocks and panels with cable number or pair identifier for cables in accordance with EIA ANSI/TIA/EIA-606A and as specified. The labeling format shall be identified and a complete record shall be provided to the Government with the final documentation. Each cable shall be identified with type of signal being carried and termination points.

3.1.9 Enclosure Sizing and Cable

Termination enclosures shall be sized to accommodate the FO equipment to be
installed. Sizing shall include sufficient space for service loops to be provided and to accommodate a neat, workmanlike layout of equipment and the
bend radii of fibers and cables terminated inside the enclosure.

3.1.10 Enclosure Penetrations

Enclosure penetrations shall be from the bottom and shall be sealed with
rubber silicone sealant to preclude the entry of water. Conduits rising
from underground shall be internally sealed.

3.2 TESTING

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**
NOTE: Insert the title of the appropriate system
specification (such as UMCS, IDS, ESS or CCTV).

****
*

3.2.1 General

The Contractor shall provide personnel, equipment, instrumentation, and

supplies necessary to perform testing.

3.2.2 Contractor's Field Test

The Contractor shall verify the complete operation of the data transmission system in conjunction with field testing associated with systems supported by the fiber optic data transmission system as specified in Section [_____] prior to formal acceptance testing. Field tests shall include a flux density test. These tests shall be performed on each link and repeated from the opposite end of each link.

3.2.2.1 Optical Time Domain Reflectometer Tests

Optical time domain reflectometer tests shall be performed using the FO test procedures of EIA ANSI/EIA/TIA-455-59A. An optical time domain reflectometer test shall be performed on all fibers of the FO cable on the reel prior to installation. The optical time domain reflectometer shall be calibrated to show anomalies of 0.2 dB as a minimum. Photographs of the traces shall be furnished to the Government. An optical time domain reflectometer test shall be performed on all fibers of the FO cable after it is installed. The optical time domain reflectometer shall be calibrated to show anomalies of 0.2 dB as a minimum. If the optical time domain
reflectometer test results show anomalies greater than 1 dB, the FO cable segment is unacceptable to the Government. The unsatisfactory segments of cable shall be replaced with a new segment of cable. The new segment of cable shall then be tested to demonstrate acceptability. Photographs of the traces shall be furnished to the Government for each link.

3.2.2.2 Power Attenuation Test

Power attenuation test shall be performed at each light wavelength of the transmitter to be used on the circuit being tested. The flux shall be measured at the FO receiver end and shall be compared to the flux injected at the transmitter end. There shall be a jumper added at each end of the circuit under test so that end connector loss shall be validated. Rotational optimization of the connectors will not be permitted. If the circuit loss exceeds the calculated circuit loss by more than 2 dB, the circuit is unsatisfactory and shall be examined to determine the problem. The Government shall be notified of the problem and what procedures the Contractor proposes to eliminate the problem. The Contractor shall prepare and submit a report documenting the results of the test.

3.2.2.3 Gain Margin Test

The Contractor shall test and verify that each circuit has a gain margin which exceeds the circuit loss by at least the minimum gain margin specified in paragraph FLUX BUDGET/GAIN MARGIN.

3.2.2.4 Analog Video Signal Test

Analog video circuits shall be tested using a signal conforming to EIA 170.

The monitor or automated test set shall be stable, and shall be as described in EIA 170. If the result is unsatisfactory, the circuit shall be examined to determine the problem. The Government shall be notified of the problem and of the procedures the Contractor proposes to eliminate the problem. The Contractor shall prepare and submit a report documenting the results of the test.

3.2.2.5 Digital Video Signal Test

Digital video circuits shall be tested using a signal conforming to EIA 170.

The monitor or automated test set shall be stable, and shall be as described in EIA 170. If the result is unsatisfactory, the circuit shall be examined to determine the problem. The Government shall be notified of the problem and of the procedures the Contractor proposes to eliminate the problem. The Contractor shall prepare and submit a report documenting the results of the test.

3.2.2.6 Performance Verification Test and Endurance Test

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***
NOTE: This requirement pertains only to UMCS, IDS, ESS and CCTV projects.

****
*

The FO data transmission system shall be tested as a part of the completed
[UMCS] [IDS] [ESS] [CCTV] [_____] during the Performance Verification

Test
and Endurance Test as specified in Section [_____].

3.3 TRAINING

3.3.1 General

The Contractor shall conduct a training course for designated personnel in the maintenance of the FO system. The training shall be oriented to the specific system being installed under this specification. The Contractor shall furnish training materials and supplies.

3.3.2 System Maintenance Course

The system maintenance course shall be taught at the project site after completion of the endurance test for a period of 1 training day. A maximum of five personnel designated by the Government will attend the course. A training day shall be 8 hours of classroom or lab instruction, including two 15 minute breaks and excluding lunchtime during the daytime shift in effect at the facility. Training shall include:

- a. Physical layout of the system and each piece of hardware.
- b. Troubleshooting and diagnostics procedures.
- c. Repair instructions.
- d. Preventative maintenance procedures and schedules.
- e. Calibration procedures. Upon completion of this course, the students shall be fully proficient in the maintenance of the system.

-- End of Section -

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SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16798A

TWO-WAY RADIO DATA ETHERNET TRANSMISSION SYSTEM

04/04

PART 1 GENERAL

1.1 REFERENCES

1.2 SYSTEM DESCRIPTION

1.2.1 General

1.2.2 Environmental Requirements

1.2.3 Electrical Requirements

1.2.4 Power Line Surge Protection

1.2.5 Communications Links Surge Protection

1.2.6 Communications Links Overvoltage Protection

1.3 TECHNICAL DATA AND COMPUTER SOFTWARE

1.3.1 Group I Technical Data Package

1.3.1.1 System Drawings

1.3.1.2 Equipment Data

1.3.1.3 Transmission System Descriptions and Analyses

1.3.1.4 RF Area Coverage Report

1.3.1.5 Manufacturer's Certifications

1.3.2 Group II Technical Data Package

1.3.3 Group III Technical Data Package

1.3.4 Group IV Technical Data Package

1.3.4.1 Performance Verification and Endurance Testing Data

1.3.4.2 Operation and Maintenance Data

1.3.4.3 Training Data

1.3.5 Group V Technical Data Package

1.3.5.1 Hardware Manual

1.3.5.2 Operator's Manual

1.3.5.3 Maintenance Manual

PART 2 PRODUCTS

2.1 RADIO FREQUENCY COMMUNICATION EQUIPMENT (RFCE)

2.1.1 General

2.1.2 Government Furnished

2.1.3 Contractor Furnished

2.2 WIRELESS ETHERNET BRIDGE

2.2.1 Ethernet Bridge Requirements

2.2.2 Stand-by Ethernet Bridge

2.2.3 Hot Stand-by Protection Switch

2.2.4 Operating Conditions

2.2.5 Security

2.2.6 Software

2.3 ANTENNA SYSTEM

2.4 GROUND RODS
2.5 COMMUNICATION WIRING LINKS
2.6 CONDUIT
2.7 ENCLOSURES
2.8 WALL PENETRATIONS
2.9 NAMEPLATES

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Wireless Ethernet Bridge
3.1.2 Antenna
3.1.3 Interior Work
3.1.4 Exterior Work
3.1.4.1 Underground
3.1.4.2 Aerial
3.2 ENCLOSURE PENETRATIONS
3.3 IMPULSE SUPPRESSION SURGE ARRESTER GROUNDING
3.4 TESTING
3.4.1 General
3.4.2 Government Furnished RFCE Test
3.4.3 Test Plan
3.4.4 Contractor's Field Test
3.4.5 Test Oversight
3.4.6 Test Reporting
3.4.7 Verification Test and Endurance Test

-- End of Section Table of Contents -

Preparing Activity: USACE MasterFormat™ 2004 - 27 05 13.00 10
Superseding
UFGS-16798A (March 1989)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

Revised throughout - changes not indicated by CHG tags

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SECTION 16798A

TWO-WAY RADIO DATA ETHERNET TRANSMISSION SYSTEM

04/04

****

NOTE: This guide specification covers the requirements for two-way radio data ethernet transmission systems.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

****

PART 1 GENERAL

****

NOTE: This section will be used in conjunction with Section 16792A WIRE LINE DATA TRANSMISSION SYSTEM;

Section 16402 INTERIOR DISTRIBUTION SYSTEM; Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL; Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND; Section 13720A ELECTRONIC SECURITY SYSTEM; Section 13451A POWER MONITORING SYSTEM; Section 13801A UTILITY MONITORING AND CONTROL SYSTEM (UMCS); and any other guide specification sections required by the design.

****

1.1 REFERENCES

****

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 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.

****

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.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

IEEE Std 142 (1992) Recommended Practice for Grounding of Industrial and Commercial Power Systems - Green Book

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)NEMA 250 (2003) Enclosures for Electrical Equipment (1000 Volts Maximum)NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)NFPA 780 (2000) Installation of Lightning Protection Systems

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)
FCC Part 15 Radio Frequency Devices (47 CFR 15)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
47 CFR 15 Radio Frequency Devices

1.2 SYSTEM DESCRIPTION

1.2.1 General

**********NOTE: Designer must show location of radio frequency (RF) equipment to be controlled. Designer must also show any Government furnished equipment (GFE). A standby bridge and hot standby protection switch may be required for critical areas.
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A two-way radio system for wireless data transmission from building to building (point-to-point) for the utility, monitoring and control system (UMCS) used to extend the Ethernet shall be provided. The two-way radio data transmission system shall consist of wireless Ethernet bridges, [hot standby protection switch], communication links, antenna systems, communication links surge and overvoltage protection, and powerline surge protection. Computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class A computing devices and labeled as set forth in 47 CFR 15. [The system shall be compatible with the existing two-way radio equipment shown.] [The system shall be interfaced with the UMCS as shown.]

1.2.2 Environmental Requirements

Equipment to be utilized indoors shall be rated for continuous operation
under ambient environmental conditions of 2 to 49 degrees C 35 to 120
degrees F dry bulb and 10 to 95 percent relative humidity, noncondensing.
All other equipment shall be rated for continuous operation under the
ambient environmental temperature, pressure, humidity, and vibration
conditions specified or normally encountered for the installed location.

1.2.3 Electrical Requirements

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NOTE: Designer must show electrical details for
power sources and UPS if required.

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The equipment shall operate from an AC voltage source as shown, plus or

minus 10 percent, at a frequency of 60 Hz, plus or minus 2 percent.

1.2.4 Power Line Surge Protection

Power Line Surge Protection Equipment connected to AC circuits shall be protected from power line surges. Equipment shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

1.2.5 Communications Links Surge Protection

Communications Links Surge Protection Communications equipment shall be protected against surges induced on any communications link. Cables and conductors which serve as communications links shall have surge protection circuits installed at each end. Protection shall be furnished at equipment and additional triple electrode gas surge protectors rated for the application on each circuit shall be installed within 1 meter 3 feet of the building cable entrance. Surge protection shall meet the requirements of NFPA 780 guidelines and specifications and shall be able to withstand the
following:

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of
1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of
1000 volts and a peak current of 500 amperes. Fuses shall not be used
for surge protection.

1.2.6 Communications Links Overvoltage Protection

All communications equipment such as repeaters and transceivers shall be protected against overvoltage on any communications links. Cables and conductors which serve as communications links shall have overvoltage protection for voltages up to 480 Vac rms, 60 Hz installed. Instrument fuses or fusible resistors are acceptable for this application.

1.3 TECHNICAL DATA AND COMPUTER SOFTWARE

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**********NOTE: The acquisition of technical data, data bases and computer software items will be in accordance with the Federal Acquisition Regulation (FAR) and the Department of Defense Acquisition Regulation Supplement (DFARS). Those regulations, as well as the Army and Corps of Engineers implementations thereof, should be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost.

Specifically, the Rights in Technical Data and
Computer Software Clause, DFARS 52.227-7013, and the
Data Requirements Clause, DFARS 52.227-7031, as well
as any requisite software licensing agreements will
be made a part of the CONTRACT CLAUSES or SPECIAL
CONTRACT REQUIREMENTS of the contract. In addition,
the appropriate DD Form 1423 Contract Data Requirements List will be filled out for each distinct deliverable data item and made a part of
the contract.

Where necessary, a DD Form 1664, Data Item Description, shall be used to explain and more fully

identify the data items listed on the DD Form 1423.
It is to be noted that all of these clauses and
forms are required to assure the delivery of the
data in question and that such data is obtained with
the requisite rights to use by the Government.

Include with the request for proposals a completed DD Form 1423, Contract Data Requirements List. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly specified, both description and quantity required. Include in the SPECIAL CONTRACT REQUIREMENTS with the request for proposals a payment schedule, obtainable from the UMCS-MCX at Huntsville Center. This payment schedule will define payment milestones and percentages at specified times during the contract period.

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The technical data specified herein shall be delivered in accordance with Contract Clauses, Special Contract Requirements, and the Contract Data Requirements List, DD Form 1423 which is attached and made a part of this Contract. Technical data shall be coordinated with the requirements of Section [_____]. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. Data shall be organized and delivered as follows:

1.3.1 Group I Technical Data Package

1.3.1.1 System Drawings

The data package shall include the following:

a. Data Transmission System block diagram.

b. Radio System component installation and wiring diagrams.

c. Radio System physical layout and schematics.

d. Details of connections to power sources, including grounding.

e. Details of surge protection device installation.

f. Details of cable splicing and connector installations.

1.3.1.2 Equipment Data

A complete data package shall be delivered for all materials, including

field and system equipment.

1.3.1.3 Transmission System Descriptions and Analyses

The Group I data package shall include complete system descriptions, analyses, and calculations used to configure required equipment. Descriptions and calculations shall show how the equipment will operate as a system to meet the specified performance requirements. Package shall include calculations and/or test results which indicate adequate signal strength to ensure reliable operation throughout areas where radio equipment is in service.

1.3.1.4 RF Area Coverage Report

The Group I data package shall include an area coverage report incorporating a topographical map with coverage indicated. The following shall be shown on the map:

a. Location of the transmitter and antenna.

b. Location of the most distant radio in each compass quadrant from the transmitting antenna.

c. Radials (straight line segments indicating direction, distance and difference in elevation) from the transmitting antenna to the radio switches described in b. above.

d. Location along each radial of any obstacle to line of sight propagation.

e. Radiation pattern of the transmitted signal.

f. Attenuation (dB) between the transmitting antenna and the radio switches described in b. above. The system loss shall take into account the effect of terrain variables such as distance, antenna height, obstructions, and absorption losses.

g. System gain for each radio switch location described in b. above. The system gain shall take into account the attenuation between the Central Station or repeater and the antennas, the gain of each antenna, and the transmission line losses.

h. Power output of the transmitter.

i. Calculated receiver input signal voltages and signal-to-noise (S/N) ratios for radio switches described in b. above.

1.3.1.5 Manufacturer's Certifications

Manufacturer's certifications shall be included with the Group I data

package.

1.3.2 Group II Technical Data Package

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NOTE: Remove Group II when there is no Government furnished equipment.

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The Group II technical data package shall include the results of the testing and calibration of the Government furnished Radio Frequency Communication Equipment (RFCE). Defective or nonrepairable equipment shall be reported. An estimate of the materials and costs required to repair or replace defective equipment shall be provided. Within 10 days after completion of testing and calibration, a certificate shall be provided that the Government furnished RFCE is in calibration and is functioning correctly.

1.3.3 Group III Technical Data Package

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NOTE: Insert section number and title for the UMCS specification.

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The Group III technical data package shall consist of factory testing data.

The Contractor shall prepare and submit test procedures using Section [_____] as a guide for the factory test. The procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the specified requirements, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system.

1.3.4 Group IV Technical Data Package

1.3.4.1 Performance Verification and Endurance Testing Data

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NOTE: Insert section number and title for the UMCS specification.

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The Contractor shall prepare and submit test procedures using Section [_____] as a guide, excluding all surge and overvoltage tests, for the performance verification test and endurance test. Surge and overvoltage tests shall not be conducted during the performance verification test. The test procedures shall describe the applicable tests to be performed, and other pertinent information such as specialized test equipment required, and length of performance verification test. The test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the specified requirements. Receiver input signal voltages and S/N ratios as required by the RF area coverage report shall be verified as adequate for system operation. Performance verification and endurance test procedures shall be submitted by the Contractor and approved by the Government in writing before starting tests.

1.3.4.2 Operation and Maintenance Data

A draft copy of the operation and maintenance data, in manual format, as
specified for the Group V technical data package, shall be delivered to the
Government prior to beginning the performance verification test, for use
during site testing.

1.3.4.3 Training Data

Lesson plans and training data, in manual format, for the training phases,
including type of training to be provided, with a list of reference
material, shall be delivered for approval.

1.3.5 Group V Technical Data Package

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**********NOTE: Unless the installation has a specific requirement, specify six copies of the operator's manual and two copies of all other manuals. The number of copies must be coordinated with requirements defined in DD Form 1423.
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The Group V technical data package shall consist of the system documentation. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subContractor installing equipment and systems and of the nearest service representative for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies, bound in hardback loose-leaf binders, shall be delivered within 30 days after completion of the endurance test, and shall include all modifications made during installation, checkout, and acceptance. Manuals delivered shall include:

a. Hardware Manual: [two] [_____] copies.

b. Operator's Manual: [six] [_____] copies.

c. Maintenance Manual: [two] [_____] copies.

1.3.5.1 Hardware Manual

A manual describing equipment furnished,

including:

a. General description and specifications.
b.Installation and checkout procedures.

c. Equipment electrical schematics and layout drawings.

d. Alignment and calibration procedures.

e. Manufacturer's repair parts list indicating sources of supply.

f. Interface definition.

1.3.5.2 Operator's Manual

The operator's manual shall fully explain procedures and instructions for operation of the system.

1.3.5.3 Maintenance Manual

The maintenance manual shall include descriptions of maintenance for all equipment including inspection, calibration, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.

PART 2 PRODUCTS

2.1 RADIO FREQUENCY COMMUNICATION EQUIPMENT (RFCE)

2.1.1 General

All equipment need for a complete two-way radio system for wireless data transmission from building to building (point-to-point) for the utility, monitoring and control system (UMCS) used to extend the Ethernet shall be provided. The two-way radio data transmission system shall consist of

wireless bridges, [hot standby protection switch], communication links,
antenna systems, communication links surge and overvoltage protection, and
powerline surge protection.

2.1.2 Government Furnished

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**********NOTE: Designer must identify Government furnished RFCE. The Government may supply the use of existing antennas or antenna space on a tower or other suitable geographical location.
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The Government will provide RFCE as indicated. All government furnished

equipment shall be tested by the Contractor to assure that the equipment is
in calibration and functioning correctly. Modifications to the Contractor's system shall be compatible with the government furnished
equipment.

2.1.3 Contractor Furnished

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NOTE: Designer to select which components of the network are Contractor furnished or Government furnished.

A. The designer must determine if there is line of
site between the point-to-point bridges. If not,
then the designer must utilize antennas to create
line of site.

B. The location where the point-to-point bridge or antenna is located may already contain RF equipment.

If this is the case, band pass or band reject filters may be needed for simultaneous operation.

C. Designer must identify Government furnished

wire lines for use as DTM with remote base station if GF wire lines are to be used and available.

D. The frequency assignment must be coordinated from the installation Director of Information Management.

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All RFCE not shown as Government furnished shall be furnished and installed by the Contractor. Contractor furnished RFCE shall provide data communication operation.

2.2 WIRELESS ETHERNET BRIDGE

**********NOTE: The frequency assignment must be coordinated with the installation Director of Information Management, Operation range must be specified, and operating conditions must be specified. The sections below show typical operating specifications but can be adjusted to increase distance, frequency, and operating conditions.
****

Bridges shall be of solid state design and shall use a license-free frequency band. The bridge shall be compliant with FCC Part 15 code. Bridges can be a single integrated unit, or it may consist of separate transmitter and receiver modules with a common power supply, amplifier and control unit. The bridge may also utilize an integrated antenna or an external antenna. The bridges shall be used to extend a connection for remote locations to allow wireless data transmission of the Ethernet.

2.2.1 Ethernet Bridge Requirements

The Ethernet bridge shall operate on a license-free frequency band of [2.4]

[5] GHz. Frequency stability shall be within 0.00025 percent over the

operating temperature range. The bridge shall have a minimum throughput of 8 Mbps. The bridge must have a minimum transmission power of +20 dBm. The bridge shall have a digital interface that utilizes a RJ-45 connector at a minimum of 10BaseTx transmission speed. The bridge power consumption must be less than 60 watts. There must be bi-colored or separate indicator lights for power and transmitting status. A low loss type "N" connector must be used to connect the bridge to the antenna. All interconnecting cables among station elements must be provided with bridge. The bridge shall have a minimum broadcast range of [1, 5, 10, 50] miles to allow connection between the point-to-point bridges. The bridges shall be used to extend a connection for remote locations to allow wireless data transmission of the Ethernet.

2.2.2 Stand-by Ethernet Bridge

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NOTE: A stand-by bridge and hot stand-by protection switch may be required for critical areas.

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A stand-by Ethernet bridge shall be provided for each bridge location. The bridge shall utilize a hot stand-by protection switch. The bridge may be manually swapped from primary to backup.

2.2.3 Hot Stand-by Protection Switch

The protection switch shall simultaneously switch all radio functioning including Ethernet bridge RF, antenna, data, orderwire, diagnostics, and auxiliary data ports to the stand-by radio whenever there is a hardware failure indicated. The protection switch shall only require the use of one antenna for both bridges. The switching time shall be less than 5 seconds. There shall be status and alarm indicator lights.

2.2.4 Operating Conditions

The environmental operating conditions for the bridge shall be a minimum of 0 to 55 degrees C 32 to 131 degrees F and a maximum of 85% relative humidity.

2.2.5 Security

The bridges must utilize a security protocol that has a minimum of 128-bit encryption on all data being transferred from the point-to-point bridges.

2.2.6 Software

Bridges shall utilize integrated web-based network management software or a direct telnet connection for configuration and diagnostic.

2.3 ANTENNA SYSTEM

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NOTE: The designer must show the topography on the drawings and select appropriate environmental conditions.

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Antenna system shall be selected to be consistent with the paragraph RADIO FREQUENCY COMMUNICATION EQUIPMENT (RFCE) SYSTEM REQUIREMENTS. The antenna,

when possible, shall be placed on a tall structure or similar geographical feature, such as a water tower, tall building, existing radio tower, or mountain to maintain the needed line of site to each antenna. The antenna system shall utilize vertical polarization antennas, communication links between bridges and antennas, and matching networks as needed for the proper coverage. The antenna system shall be either omni-directional or shaped-coverage as determined by the Contractor from the topography. The antenna

system and cabling shall be furnished to provide adequate system gain. The antennas shall be capable of withstanding the environmental conditions of 201.2 km/hour 125 mph wind and 13 mm 1/2-inch radial ice without failure. The antenna system shall be selected by the Contractor to meet the requirements as determined from the topography. Lightning protection shall comply with NFPA 780. Grounding Conductors Antenna grounding conductors shall be minimum 32-strand, No. 17 AWG copper.

2.4 GROUND RODS

Ground rods shall be as specified in Section 16402 INTERIOR DISTRIBUTION

SYSTEM.

2.5 COMMUNICATION WIRING LINKS

Transmission line between the wireless bridge and the antenna shall be 50-ohm impedance rated for the transmitter output power. Minimum requirement shall be cable that exhibits an attenuation not exceeding 1.1 dB per 30.5 m 100 feet.

2.6 CONDUIT

Conduit as specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM and Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and as shown shall be furnished.

2.7 ENCLOSURES

**********NOTE: The designer must show where enclosures are needed on the drawings. All outdoor equipment shall utilize an enclosure. Indoor units may utilize an enclosure or be placed in existing communication racks. Coordinate the location of the indoor units with the Director of Information Management.
****

Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures installed indoors may be NEMA Type 1 when located in a clean dry environment, and shall be NEMA Type 12 when installed indoors in other than clean dry environment, or as shown. Enclosures installed outdoors shall be NEMA Type 4 unless otherwise shown.

2.8 WALL PENETRATIONS

Provide firestopping around all wall penetrations in accordance with Section 07840 FIRESTOPPING.

2.9 NAMEPLATES

Nameplates shall have unique identifiers engraved or stamped. Permanently attach nameplates to enclosure panel doors and back plates. For each field mounted piece of equipment attach a plastic or metal tag with equipment name and point identifier.

PART 3 EXECUTION

3.1 INSTALLATION

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NOTE: This section must be used in conjunction with Section 13801A UTILITY MONITORING AND CONTROL SYSTEM (UMCS); Section 16402 INTERIOR DISTRIBUTION SYSTEM; Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND; Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL; and any other guide specification sections required by the design.
****

System components and appurtenances shall be installed in accordance with the manufacturer's instructions and as shown. Necessary interconnections, services, and adjustments required for a complete and operable wireless radio data transmission system shall be provided and shall be fully integrated with the UMCS Ethernet. Grounding shall be in accordance with IEEE Std 142.

3.1.1 Wireless Ethernet Bridge

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NOTE: Coordinate the location of the indoor and outdoor units with the Director of Information Management.
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All system components and appurtenances shall be installed in accordance with the manufacturer's instructions. Indoor components shall be installed in communication closet utilizing existing equipment racks or in new enclosures. All outdoor components shall be installed in enclosures.

3.1.2 Antenna

Tubular radiator elements shall be plugged to prevent wind vibration fatigue. Vertical tubular elements shall have drain holes near the bottom.

Outside connectors shall be snug, filled with silicone grease, and properly sealed with heat-shrink wrap suitable for ambient temperatures of minus 30 to plus 60 degrees C minu 22 to plus 140 degrees F.

3.1.3 Interior Work

All interior electrical work shall be installed as specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM and as shown.

3.1.4 Exterior Work

3.1.4.1 Underground

Except as otherwise specified, underground electrical work shall be

installed as specified in Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and as shown.

a. Where direct burial cable will pass under sidewalks, roads, or other paved areas, the cable shall be placed in minimum 25 mm 1 inch rigid galvanized steel conduit. Conduit may be installed by jacking or trenching, as approved. When direct burial cable is to be placed in heavy use areas other than paved areas and where the cable may be subject to damage from heavy equipment, the cable shall be placed in minimum 25 mm 1 inch rigid PVC conduit schedule 80, buried a minimum of 1067 mm 42 inches below the surface.

b. Direct burial cable shall be placed below a minimum 75 mm 3 inch wide plastic warning tape buried in the same trench or slot. The tape shall be 305 mm 12 inches above the cable. The warning tape shall be continuously imprinted with the words "WARNING--COMMUNICATION CABLE BELOW" at not more than 1.2 meter 4 foot intervals.

c. Transitions from underground cable to aerial cable shall be as specified for CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS in Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

d. Splices shall be installed in cable boxes. Sufficient cable shall be provided in each splicing location to properly rack and splice the cables, and to provide extra cable for additional splices. Proper strain relief shall be provided. Cable ends shall be protected at all times with end caps except during actual splicing. During the splicing operations, means shall be provided to protect the unspliced portions of the cable from the intrusion of moisture and other foreign matter.

e. For cable installed in ducts and conduit, a cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it into the duct and conduit as it is played off the reel. As the cable is played off the reel, it shall be inspected for jacket defects. Cable shall not be kinked or crushed during installation. A pulling eye shall be attached to the cable and used to pull the cable through the duct and conduit system. Cable shall be hand fed and guided through each manhole. As the cable is played off the reel into the cable feeder guide, it shall be sufficiently lubricated with a type of lubricant recommended by the cable manufacturer. Where the cable is pulled through a manhole, additional lubricant shall be applied at intermediate manholes. Dynamometers or load-cell instruments shall be used to ensure that the pulling line tension does not exceed the installation tension value specified by the cable manufacturer. The mechanical stress placed upon a cable during installation shall not be such that the cable is twisted or stretched.

3.1.4.2 Aerial

**********NOTE: Aerial cable should be installed on existing poles. Where this is not possible, requirements must be shown on drawings. Designer must coordinate with facility personnel for ground clearance and establish clearances to be shown on drawings.
****

Except as otherwise specified, aerial electrical work shall be installed as

specified in Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL and as shown.

a. A messenger cable system to support aerial cable shall be furnished.

The messenger system, including appurtenances, guys and hardware, shall be capable of withstanding a minimum of 20 kN 4500 pounds of tension.

b. Transitions from aerial cable to underground cable shall be as specified for CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS in Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

c. Splices in aerial cable shall be within 1 meter 3 feet of a pole and placed inside a watertight enclosure. Drip loops shall be formed at the cable entrance to the enclosure. Lashing clamps shall be placed within 305 mm 12 inches of the enclosure.

d. Lashing wire shall be wound tightly around both the communication cable and the messenger cable by machine methods. The lashing wire shall have a minimum of 3 turns per 305 mm linear foot. Lashing clamps shall be placed at all poles and splices.

e. Loops shall be formed in the aerial cable at points of connection and at poles to prevent damage from thermal stress and wind loading. The communication cable shall be protected from chafing and physical damage with the use of spiral cut tubing and PVC tape, or plastic sleeves. The ground clearance of installed cabling shall be as shown.

3.2 ENCLOSURE PENETRATIONS

Enclosure penetrations shall be from the bottom and shall be sealed with rubber silicone sealant to preclude the entry of water.

3.3 IMPULSE SUPPRESSION SURGE ARRESTER GROUNDING

Impulse suppression surge arresters shall be grounded. Ground resistance shall be not more than 10 ohms. Connections to earth shall be made in the same manner as for secondary neutral ground rod. The aerial portions of surge arrester and secondary neutral ground conductors shall be separate from and independent of each other but both grounds shall be bonded together below grade at the ground rods, or to the ground counterpoise, as applicable and the ground rods shall be spaced a minimum of 6.1 meters 20 feet apart.

3.4 TESTING

3.4.1 General

Demonstrate compliance of the two-way Radio Data transmission System with the contract documents. Furnish personnel, equipment, instrumentation, and supplies necessary to perform site testing. Ensure that test personnel are regularly employed in the testing and calibration of radio data transmission systems. Testing shall include the field tests and the performance verification tests. Field tests shall be conducted by the Contractor to determine the system is completely operational. Performance verification test shall be a demonstration to the Government to ensure proper operation of all the components and proper execution of the sequence of operation.

3.4.2 Government Furnished RFCE Test

The Contractor shall test the Government furnished RFCE and certify that the equipment is in calibration and functioning correctly.

3.4.3 Test Plan

Submit and obtain approval of the field test plan and performance verification test plan for each phase of testing before beginning that phase of testing. Give to the Contracting Officer written notification of planned testing at least 30 days prior to test. Notification shall be accompanied by the proposed test procedures. In no case will the Contractor be allowed to start testing without written Government approval of field test plan and performance verification test plan.

3.4.4 Contractor's Field Test

The Contractor shall verify the complete operation of the two-way radio data transmission system during the Contractor's Field Testing. The Contractor's Field Test shall include an error rate test. The Contractor shall perform the test by sending 100,000 commands and measuring the error rate. The error rate shall be not greater than 5 out of 100,000. The Contractor shall prepare a report containing results of the field test.

3.4.5 Test Oversight

Tests are subject to oversight and approval by the Contracting Officer.

3.4.6 Test Reporting

Before scheduling the performance verification test, furnish field test documentation and written Certified Statement of Field Test Completion to the Contracting Officer for approval. The statement, certified by the two-way radio data transmission system provider, states that the installed system has been tested and is ready for the performance verification test. Do not start the performance verification test prior to receiving written permission from the Government. During and after completion of the Field Tests, and again after the Performance Verification Tests, identify, determine causes, replace, or repair equipment that fails to meet the specification, and submit a written report to the Government. Document all tests with detailed test results. Explain in detail the nature of each failure and corrective action taken. Provide a written report containing test documentation after the Field Tests and again after the Performance Verification Tests.

3.4.7 Verification Test and Endurance Test

The two-way radio data transmission system shall be tested as a part of the completed UMCS during the Performance Verification Test and Endurance Test as specified in Section 13801 UTILITY MONITORING AND CONTROL SYSTEM (UMCS).

-- End of Section -