PCN	DOCUMENT RELEASE AUTHORIZATION KENNEDY SPACE CENTER, NASA	PAGE 1 OF 3
98778		
ESR		REV/DATE
DIR	DRA NO. E-AC000000 -1108	SIGNATURE
EFF	TITLE	
EQ. LOC. UK-0020, K6-1141, M6-0996	REPLACE FDRS & DUCTS, VAB AREA N, PADS A, B REPLACE PROTECTIVE RELAYS AT C5, C5A & ORSINO SUBSTATION WITH SEL RELAYS MODIFY C-5 SUBSTATION FOR RING BUS \ CONFIGURATION , REPLACE PAD B SWITCHGEARS	VEN CODE
SDL 79K11107		CONTRACT

DOCUMENTS

I#	PREF	DOCUMENT NUMBER	ISSUE	SIZE	SHTS	B/L NO.	SS	MODEL NUMBER	WUC
1	DR	79K38608	NEW	F	21	353.00	K-	K60-0419	K-FAC90000
2	SP	79K38609	NEW	A	93	*	*	*	*
3	DR	79K38612	NEW	F	29	353.00 353.01	EU MS	K61-0415 K61-0546	EUFAC60000 MSFAC60000
4	SP	79K38613	NEW	A	109	*	*	*	*
5	DR	79K38551	NEW	F	37	353.00	EU	K61-0415	EUFAC60000
6	DR	79K38550	NEW	F	25	353.00 353.25 355.00	LB LB LB	K61-1685 K61-1663 K61-0619	LBFACR0000 LBFACRL000 LBSSAAS000
7	DR	79K36517	REV. A	F	18	353.00	LB	K61-1685	LBFACR0000
8	SP	79K38549	NEW	A	210	*	*	*	*
9	DM	KSC-TA-10354 cover, 1-110, 110a, 111-176, 183-290, 291-335	NEW	A	327	*	*	*	*
		177-182, 283-286	NEW	B	10	*	*	*	*
10	SW	79K38608	NEW	M(1)	1	**	**	**	**
11	SW	79K38609	NEW	M(1)	1	**	**	**	**
12	SW	79K38612	NEW	M(1)	1	**	**	**	**
13	SW	79K38613	NEW	M(1)	1	**	**	**	**
14	SW	79K38551	NEW	M(1)	1	**	**	**	**

TECHNICAL REMARKS

*: Denotes Item 2 same as Item 1; Denotes Item 4 same as Items 3 and 5; Denotes Item 9 same as Items 6 and 7;
1: CD-1 contains 79K38608, 79K38609, 79K38612,79K38613,79K38551 and KSC-TA-10354
**: Denotes same as Items 1 through 5
***: Denotes same as Items 7, 8 and 9
2: CD-2 contains 79K36517 Rev. A, 79K38549 and 79K38550

Note: Drawings released on this DRA are accessible by using WWW browsers (i.e. Mosaic, Netscape, etc) via a hyperlink on the DE home page or by typing the URL location: http://www-de.ksc.nasa.gov/keds/keds.htm

APPROVALS

TECHNICAL CONTACT	MAIL CODE	DATE	R&QA	MAIL CODE	DATE
Dung Trang, 861-2266	TA-B3-B	9/30/09	N/A		
TECHNICAL Ernesto Camacho, 867-4002	TA-B3-B	9/30/09	OTHER N/A		
N/A			JOINT RELEASE N/A		
PROCUREMENT PKG.			RELEASE Dung Trang, 861-2266	TA-B3-B	9/30/09

9/30/09

KSC FORM 21-68 (C/G 10/95)

DOCUMENT RELEASE AUTHORIZATION CONTINUATION
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1. DRA No. E-AC000000 -1108

2.

DOCUMENTS

3. I #	4. PREF	5. DOCUMENT NUMBER	6. ISSUE	7. SIZE	8. SHTS	9. B/L NO.	10. SS	11. MODEL NUMBER	12. WUC
15	SW	79K36517	Rev. A	M-2	1	***	***	***	***
16	SW	79K38549	NEW	M-2	1	***	***	***	***
17	SW	79K38550	NEW	M-2	1	***	***	***	***

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DRA+1C+1S	ISC-4013	M. SKIDMORE	DRA+1C+1S	ISC-4220	D. HAINSEY
DRA	ISC-4013	T. POBJECKY	DRA+1B+1S	TA-B3B	D. TRANG
DRA+1C+1S	ISC-2100	S. T. HO	DRA+1B+1S	USK-427	R. SALAS
DRA+1C+1S	ISC-2100	D. BAYLER	DRA+1B+1S	USK-069	R. BRAHM
DRA	ISC-5140	B. MARTIN	DRA+1C+1S	TA-B3D	J. NELSON
DRA	ISC-8600	L. SARDELLA	DRA+1C+1S	TA-B3B	J. MILLER
DRA	ISC-4027	M. DIXON	DRA+1C+1S	IHA-4100	M. RAMSEY
DRA	ISC-4026	R. WILSON	DRA+1C+1S	TA-B1C	J. SHAFFER
DRA	ISC-4250	B. BUCKAWIECKI	DRA+1C+1S	SA-E2	J. BOBERSKY
DRA+1C+1S	ISC-4300	E. BEYETTE	DRA+1C+1S	TA-B3E	R. DAVIS
DRA	TA-B3C	B. GRAF	DRA+1C+1S	TA-B3E	K. LUTHER
DRA+1C+1S	OP-CS	S. GASAWAY	DRA+1C+1S	NE-M8	D. GOVAN
DRA	NE-M8	M. CABRERA	DRA+1C+1S	SA-E3-MSRS	J. LeBLANC
			1P + 1S	FW&A 3970 Hendricks Ave Jacksonville, Florida 32207	

REPRODUCTION AND DISTRIBUTION INSTRUCTIONS

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P = F-Size Drawings (79K38608, 79K38612, 79K38551, 79K36517 Rev. A, and 79K38550)
S = A-Size Specification (79K38609, 79K38612, and 79K38549)
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Ernesto T. Camacho, TA-B3B	Ernesto T. Camacho	9/29/09

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(Stamp Revision: (05-19-2009)

UNLESS OTHERWISE SPECIFIED DIMENSION ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING DRAFTSMAN M.YUDIN / CHECKER W.WILSON TRACER / CHECKER ENGINEER D. TRANG / ENGINEER	Replace Feeders and Ducts, Pads A and B, and Pad B Switchgears PCN 98778 September 29, 2009	**JOHN F. KENNEDY SPACE CENTER, NASA** KENNEDY SPACE CENTER, FLORIDA
MATERIAL	SUBMITTED 9/29/09		
HEAT TREATMENT		SCALE	DWG SIZE **A** / **79K38549**
FINAL PROTECTIVE FINISH	APPROVAL 9/29/09	UNIT WT	SHEET 1 OF 210

PROJECT TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

01000 SCOPE AND DESCRIPTION
01330 SUBMITTAL PROCEDURES
01420 SOURCES FOR REFERENCE PUBLICATIONS
01780 PROJECT RECORD DOCUMENTS

DIVISION 02 - SITE CONSTRUCTION

02220 DEMOLITION
02312 EXCAVATION, BACKFILLING, AND COMPACTING FOR UTILITIES
02441 TRENCHLESS EXCAVATION USING MICROTUNNELING
02585 UNDERGROUND POWER DISTRIBUTION

DIVISION 03 - CONCRETE

03300 CAST-IN-PLACE CONCRETE (SHORT SECTION)

DIVISION 13 - SPECIAL CONSTRUCTION

13850 FIRE DETECTION AND ALARM (PROPRIETARY)

DIVISION 16 - ELECTRICAL

16003 GENERAL ELECTRICAL PROVISIONS
16065 SECONDARY GROUNDING
16124 MEDIUM VOLTAGE CABLE
16135 CABLE TRAYS
16145 STANDARD WIRING SYSTEMS
16275 TRANSFORMERS
16286 OVERCURRENT PROTECTIVE DEVICES
16345 MOTOR CONTROL
16361 MEDIUM VOLTAGE SWITCHGEAR
16410 AUTOMATIC/MANUAL TRANSFER AND BYPASS/ISOLATION SWITCHES
16445 SWITCHGEAR ASSEMBLIES
16446 PANELBOARDS
16960 APPARATUS COORDINATION, INSPECTION AND TESTING

-- End of Project Table of Contents --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01000

SCOPE AND DESCRIPTION

04/09

PART 1 GENERAL

1.1 SUMMARY
1.2 DESCRIPTION
1.3 CONTRACT DRAWINGS/PUBLICATIONS

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section Table of Contents --

SECTION 01000

SCOPE AND DESCRIPTION
04/09

PART 1 GENERAL

1.1 SUMMARY

The work to be performed under this project consists of providing the labor, equipment, and materials to replace low and medium voltage equipment at the VAB Utility Annex.

1.2 DESCRIPTION

The work consists of replacing the following:

Replacing Switching Station 1001 with Arc-resistant vacuum switchgear, substations T1050A and T1050B, ECS switchgears No. 1 and 2, MCCA and MCCB, battery and battery charger, conduits, and medium and low voltage cables.

All 15 kV cables and upgrade ductbank system as required from switching station 902 to all substations for Pad A.

All 15 kV cables and ugrade ductbank system as required from VFI 1002-1A, VFI 1002-1B, VFI 1002-1C, VFI 1002-2A, VFI 1002-2B, and VFI 1002-3 to all substations for Pad B.

The work will also consist of integrating all the switchgear provided in this contract with the existing operator workstation using CITECT software and the existing Government library of symbols, genies and super genies. If the new switchgear contains monitor and control elements that are not in the Government library, development of the new CITECT interface elements (screens, symbols, genies and super genies) and the connection to the KCCS controls network will also be required.

1.3 CONTRACT DRAWINGS/PUBLICATIONS

The following drawings accompany this specification and are a part thereof.

Drawing No. 79K36014 Rev. A
Sheets 1 through 18

Drawing No. 79K38550
Sheets 1 through 25

The publications of the issues of referenced documents in effect on the date of issuance of invitation for bids form a part of this specification and, where referred to herein by basic designation only, are applicable to the extent indicated by the references thereto. In the event of difference between this specification or its accompanying drawings and the referenced document, this specification and its accompanying drawings shall govern to the extent of such difference.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01330

SUBMITTAL PROCEDURES

09/99

PART 1 GENERAL

1.1 SUMMARY
1.2 REFERENCES (Not Applicable)
1.3 SUBMITTALS
1.4 SUBMISSION REQUIREMENTS
1.4.1 Organization
1.4.2 Marking
1.4.3 Submittal Binding

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section Table of Contents --

SECTION 01330

SUBMITTAL PROCEDURES
09/99

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS

A standard transmittal form provided by the Government shall be used to transmit each submittal.

Submittal Description (SD): Drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials to be furnished by the Contractor explaining in detail specific portions of the work required by the contract.

The following items, SD-01 through SD-11, are descriptions of data to be submitted for the project. The requirements to actually furnish the applicable items will be called out in each specification.

SD-01 Preconstruction Submittals

Submittals which are required prior to a notice to proceed on a new contract. Submittals required prior to the start of the next major phase of the construction on a multi-phase contract. Schedules or tabular list of data or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work, submitted prior to contract notice to proceed or next major phase of construction.

SD-02 Shop Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, detail of fabrications, layout of particular elements, connections, and other relational aspects of the work.

SD-03 Product Data

Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents.

SD-04 Samples

Samples, including both fabricated and unfabricated physical examples of materials, products, and units of work as complete units or as portions of units of work.

SD-05 Design Data

Design calculations, mix design analyses, or other data, written in nature, and pertaining to a part of the work.

SD-06 Test Reports

Written reports of a manufacturer's findings of his product during field inspections, attesting that the products are installed in accordance with the manufacturer's installation instructions, shop drawings, or other manufacturer's requirements. Written reports by a general contractor or his subcontractors including daily logs reporting on the progress of daily activities or attesting that the work has been installed in accordance with the contract plans and specifications.

SD-07 Certificates

A document, required of the Contractor, or through the Contractor by way of a supplier, installer, manufacturer, or other Lower Tier Contractor, the purpose of which is to further the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications, or other verification of quality.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system, or material, including special notices and material safety data sheets, if any concerning impedances, hazards, and safety precautions.

SD-09 Manufacturer's Field Reports

A written report which includes the findings of a test made at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation. Report must be signed by an authorized official of a testing laboratory or agency and must state the test results; and indicate whether the material, product, or system has passed or failed the test.

SD-10 Operation and Maintenance Data

Data intended to be incorporated in an operations and maintenance manual.

SD-11 Closeout Submittals

Special requirements necessary to properly close out a construction contract. For example, as-built drawings, manufacturer's help and product lines necessary to maintain and install equipment. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.4 SUBMISSION REQUIREMENTS

1.4.1 Organization

Submittals shall be organized by specification section, one submittal for each section. All submittal requirements for a specification section shall be submitted in one submittal. The submittal shall contain all information required for checking without reference to material contained in other submittals. Partial submittals for a specification section are not acceptable.

1.4.2 Marking

Manufacturer catalog cuts, data sheets and product information sheets shall be clearly marked to identify the items being proposed for use.

1.4.3 Submittal Binding

Submittals shall be bound in a report binder, spiral binder or 3-ring binder and labeled on front with project information and specification section. All items in the submittal shall be indexed. Identify where a proposed item is to be used, if not clear from the nature of the item.

Loose, stapled or unbound submittal sheets are not acceptable.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01420

SOURCES FOR REFERENCE PUBLICATIONS

01/04

PART 1 GENERAL

1.1 REFERENCES

-- End of Section Table of Contents --

SECTION 01420

SOURCES FOR REFERENCE PUBLICATIONS
01/04

PART 1 GENERAL

1.1 REFERENCES

Reference publications are cited in other sections of the specifications along with identification of their sponsoring organizations. The addresses of the sponsoring organizations are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided.

ACI INTERNATIONAL (ACI)
P.O. Box 9094
Farmington Hills, MI 48333-9094
Ph: 248-848-3700
Fax: 248-848-3701
Internet: http://www.aci-int.inter.net

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
444 N. Capital St., NW, Suite 249
Washington, DC 20001
Ph: 800-231-3475 or 202-624-5800
Fax: 800-525-5562 or 202-624-5806
Internet: www.aashto.org

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
11 West 42nd St
New York, NY 10036
Ph: 212-642-4900
Fax: 212-302-1286
Internet: http://www.ansi.org/

AMERICAN PETROLEUM INSTITUTE (API)
1220 L St., NW
Washington, DC 20005-4070
Ph: 202-682-8000
Fax: 202-962-4776
Internet: http://www.api.org

AMERICAN WATER WORKS ASSOCIATION (AWWA)
6666 West Quincy
Denver, CO 80235
Ph: 800-926-7337
Fax: 303-795-2114
Internet: www.awwa.org

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)
600 No. 18th St.
P.O. Box 2641
Birmingham, AL 35291-0992
Ph: 205-257-2530
Fax: 205-257-2540
Internet: http://www.aeic.org/index.htm

E-Mail: veazey-white@apc.com

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
Ph: 610-832-9500
Fax: 610-832-9555
Internet: www.astm.org

ELECTRONIC INDUSTRIES`ALLIANCE (EIA)
2500 Wilson Blvd.
Arlington, VA 22201-3834
Ph: 703-907-7500
Fax: 703-907-7501
Internet: www.eia.org

FM GLOBAL (FM)
1301 Atwood Avenue
P.O. Box 7500
Johnston, RI 02919
Ph: (for publications) 781-255-6681
Ph: (Toll-Free): 877-364-6726
Fax: 781-255-0181
Internet: http://www.fmglobal.com

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
445 Hoes Ln, P. O. Box 1331
Piscataway, NJ 08855-1331
Ph: 732-981-0060 OR 800-701-4333
Fax: 732-981-9667
Internet: http//www.standards.ieee.org
E-mail: customer.service@ieee.org

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
P.O. Box 440
South Yarmouth, MA 02664
Ph: 508-394-4424
Fax: 508-394-1194
E-mail: www.electricnet.com/orgs/insucbl.htm

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)
P.O. BOX 687
106 STONE STREET
MORRISON, COLORADO 08465
PH: 303-697-8441
FAX: 303-697-8431
INTERNET: http://www.netaworld.org

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)
3, rue de Varembe, Case Postale 131
CH-1211 Geneva 20, Switzerland
Ph: 41-22-919-0211
Fax: 41-22-919-0300
Internet: http://www.iec.ch
e-mail: custserv@iec.ch

IPI - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)
2215 Sanders Rd.
Northbrook, IL 60062-6135

Ph: 847-509-9700
Fax: 847-509-9798
Internet: www.ipc.org
e-mail: orderipc@ipc.org

JOINT INDUSTRIAL COUNCIL (JIC)
Association for Manufacturing Technology
7901 Westpark Dr.
McLean, VA 22102
Ph: 703-893-2900
Fax: 703-893-1151

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
1300 N. 17th St., Suite 1847
Rosslyn, VA 22209
Ph: 703-841-3200
Fax: 202-841-3300
Internet: http//www.nema.org/

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
One Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
Ph: 800-344-3555
Fax: 800-593-6372
Internet: http://www.nfpa.org

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)
1420 King Street
Alexandria, VA 22314-2794
Ph: 888-476-4238
Internet: www.nicet.org

UNDERWRITERS LABORATORIES (UL)
333 Pfingsten Rd.
Northbrook, IL 60062-2096
Ph: 847-272-8800
Fax: 847-272-8129
Internet: http://www.ul.com/
Order from:
Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112-5776
Ph: 800-569-7128
Fax: 303-397-7945
Internet: http://global.ihs.com
E-mail: global@ihs.com

U.S. DEPARTMENT OF DEFENSE (DOD)
Order DOD Documents from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Ph: 703-605-6000
FAX: 703-605-6900
Internet: http://www.ntis.gov
Order Military Specifications, Standards and Related Publications from:

Department of Defense Single Stock Point for (DODSSP)
Defense Automation and Production Service (DAPS)
Bldg 4D
700 Robbins AV
Philadelphia, PA 19111-5094
Ph: 215-697-2179
Fax: 215-697-1462
Internet: http://www.dodssp.daps.mil

U.S. GENERAL SERVICES ADMINISTRATION (GSA)
General Services Administration
1800 F Street, NW
Washington, DC 20405
PH: 202-501-0705
Order from:
General Services Administration
Federal Supply Service Bureau
1941 Jefferson Davis Highway
Arlington, VA 22202
PH: 703-605-5400
Internet: http://www.fss.gsa.gov/pub/fed-specs.cfm

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01780

PROJECT RECORD DOCUMENTS

05/09

PART 1 GENERAL

1.1 SUMMARY
1.3 SUBMITTALS
1.4 GENERAL
1.5 MAINTENANCE OF DOCUMENTS
1.5.1 Government Furnished Material
1.5.2 Record Documents
1.5.3 Guidelines
1.6 RECORDING
1.6.1 As-Built Drawings
1.6.1.1 As-Built Drawings - Interior
1.6.1.2 Utility As-Built Drawings - Exterior
1.6.4 Other Records

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EQUIPMENT/PRODUCT WARRANTIES
3.1.1 Equipment/Product Warranty List
3.1.2 Equipment Warranty Tags and Guarantor's Local Representative
3.2 OPERATION AND MAINTENANCE

-- End of Section Table of Contents --

SECTION 01780

PROJECT RECORD DOCUMENTS
05/09

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications as pertains to the preparation of project record documents to include, but not limited to, as-built drawings, utility as-built drawings, equipment warranty lists, and operation and maintenance manuals..

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with each section of the project's specification:

SD-01 Preconstruction Submittals

Initial as-built drawings

SD-07 Certificates

A Work Plan shall be submitted in accordance with paragraph entitled, "General," of this section.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section.

SD-11 Closeout Submittals

Special requirements necessary during and at the closeout of a construction project.

Equipment/Product Warranty List
Equipment/Product Warranty Tag
Posted Instructions
Spare Parts List
As-built drawings
Utility as-built drawings

1.4 GENERAL

A Work Plan shall be submitted to the Contracting Officer for project closeout. Plan shall include all scheduled inspections, instruction classes, items, closeout dates for all functions, and shall list the required Government and Contractor personnel that will be taking part in these functions.

Initial as-built drawings shall be submitted prior to any demolition. These as-built drawings will document all control wiring for the exisiting motor

control centers one through four.

Posted Instructions shall be submitted by the Contractor with labels, signs, and templates of operating instructions that are required to be mounted or installed on or near the product for normal, safe operation.

Contractor shall submit 6 copies of the project operation and maintenance manuals 30 days prior to testing the system involved. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

Spare Parts List shall indicate manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair. List those items that may be standard to the normal maintenance of the system.

1.5 MAINTENANCE OF DOCUMENTS

1.5.1 Government Furnished Material

Two (2) sets of full size (28-inch x 40-inch) drawings revised to reflect bid amendments will be provided by the Contracting Officer prior to start of construction. These drawings will be used for the maintenance of as-built drawings. One (1) set of electronic CADD files in AutoCad (Version 14 or later) or Microstation (Version "J" or later) will be provided by the Contracting Officer prior to start of construction.

1.5.2 Record Documents

Maintain at the job site, one copy of each of the following as Record Documents:

a) Contract Drawings.

b) Technical Specifications including Addenda/Bulletins.

c) Approved shop drawings and samples.

d) Contracting Officer Approved Engineering Orders, Answers to RFI's, Revisions, Directives and other written Amendments to the Contract.

e) Field Test reports.

1.5.3 Guidelines

Adhere to the following guidelines for maintenance of Record Documents:

a) Store record documents in temporary field office, apart from documents used for construction purposes.

b) Provide files and racks for the storage of Record Documents.

c) Maintain Record Documents in clean, dry and legible condition.

d) Do not use Record Documents for construction purposes.

e) Make Record Documents available at all times for inspection by the Contracting Officer's representative, and the red-lined record drawings shall be available at each construction status meeting for review.

1.6 RECORDING

Provide fine ball-point red and green pens for marking. Markings shall comply with good drafting standards as follows:

a) Green shall indicate deletions and red shall indicate additions.

b) Lettering for the changes shall be printed block lettering.

c) Lines drawn to indicate changes shall be done using a straight edge and curves to provide clear and clean lines.

d) Use the same symbols and follow as much as possible the same drafting standards used on the Contract Drawings.

1.6.1 As-Built Drawings

a) Label each record document PROJECT RECORD in 2-inch printed letters.

b) Keep Record Documents current at the end of work each day marking any changes and inserting all engineering changes into the documents.

c) Do not permanently conceal any work until required information has been recorded. This includes markups and any as-built survey as required by these Specifications.

d) Fully as-built the following:

1) Field changes of dimension and detail.

2) Changes made by Contracting Officer Approved Engineering Orders, Ansers to RFI's, Revisions, and other written modifications. A copy of all documents relating to a change shall be kept in a 3-ring binder with the red-lined record drawings.

3) Details not shown on the original Contract Drawings.

4) Update all drawings effected by each change.

5) Cloud each change on the drawings and identify change with change document number, if applicable. Clouding the changed area and marking with change document number without showing the actual change, is not acceptable.

1.6.1.1 As-Built Drawings - Interior

1) Fully as-built the following: Interior

a) Installation of power and control wiring with point-to-point wiring identification as required.

b) Update all cable and panel schedules to show actual installation.

1.6.1.2 Utility As-Built Drawings - Exterior

1) Installation of cables in manholes and conduits. Identify the duct or conduits used to install new cable in manhole layouts and

duct cuts on plan sheets and details. Clearly show all changes, such as where cables were to be removed but were in fact abandoned.

2) Update cable schedules to show actual installation.

1.6.4 Other Records

Legibly mark-up Specification and Addenda Sections for record including:

a) Changes made by Revision Order, Directive and other modifications.

b) Other materials or equipment not originally specified.

c) Maintain legibly annotated shop drawings and samples for record changes made after approval as record documents.

A set of As-Build documents shall be provided at the end of the project which shall include point to point wiring diagrams with cable indentifiers. Other requirements as provided in these specifications.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EQUIPMENT/PRODUCT WARRANTIES

3.1.1 Equipment/Product Warranty List

Furnish to the Contracting Officer a bound and indexed notebook containing written warranties for equipment/products furnished under the contract, and prepare a complete listing of such equipment/products. The equipment/products list shall state the specification section applicable to the equipment/product, duration of the warranty therefor, start date of the warranty, ending date of the warranty, and the point of contact for fulfillment of the warranty. The warranty period shall begin on the same date as project acceptance and shall continue for the full product warranty period. Execute the full list and deliver to the Contracting Officer prior to final acceptance of the project.

3.1.2 Equipment Warranty Tags and Guarantor's Local Representative

Furnish with each warranty the name, address, and telephone number of the guarantor's representative nearest to the location where the equipment is installed. The guarantor's representative, upon request of the Government representative, shall honor the warranty during the warranty period, and shall provide the services prescribed by the terms of the warranty. At the time of installation, tag each item of warranted equipment with a durable, oil- and water-resistant tag approved by the Contracting Officer. Attach tag with copper wire and spray with a clear silicone waterproof coating. Leave the date of acceptance and Government inspectors signature blank until project is accepted. Tag shall show the following information:

EQUIPMENT/PRODUCT WARRANTY TAG

Type of Equipment/Product _____
Warranty Period _____ From _____ To _____
Contract No. _____
Inspector's Signature _____ Date Accepted _____

Construction Contractor:
Name: _____
Address: _____
Telephone: _____

Warranty Contact: _____
Name: _____
Address: _____
Telephone: _____

3.2 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals shall be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Information shall be bound in manual format and grouped by technical sections. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Pages for vendor data and manuals shall have 10 millimeter holes and be bound in 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets, in a loose-leaf binder. Binder shall lie flat with printed sheets that are easy to read. Caution and warning indications shall be clearly labeled.

Contractor shall submit as part of the closeout work plan, the schedule for the classroom and field instructions in the operation and maintenance of systems equipment where required by the technical provisions. These services shall be directed by the Contractor, using the manufacturer's factory-trained personnel or qualified representatives. After approval of the work plan, the Contracting Officer shall be given 7 days written notice of scheduled instructional services. Instructional materials belonging to the manufacturer or vendor, such as lists, static exhibits, and visual aids, shall be made available to the Contracting Officer.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE CONSTRUCTION

SECTION 02220

DEMOLITION

09/99

PART 1 GENERAL

1.2 SUBMITTALS
1.3 DEMOLITION PLAN
1.4 EXISTING CONDITIONS
1.5 INTERRUPTION OF SERVICE

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 DISCONNECTING EXISTING UTILITIES
3.2 DEMOLITION AND REMOVAL WORK
3.2.1 Protective Measures
3.2.2 Salvageable Materials and Equipment
3.2.3 Scrap Metal
3.2.4 Electrical Equipment and Fixtures
3.2.4.1 Electrical Devices
3.2.4.2 Conductors
3.2.4.3 Conduit
3.2.4.4 Wiring Ducts or Troughs
3.2.4.5 Miscellaneous Items
3.3 DISPOSAL OF REMOVED MATERIALS
3.3.1 General
3.3.2 Burning on Government Property
3.3.3 Removal to Spoil Areas on Government Property
3.3.4 Removal from Government Property
3.4 REUSE OF SALVAGED ITEMS

-- End of Section Table of Contents --

SECTION 02220

DEMOLITION
09/99

PART 1 GENERAL

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Contractor shall submit a detailed Demolition Plan of the work procedures and safety precautions to be used prior to the beginning of work. Contractor shall record Existing Conditions prior to starting work in accordance with the paragraph entitled, "Existing Conditions," of this section.

Interruption of the following shall be submitted:

Utility Outages

1.3 DEMOLITION PLAN

Contractor shall prepare and submit a detailed Demolition Plan of the work procedures and safety precautions to be used in the identification, demolition, handling, removal, transportation, and reclamation or disposal of removed materials. Contractor shall meet with the Contracting Officer, prior to beginning work, to discuss in detail the demolition plan.

1.4 EXISTING CONDITIONS

Existing Conditions shall be recorded in the presence of the Contracting Officer showing the condition of structures and other facilities adjacent to areas of alteration or removal. Such record shall contain the elevation of the top of foundation walls, the location and extent of cracks and other damage and description of surface conditions that exist prior to the start of work. Copies of the record shall be submitted and the stated conditions before starting work shall be verified.

1.5 INTERRUPTION OF SERVICE

Written approval by the Contracting Officer for interruption of service Utility Outages shall be submitted at least 14 days prior to work.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 DISCONNECTING EXISTING UTILITIES

Prior to the start of work, the Government will disconnect and seal the utilities serving each area of alteration or removal.

3.2 DEMOLITION AND REMOVAL WORK

3.2.1 Protective Measures

Existing construction shall not be disturbed beyond the extent indicated or necessary for installation of new work. Temporary shoring and bracing shall be provided for support of building components to prevent settlement or other movement.

Protective measures shall be provided to control accumulation and migration of dust and dirt in all areas of work. Dust, dirt, and debris shall be removed from the areas of work daily.

3.2.2 Salvageable Materials and Equipment

Salvageable material is defined as material or equipment that is reusable or recyclable. All salvageable material and equipment shall be returned to the Government unless otherwise indicated in these specifications or on the project drawings.

Salvageable materials and equipment shall be removed in a manner that will cause the least possible damage thereto. Contractor personnel shall handle, store, and protect removed items that are to be reused in the work or are to be returned to the Government.

Identification tags shall be provided on items boxed or placed in containers, indicating the type, size, and quantity of materials. Contractor shall transport all salvageable material and equipment to Ransom Road.

Materials and equipment that becomes the property of the Contractor shall be removed as it accumulates.

3.2.3 Scrap Metal

Scrap metal shall become the Contractor's property and shall be removed from the site as it accumulates.

3.2.4 Electrical Equipment and Fixtures

3.2.4.1 Electrical Devices

Transformers shall be salvaged.

Existing Switching Station 1001, switchgears, motor control centers, meters, instruments, circuit breakers, panelboards, and similar items shall become the property of the Contractor.

3.2.4.2 Conductors

Conductors, including insulated wire and nonmetallic sheathed and flexible armored cable, shall become the property of the Contractor.

3.2.4.3 Conduit

Conduit, except where embedded in concrete or masonry, shall become the property of the Contractor. Corroded, bent, or damaged conduit shall be considered as scrap metal.

3.2.4.4 Wiring Ducts or Troughs

Wiring ducts or troughs shall become the property of the Contractor.

3.2.4.5 Miscellaneous Items

Supports, knobs, tubes, cleats, and straps shall be classified as debris to be removed and disposed.

3.3 DISPOSAL OF REMOVED MATERIALS

3.3.1 General

Debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations shall be disposed of in accordance with all applicable federal, state and local regulations as contractually specified off the center. Removed materials shall not be stored on the project site.

3.3.2 Burning on Government Property

Burning of materials removed from demolished structures will not be permitted on Government property.

3.3.3 Removal to Spoil Areas on Government Property

Noncombustible materials removed from demolished structures shall be transported to designated spoil areas on Government property.

3.3.4 Removal from Government Property

Waste materials removed from demolished structures, except waste soil, shall be transported from Government property and legally disposed of. Waste soil shall be disposed of as directed.

3.4 REUSE OF SALVAGED ITEMS

Salvaged equipment shall be stored separately for the Contracting Officer to turn over to plant maintenance personnel. Items damaged during removal and salvage operations shall be repaired or replaced as necessary to restore them to usable condition.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE CONSTRUCTION

SECTION 02312

EXCAVATION, BACKFILLING, AND COMPACTING FOR UTILITIES

04/09

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.4 PLANS
1.6 RECORDS OF EXISTING CONDITIONS

PART 2 PRODUCTS

2.1 STRUCTURAL MATERIALS
2.2 BACKFILL MATERIAL
2.2.1 Proposed Soil Materials
2.2.2 Satisfactory Materials
2.2.3 Unsatisfactory Materials
2.3 TOPSOIL

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS
3.2 PROTECTION OF PERSONS AND PROPERTY
3.3 SHORING, BRACING, AND SHEETING
3.4 TRENCH EXCAVATION
3.5 WATER REMOVAL
3.9 EXCAVATION FOR ELECTRICAL UTILITIES
3.12 BACKFILLING AND COMPACTION
3.12.1 Bedding
3.12.2 Backfill Around Pipe
3.12.3 Lower Portion of Trench
3.12.4 Remainder of Trench
3.13 FIELD QUALITY CONTROL
3.14 RESTORATION OF SURFACES
3.15 DISPOSAL OF EXCESS AND WASTE MATERIALS

-- End of Section Table of Contents --

SECTION 02312

EXCAVATION, BACKFILLING, AND COMPACTING FOR UTILITIES
04/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 145	(1991) Recommended Practice for the Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T 180	(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
AASHTO T 2	(1991) Standard Methods of Sampling of Aggregates
AASHTO T 87	(1986; Rev 1993) Standard Method for the Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test

ASTM INTERNATIONAL (ASTM)

ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 2922	(2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(2008) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 422	(1963; R 1990) Standard Test Method for Particle-Size Analysis of Soils
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Record of Existing Conditions shall be submitted in accordance with the paragraph entitled, "Records of Existing Conditions," of this section.

The records shall include the following:

Location of Underground Utilities
Location of Approved Utilities
Location of Test
Location of Inspection

SD-06 Test Reports

Test reports shall be submitted in writing by the Contractor for Soil Test results within 3 working days. Reports shall be according to the paragraph entitled, "Field Quality Control," of this section.

SD-07 Certificates

Certificates for the following shall be submitted by the Contracting Officer in accordance with the paragraph entitled, "Plans," of this section.

Demolition Plan
Work Plan
Protection Plan

Certificates for Proposed Soil Materials shall be submitted by the Contracting Officer in accordance with paragraph entitled, "Proposed Soil Materials," of this section.

1.3 QUALITY ASSURANCE

Soil survey for satisfactory soil materials and samples of soil materials shall be furnished by the Contractor. A certified soil-testing service approved by the Contracting Officer shall be provided by the Contractor. Testing shall include soil survey for satisfactory soil materials, sampling and testing soil materials proposed for use in the work, subbase materials at the mixing plant, and field-testing facilities for quality control during construction period.

Testing agencies shall conform to the requirements of ASTM D 3740.

1.4 PLANS

The Demolition Plan shall be approved by the Contracting Officer at least 48 hours in advance of the work. The plan shall include all special environmental consideration and safety precautions along with the coordination procedures for the protection plan and work plan of this phase of work.

A Work Plan shall be submitted including proposed methods of excavation, earth support, utility construction, and backfilling at least 48 hours in advance of the work, for approval by the Contracting Officer. The plan shall be coordinated with the demolition and protection plans of this section.

The Contractor shall provide a Protection Plan of existing utilities place, and coordinate the plan with the demolition plan.

1.6 RECORDS OF EXISTING CONDITIONS

The Contractor shall verify the existing conditions are correct as shown on the plans and mentioned in the specification. Any discrepancies found shall be noted immediately, and notification given to the Contracting Officer.

The records shall include Location of Underground Utilities, Location of Approved Utilities, Location of Test and Location of Inspection.

PART 2 PRODUCTS

2.1 STRUCTURAL MATERIALS

Materials used for shoring and bracing, such as sheet piling, uprights, stringers, and crossbraces, shall be in good serviceable condition. Any timber used shall be sound and free from large or loose knots.

2.2 BACKFILL MATERIAL

Backfill material shall consist of sandy clay, sand, gravel, soft shale, or other satisfactory soil materials.

2.2.1 Proposed Soil Materials

Soil materials proposed for use in the work shall be tested. The materials shall be approved by the Contracting Officer prior to start of work, as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Satisfactory soil materials	Sampling	AASHTO T 2	One for each source of material to determine conformance to definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis of fine and coarse aggregate	ASTM C 136	
	Mechanical analysis of soils	ASTM D 422	
	Liquid limit of soils	ASTM D 4318	
	Plastic limit and plasticity index of soils	ASTM D 4318	
	Moisture-density relations of soil	AASHTO T 180, Method B or D	

2.2.2 Satisfactory Materials

Satisfactory soil materials - AASHTO M 145 Soil Classification Groups A-1, A-2-4, A-2-5, and A-3.

2.2.3 Unsatisfactory Materials

Unsatisfactory soil materials - AASHTO M 145 Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, highly organic soils, and soil materials of any classification that have a moisture content at the time of compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.

2.3 TOPSOIL

Topsoil shall be any soil removed from the project site which consists of clay or sandy loam. The topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, roots, and other objectionable materials larger than 2 inch in any dimension.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Before starting earthwork, the location of underground utilities shall be carefully verified by hand methods. Utilities to be left in place shall be protected from damage.

Excavation, filling, backfilling, and grading shall be to subgrade elevations specified.

Excavated materials suitable for backfill shall be piled in an orderly manner sufficiently distant from excavations to prevent overloading, slides, and cave-ins.

Excavations shall be done in ways that will prevent surface water and subsurface water from flowing into excavations and will also prevent flooding of the site and surrounding area.

3.2 PROTECTION OF PERSONS AND PROPERTY

Excavations shall be barricaded and posted with warning signs for the safety of persons. Warning lights shall be provided during hours of darkness.

Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations shall be protected against damage including settlement, lateral movement, undermining, and washout.

Topsoil removal operations shall be conducted to ensure safety of persons and to prevent damage to existing structures and utilities, construction in progress, trees and vegetation to remain standing, and other property.

3.3 SHORING, BRACING, AND SHEETING

Shoring and bracing in excavations shall be maintained for the entire length of time excavations will be open. Shoring and bracing shall be

carried down with the excavation.

Sheeting used to prevent lateral movement of soil shall be removed in accordance with the requirements.

Untreated sheeting shall not be left in place beneath structures or pavements.

3.4 TRENCH EXCAVATION

Trenches shall be of adequate width and depth for the specified purpose. Side slopes of the trenches shall be as nearly vertical as practicable. Care shall be taken not to overexcavate. Bottoms of the trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on undisturbed soil at every point along its entire length except where it is necessary to excavate for bell holes and for proper sealing of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded to ensure that the pipe rests on the prepared bottom for as much of its full length as practicable. Bell holes and depressions shall be only of such length, depth, and width as required to make the joint. Stones shall be removed, as necessary, to avoid point bearing. Where rock excavation is required in trenches for pipe, the rock shall be excavated to a minimum overdepth of 6-inches below the trench depth specified. Except as specified for wet or otherwise unstable material, overdepths shall be backfilled with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe, as determined by the Contracting Officer, is encountered in the bottom of the trench, it shall be removed and the trench shall be backfilled to the proper grade with coarse sand, fine gravel, or other suitable, approved material.

Trench excavations in surfaced areas shall be by open cut, unless otherwise shown. The pavement shall be cut by concrete saw or other approved method. Cuts shall be in straight lines parallel to the utility line location and shall be to a depth of at least one quarter of the pavement thickness. The remainder of the pavement shall be broken out. Pavement shall be removed a minimum of 12 inches on each side of the trench and 6 inches beyond where the base course is to be removed.

3.5 WATER REMOVAL

Water shall not be permitted to accumulate in excavations. Dewatering systems shall be provided by the Contractor to convey water away from excavations so that softening of foundation bottoms, footing undercutting, and soil changes detrimental to subgrade stability and foundation will not occur. Dewatering systems and methods of disposal shall be approved by the Contracting Officer.

Dewatering shall be continued until construction subject to water pressure has obtained full specified strength and backfill is completed.

Water removal from excavations shall be conveyed to approved collecting or runoff areas. Temporary drainage ditches and other diversions as necessary shall be provided and maintained outside of excavation limits.

Trench excavations for utilities shall not be used for temporary drainage ditches.

3.9 EXCAVATION FOR ELECTRICAL UTILITIES

Excavation of trenches for electrical cables and duct lines shall provide vertical walls, unless otherwise approved by the Contracting Officer, and the trench shall be only as wide as necessary for workers to install the cables or ducts. Abrupt changes in grade of the trench bottom shall be avoided. Trenches shall be of a depth to provide a minimum cover over the top of the cables or ducts of 2-feet below finished grade, and at additional depth if necessary to avoid interference of the electrical cables or ducts with other utilities.

3.12 BACKFILLING AND COMPACTION

Where trench sheeting is pulled, withdrawal shall be in increments of not more than 1 foot and backfilling and compaction operations shall be carried on simultaneously with trench sheeting pulling.

Trenches shall not be backfilled until required tests are performed and until the utilities systems, as installed, conform to the requirements for the installation of the various utilities. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified, or the condition shall be otherwise corrected as directed.

3.12.1 Bedding

Where the trench is excavated in rocks, a minimum of 6 inches of specified bedding material shall be placed on the rock surface before laying conduit or electrical cable.

3.12.2 Backfill Around Pipe

Backfill around pipe shall be applied to 6-inches above pipe with the specified bedding material.

3.12.3 Lower Portion of Trench

Backfill material shall be deposited in 8-inch uncompacted layers and compacted to the density of the adjacent soil until there is a cover of not less than 1 foot. The backfill material in this portion of the trench shall consist of sandy clay, sand, gravel, soft shale, or other approved materials, free from hard clods and stones larger than 1 inch in any dimension.

3.12.4 Remainder of Trench

The remainder of the trench shall be backfilled with material that is free of stones larger than 3 inches in any dimension. Backfill material shall be deposited in layers not exceeding the thickness specified, and each layer shall be compacted to the minimum density specified.

Under concrete slabs and paved parking areas:

6-inch layers, 95 percent of maximum density prescribed in AASHTO T 180, Method B or D

Under other areas:

8-inch layers, 90 percent of maximum density prescribed in

AASHTO T 180, Method B or D

3.13 FIELD QUALITY CONTROL

The Contractor shall arrange his Soil Test work so that sampling and testing may be performed without interruption. Moisture-density relations shall be determined in accordance with AASHTO T 180, Method B or D. Field density tests shall be performed by methods in sufficient number to ensure that the specified density is obtained.

Soil materials shall be tested during construction as follows:

MATERIAL	REQUIREMENT	TEST METHOD	MATERIAL TESTED AND NUMBER OF TESTS
Soil material-in-place after compaction	Density of soil-in-place	ASTM D 1556, Sand Cone Method or ASTM D 2922, Nuclear Method (when approved by Contracting Officer)	At least three daily for each subgrade soil material, and for each layer of soil material; additional test whenever there is in moisture

3.14 RESTORATION OF SURFACES

Areas within the limits of earthwork under this section, including adjacent transition areas, shall be uniformly graded. The finished surface shall be smooth within the specified tolerances, compacted, and with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

Grassed areas:

The finished surface of areas to receive topsoil blend shall be not more than 0.10-foot above or below the specified finish elevations.

Walks:

The surface of areas under walks shall be shaped to line, grade, and cross section, and the finished surface shall be not more then 0.0 foot above or 0.10-foot below the specified finish elevations.

Pavements:

The surface of areas under pavements shall be shaped to line, grade, and cross section, and the finished surface shall be not more than 1/2-inch above or below the specified finish elevations.

3.15 DISPOSAL OF EXCESS AND WASTE MATERIALS

Waste materials, including excavated material classified as unsatisfactory soil material, trash, and debris, shall be removed from Government property and legally disposed of, by the Contractor.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE CONSTRUCTION

SECTION 02441

TRENCHLESS EXCAVATION USING MICROTUNNELING

04/06

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.4 SUBMITTALS
1.5 DELIVERY, STORAGE, AND HANDLING
1.5.1 Handling

PART 2 PRODUCTS

2.1 CONDUIT MATERIALS
2.1.1 Conduit
2.1.1.1 Polyethylene, Flexible Conduit
2.1.1.2 Transition Couplings, HDPE to PVC
2.3 BENTONITE
2.4 BACKFILL

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Installation of Conduit
3.1.2 Installation of Tracer Wire
3.1.3 Microtunneling
3.1.4 Spoil Transportation
3.2 RECORD DRAWINGS
3.3 FIELD QUALITY CONTROL
3.3.1 Field Tests and Inspections

-- End of Section Table of Contents --

SECTION 02441

TRENCHLESS EXCAVATION USING MICROTUNNELING
04/06

PART 1 GENERAL

1.1 REFERENCES

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 PETROLEUM INSTITUTE (API)

API Spec 13A	(2006; Errata 2008) Specification for Drilling-Fluid Materials

AMERICAN WATER WORKS ASSOCIATION (AWWA)

ANSI C2	(1997) National Electrical Safety Code

ASTM INTERNATIONAL (ASTM)

ASTM D 1248	(2005) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

1.2 RELATED REQUIREMENTS

Section 16003 "General Electrical Provisions," applies to this section with additions and modifications specified herein.

1.4 SUBMITTALS

Submit the following in accordance with Section 01330 entitled "Submittals."

SD-01 Preconstruction Submittals

Conduit, data shall include all technical information, strength, size, tensions, etc.

Bentonite - data include all technical information composition, biodegradability, etc.

Submit manufacturer's standard drawings or catalog cuts.

SD-05 Design Data

Design calculations of conduit

Submit design calculations of conduit demonstrating that the conduit selected has been designed to support the maximum anticipated earth loads and superimposed live loads, both static and dynamic, which may be imposed

on the conduit.

SD-07 Certificates

Conduit

Transition Couplings, HDPE to PVC

Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within 3 years of the date of submittal or certificates on the same type, class, grade, and size of material as is being provided for the project.

SD-08 Manufacturer's Instructions

Procedures for Installation of conduit

Transition Couplings, HDPE to PVC

SD-11 Closeout Submittals

Record Drawings of conduit locations

1.5 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.5.1 Handling

Handle conduit, fittings, and other accessories in a manner to ensure delivery to the excavation in sound undamaged condition. Carry, do not drag pipe to the excavation. Store conduit that is not to be installed immediately, under cover out of direct sunlight.

PART 2 PRODUCTS

2.1 CONDUIT MATERIALS

2.1.1 Conduit

2.1.1.1 Polyethylene, Flexible Conduit

ASTM D 1248. Conduit shall be continuous, flexible, high-density polyethylene Type III, SDR II, IPS pipe of the size indicated on the drawings.

2.1.1.2 Transition Couplings, HDPE to PVC

Coupling for joining high-density polyethylene conduit Type III, SDR 11 pipe to Schedule 40 PVC conduit. Couplings shall have a socket end for PVC conduit and an opposite end with self-tapping threads for the high-density polyethylene conduit. A compatible sealing compound shall be applied to the threaded side.

2.3 BENTONITE

Bentonite shall conform with API Spec 13A and have the capacity of mixing with water to form a stable and homogeneous suspension. The Bentonite product must contain the proper additives according to the manufacturer for use in directional drilling in the soil conditions that are expected to be encountered on the project.

2.4 BACKFILL

Reuse excavated sand for backfill that conforms with Section 02585 UNDERGROUND POWER DISTRIBUTION.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Installation of Conduit

Shall meet NFPA 70, ANSI C2 and the following:

Conduit shall be installed in the locations indicated and as near as practicable to those shown on the drawings. Level runs of conduits must maintain a minimum of 1830mm below finish grade, canal or lake inverts, along the entire drilled length, except when crossing railroad tracks where a minimum of 2130mm below grade shall be maintained or when crossing the Crawlerway where a minimum of 3000mm below the bottom layer of Crawlerway material. The depths at the ends shall match, on horizontal plain, that of the adjoining duct bank, conduit or direct burial cable, whichever is applicable.

The conduit may not deviate more than 450mm from the horizontal centerline shown on the drawing without the approval of the Contracting Officer.

Vertical variance shall not exceed 150mm and still maintain a minimum of 1830mm below grade. Avoid crossing between existing underground structures. A minimum of 450mm shall be maintained where the directional drilled conduit crosses other utilities or underground structures.

Once the conduit attains a flat running level on the horizontal plane, it shall not descend in elevation again.

Minimum bending radius shall be 6 meters and the sum of all bends including the descending and ascending curves shall not exceed 270 degrees. Any conduit run having a number of bends adding to 180 degrees or more shall require a cable pulling analysis before acceptance. Where multiple runs of single conduits are required, maintain a distance of no more than 610mm between conduits.

Use fusion heads when pulling conduits, to prevent foreign material from entering conduit during pull.

Any drilling or installation activity that causes an upheaval of earth or moleing effect shall not be acceptable.

Thoroughly clean out each conduit run as it is completed by drawing a stiff bristle brush, of the nominal conduit size,

through until conduit is clear of particles of earth, sand, gravel and water. Swab the conduits with a poly-pig of the nominal conduit size and test the conduit with a non-flexible testing mandrel no less than 7-inches in length with a diameter suitable for the conduit being cleaned After cleaning immediately install conduit caps. Provide mule tape in each conduit with minimum 8900 newton pulling strength. Mandrel shall be approved by the Contracting Officer prior to use. A tag line is required on each end of the mandrel during the testing process. The tag line shall be of sufficient strength to withdraw the cleaning device.

Where the work is conducted adjacent to any body of water or wetlands, install and maintain a double silt fence or any other necessary measures to prevent construction contaminants from reaching the environmentally sensitive areas.

Contain all excess drillers mud from the area and dispose of material off site or as directed by the Contracting Officer. The Contractor shall be responsible for any dewatering required.

After terminating conduits in manholes as shown on drawings, backfill work area per Section 02585, "UNDERGROUND POWER DISTRIBUTION". Clean and dress all areas disturbed by Contractor operations and provide for re-establishing grass as described in Section 02585, "UNDERGROUND POWER DISTRIBUTION" in paragraph entitled "Restoration of Surfaces".

Observe extreme caution while installing the drilling equipment, conducting the work and removing the equipment. Comply with the rules and regulations of Kennedy Space Center.

3.1.2 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.

3.1.3 Microtunneling

a. Only tunneling equipment capable of fully supporting the face of the tunnel shall be used for pipe jacking work described.

b. Tunneling equipment selected for the project shall be compatible with the geotechnical information contained in this contract. The tunneling equipment shall be capable of tunneling through mixed face conditions without exceeding the settlement tolerances specified in paragraph "Settlement, Alignment and Tolerances."

c. Face pressure exerted at the heading by the tunneling machine shall be maintained as required to prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface by balancing soils and groundwater pressures present.

d. Dewatering for groundwater control shall be allowed at the jacking and receiving pits only.

e. A topographic survey will be performed by the Contractor before and after microtunneling

3.1.4 Spoil Transportation

The soil transportation system shall match the excavation rate with rate of spoil removal. The system must also be capable of balancing groundwater pressures and adjustment to maintain face stability for the particular soil conditions of this project.

3.2 RECORD DRAWINGS

Provide record drawings of the completed installation to comply with the requirements of Section 01780, "Project Record Documents".

3.3 FIELD QUALITY CONTROL

3.3.1 Field Tests and Inspections

The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor will product evidence, when required, that any item of work has been constructed in accordance with drawings and specifications.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE CONSTRUCTION

SECTION 02585

UNDERGROUND POWER DISTRIBUTION

04/09

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL REQUIREMENTS
1.3 SUBMITTALS

PART 2 PRODUCTS

2.1 CONDUIT AND FITTINGS
2.2 SEPARATORS
2.3 BURIED WARNING AND IDENTIFICATION TAPE
2.4 COUNTERPOISE GROUND CONDUCTOR
2.6 REPORTS

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Duct Banks

-- End of Section Table of Contents --

SECTION 02585

UNDERGROUND POWER DISTRIBUTION
04/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM F 512	(2006) Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

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

Conduit and Fittings
Separators
Counterpoise Ground Conductor
Buried Warning and Identification Tape

SD-06 Test Reports

Test Reports shall be submitted in accordance with the paragraph entitled,"Reports," of this section.

PART 2 PRODUCTS

2.1 CONDUIT AND FITTINGS

Conduit and fittings in duct banks shall be rigid unplasticized polyvinylchloride and shall conform to ASTM F 512, (heavy-wall, Schedule 40, polyvinylchloride designed for underground and in walls when encased in concrete).

Aluminum conduit shall not be permitted.

2.2 SEPARATORS

Separators or spacing blocks shall be made of concrete, plastic, or other

suitable nonmetallic nondecaying material.

2.3 BURIED WARNING AND IDENTIFICATION TAPE

Polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 6-inch-minimum width, color coded red for electric 15kV cable with warning and identification imprinted in bold black letters continuously over the entire tape length. Color and printing shall be permanent, unaffected by moisture or soil. Warning and identification shall read "CAUTION, BURIED ELECTRIC LINE BELOW".

2.4 COUNTERPOISE GROUND CONDUCTOR

A counterpoise ground conductor shall be installed above the concrete encasement of the duct banks and shall be no smaller than a AWG No. 4/0 stranded bare copper conductor. Where duct bank runs over the top of an existing duct bank, tie new counterpoise to existing counterpoise.

2.6 REPORTS

Test Reports for 2500-psi concrete shall be submitted to the Contracting Officer.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Duct Banks

Duct banks shall consist of single or multiple conduit assemblies encased in concrete and installed with top of duct or duct bank not less than depth indicated below established grade. Duct bank assemblies shall conform to the requirements indicated.

Conduit shall be thoroughly cleaned before using or installing. During construction and after the duct line is completed, the ends of the conduit shall be plugged to prevent water from washing mud into the conduit or manholes. Conduit shall be kept clean and free of concrete, dirt, and any other foreign substance during construction. All conduit runs should be installed so they will drain throughout the run (cable are safe in dry conduits).

Duct banks installed under or adjacent to roads or shoulders of roads shall be encased in reinforced concrete. Duct lines shall be installed so that the top of the concrete in encased ductlines is not less than 18 inches, or so that the duct in nonencased ductlines is not less than 24-inches below finished grade or finished paving at any point.

Changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long-sweep bends having a minimum radius of 25 feet, except that manufactured bends may be used at ends of short runs of 100 feet or less and then only at or close to the end of the run. Long-sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 18 inches for use with ducts of less than 3 inches in diameter and a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.

Conduit shall terminate in end bells where duct lines enter manholes.

After the duct line has been completed, a standard flexible mandrel not less than 12-inches long, with a diameter approximately 1/4 inch less than the inside diameter of the conduit, shall be pulled through each conduit, after which a brush with stiff bristles shall be pulled through each conduit to make certain that no particles of earth, sand, or gravel have been left in the line.

Pneumatic rodding may be used to draw in the lead wire.

Where connection is made to an existing duct that is of a different material and shape from the duct line being installed, a suitable coupling of a type recommended by the duct manufacturer shall be used.

Conduit joints in concrete encasement may be placed side by side horizontally but shall be staggered at least 6 inches vertically.

Separators shall be placed not greater than 4 feet on center. Ducts shall be securely anchored to prevent movement during the placement of concrete. At least 3 inches of concrete shall be provided at bottom, top, and sides, except that concrete shall be at least 6 inches at railroad crossings.

Both concrete bed and cover under railroad tracks, across ditches, or under paving shall be reinforced with two No. 4 reinforcing bars. Each single conduit of the duct bank shall be completely encased in concrete. Specified thickness of concrete encasement is minimum and may be increased to fit the actual shape of the trench.

Conduit joints shall be made up in accordance with the manufacturer's recommendations for the particular conduit and coupling selected.

A counterpoise ground conductor shall be installed above the concrete encasement. Counterpoise ground conductor shall extend along all electrical duct banks including stubs through each electrical distribution system manhole and to each transformer and switching-station installation.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03300

CAST-IN-PLACE CONCRETE (SHORT SECTION)

04/09

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL
1.3 SUBMITTALS

PART 2 PRODUCTS

2.1 READY-MIX CONCRETE
2.2 STEEL REINFORCEMENT
2.2.1 Deformed Steel Bars
2.2.2 Welded Wire Fabric
2.3 FORMS
2.4 ACCESSORIES
2.4.3 Curing Compound

PART 3 EXECUTION

3.1 FORM WORK
3.1.1 Preparation of Form Surfaces
3.1.2 Form Coating
3.1.3 Removal of Forms
3.2 STEEL REINFORCING
3.2.1 General
3.2.2 Fabrication
3.2.3 Splicing
3.2.4 Supports
3.3 EMBEDDED ITEMS
3.4 BILL OF LADING
3.5 CONCRETE CONVEYING
3.6 CONCRETE PLACING
3.6.1 General Placing Requirements
3.6.2 Lifts in Concrete
3.7 FINISHING
3.10 CURING AND PROTECTION
3.11 FIELD TESTING

-- End of Section Table of Contents --

SECTION 03300

CAST-IN-PLACE CONCRETE (SHORT SECTION)
04/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ACI INTERNATIONAL (ACI)

ACI 308	(1992) Standard Practice for Curing Concrete
ACI 315	(1992) Details and Detailing of Concrete Reinforcement
ACI 318	(2008; Errata 2008) Building Code Requirements for Structural Concrete and Commentary
ACI 347	(2004) Guide to Formwork for Concrete

ASTM INTERNATIONAL (ASTM)

ASTM A 185	(1994) Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615/A 615M	(2008b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 143	(1990) Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 172	(2008) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 183	(2002) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 39	(1994) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 494	(1992) Chemical Admixtures for Concrete

ASTM C 618	(2008a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 94	(1994) Standard Specification for Ready-Mixed Concrete

1.2 GENERAL

All work shall be in accordance with ACI 318.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-05 Design Data

Mix design data shall be submitted in accordance with the paragraph entitled, "Ready-Mix Concrete," of this section.

SD-06 Test Reports

Test reports shall be in accordance with tests as described in the paragraph entitled, "Field Testing," of this section for the following items:

Slump Tests
Compressive Strength Tests

SD-07 Certificates

Bill of Lading for Ready-Mix Concrete deliveries.

SD-07 Certificates

Certificates of compliance shall be provided showing conformance with referenced standards contained in this section for the following:

Proposed Ready-Mix Concrete
Fly Ash
Air-Entraining Admixtures
Steel Reinforcement
Curing Compound

PART 2 PRODUCTS

2.1 READY-MIX CONCRETE

Concrete shall be ready-mix concrete and mix design data shall conform to ASTM C 94, minimum Compressive Strength 3000 psi at 28 days. Slump shall be between 1 and 5 inches, according to ASTM C 143.

Air-Entraining Admixtures shall conform to ASTM C 260.

Water-reducing admixtures, retarding admixtures, accelerating admixtures, water-reducing and accelerating admixtures, and water-reducing and

retarding admixtures shall conform to ASTM C 494.

Fly Ash or other pozzolans used as admixtures shall conform to ASTM C 618, Class C or F with 4 percent maximum loss on ignition and 20 percent maximum cement replacement by weight.

2.2 STEEL REINFORCEMENT

2.2.1 Deformed Steel Bars

Steel bars shall conform to ASTM A 615/A 615M, Grade 60 and ACI 318.

2.2.2 Welded Wire Fabric

Welded wire fabric shall conform to ASTM A 185.

2.3 FORMS

Forms shall be of wood, steel, or other approved material and shall conform to ACI 318.

Form release shall conform to ACI 347.

2.4 ACCESSORIES

2.4.3 Curing Compound

Curing compound shall conform to ASTM C 309.

PART 3 EXECUTION

3.1 FORM WORK

Form work shall be in accordance with ACI 318.

3.1.1 Preparation of Form Surfaces

Forms shall be true to line and grade, mortar-tight, and sufficiently rigid to prevent objectionable deformation under load. Form surfaces for permanently exposed faces shall be smooth, free from irregularities, dents, sags, or holes. Exposed joints and exposed edges shall be chamfered. Internal ties shall be so arranged that when the forms are removed, the form ties will be not less than 2 inches from concrete surfaces permanently exposed to view or exposed to water on the finished structure.

3.1.2 Form Coating

Forms for exposed surfaces shall be coated with a nonstaining form release coating which shall be applied before the steel case is added to avoid contaminating the renforcing steel. Forms for unexposed surfaces may be wetted in lieu of coating immediately before the placing of concrete, except that in freezing weather form release coating shall be used.

3.1.3 Removal of Forms

Forms shall be removed carefully to prevent damage to the concrete. Forms shall not be removed before the expiration of the minimum time indicated below:

Slabs	24 hours

3.2 STEEL REINFORCING

3.2.1 General

Reinforcement shall be free from loose, flaky rust and scale, and free from oil, grease, or other coating which might destroy or reduce the reinforcement's bond with the concrete.

3.2.2 Fabrication

Steel reinforcement shall be shop fabricated in accordance with ACI 315. Shop details and bending shall be in accordance with ACI 318.

3.2.3 Splicing

Splices shall be in accordance with ACI 318.

3.2.4 Supports

Reinforcement shall be secured in place by the use of metal or concrete supports, spacers, or ties.

3.3 EMBEDDED ITEMS

Before placing concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place. Embedded items shall be free of oil and other foreign matter such as loose coatings of rust, paint and scale. Embedding of wood in concrete will be permitted only when specifically authorized or directed.

3.4 BILL OF LADING

Bill of Lading for each ready-mix concrete delivery shall be in accordance with ASTM C 94.

3.5 CONCRETE CONVEYING

Concrete shall be conveyed from mixers to forms as rapidly as practical by methods that will prevent segregation or loss of ingredients.

3.6 CONCRETE PLACING

3.6.1 General Placing Requirements

Concrete shall be placed in accordance with ACI 318.

Concrete shall be worked into the corners and angles of the forms and around reinforcement and embedded items without permitting the materials to segregate. Concrete shall be placed within 90 minutes after it has been mixed. It shall be placed on clean, damp surfaces free from water, ice, frost, mud, debris, or objectionable coatings. Concrete shall be consolidated with the aid of mechanical vibrating equipment supplemented by handspading and tamping. Vibrating equipment shall be of the internal type.

3.6.2 Lifts in Concrete

Concrete shall be deposited in horizontal layers not to exceed 24 inches in

thickness. Placement shall be carried on at a rate that will prevent the formation of cold joints. Slabs shall be placed in one lift.

3.7 FINISHING

Defective concrete, voids left by the removal of tie rods, and ridges and local bulging on concrete surfaces permanently exposed to view or exposed to water on the finished structure shall be repaired immediately after the removal of forms. Voids left by the removal of the tie rods shall be reamed and completely filled with dry-patching mortar. Defective concrete shall be repaired by cutting out the unsatisfactory material and placing new concrete secured with keys, dovetails, or anchors. Excessive rubbing of formed surfaces will not be permitted. Unformed surfaces of concrete exposed in the completed work shall have a wood float finish without additional mortar and shall be true to indicated elevations. Other surfaces shall be brought to specified elevations and left true and regular.

3.10 CURING AND PROTECTION

Concrete shall be cured in accordance with ACI 308.

Curing shall be accomplished by moist curing, by moisture-retaining cover curing, by membrane curing, or by combinations thereof.

Moist curing shall be accomplished by keeping surface of concrete wet or by covering with absorptive cover saturated with water and kept wet.

Moisture-retaining cover curing shall be accomplished by covering concrete surfaces with moisture-retaining cover for curing concrete.

Membrane curing shall be accomplished by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared.

3.11 FIELD TESTING

Testing shall conform to ASTM C 39. Quality-control during construction shall be by the Contractor.

Specimens shall be tested for Compressive Strength at 7 days and at 28 days for each design mix.

Slump shall be tested at the plant for each design mix according to ASTM C 143.

Test frequency according to ASTM C 183 and ASTM C 172.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13850

FIRE DETECTION AND ALARM (PROPRIETARY)

05/09

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 GENERAL REQUIREMENTS
1.4 SYSTEM REQUIREMENTS
1.5 QUALITY ASSURANCE PLAN
1.6 SERVICES OF A CERTIFIED FIRE ALARM SPECIALIST

PART 2 PRODUCTS

2.1 FIRE ALARM CONTROL PANEL
2.2 CFMS REPORTING EQUIPMENT
2.2.1 Color Graphics Screens
2.3 ADDRESSABLE MODULES/DEVICES
2.4 FLAME DETECTORS
2.4.1 Triple IR Flame Detectors
2.5 REMOTE AUXILIARY CONTROL RELAYS
2.6 POWER SOURCE
2.7 WIRING
2.7.1 Conduit
2.8 SURGE SUPPRESSORS
2.8.1 Line Voltage Surge Suppressors
2.8.2 Low Voltage Surge Suppressors

PART 3 EXECUTION

3.1 SYSTEM SEQUENCE OF OPERATION
3.1.1 Normal Operation
3.1.2 Supervisory Condition
3.1.3 Trouble Condition
3.1.4 Alarm Condition
3.2 INSTALLATION
3.2.1 Fire Alarm Control Panels and Reporting Equipment
3.2.2 Addressable Modules and/or Devices
3.2.3 Flame Detectors
3.2.4 Wiring
3.2.4.1 60-Hertz Power
3.2.4.2 Installation in Cabinets and Boxes
3.2.5 Conduit and Raceways
3.3 FIELD TESTING
3.3.1 External System Wiring
3.3.2 Fire Alarm System Acceptance Tests
3.3.3 Reacceptance System Tests
3.4 PAINTING

-- End of Section Table of Contents --

SECTION 13850

FIRE DETECTION AND ALARM (PROPRIETARY)
05/09

PART 1 GENERAL

1.1 REFERENCES

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.

FM GLOBAL (FM)

FM P7825	(2009) Approval Guide

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code
NFPA 72	(2008) National Fire Alarm Code

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1016-2	(2003) Program Detail Manual Fire Alarm Systems, 8th Edition

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev B; Am 1) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2006) Surge Protective Devices
UL 2196	(2001) UL Standard for Tests for Fire Resistive Cables, 1st Edition
UL 497B	(2004; Rev thru Oct 2008) Protectors for Data Communication and Fire Alarm Circuits
UL Fire Prot Dir	(2009) Fire Protection Equipment Directory

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Submit Evidence of the Contractor's State Certification to the Contracting Officer for approval, prior to any work being started on the Fire Alarm System.

SD-02 Shop Drawings

Submit the following in accordance with the paragraph entitled, "General Requirements".

Connection Drawings;

Module Schematic Drawings;

As-Built Drawings;

Software Programs;

Fire Alarm System Acceptance Test Forms (For Both Preliminary and Final Tests);

Fire Service Floor Plans;

Record As-Built Drawings(As-Built drawings after completion of the final acceptance test);

SD-03 Product Data

Where multiple types of the same item are required (Example: indoor, weatherproof & explosion-proof types) provide separate Catalog Data for each type of device. Submit Manufacturer's Catalog Data for the following items:

Addressable Modules/Devices;

Flame Detectors;

Remote Auxiliary Control Relays;

Power Source;

Line Voltage Surge Suppressors;

Low Voltage Surge Suppressors;

Wiring (Wire and Multi-Conductor Cable);

CFMS Reporting Equipment;

SD-05 Design Data

Design Analysis and Battery Calculations;
Flame Detectors;

Submit list of parts and components. Provide a list of parts and components for the installed system by manufacturer's name, part number, and nomenclature, and recommended stock level required for normal maintenance and unscheduled repairs.

SD-07 Certificates

Submit Quality Assurance Plan; consisting of the following in accordance with the paragraph entitled, "Quality Assurance" of this section.

Submit proof that all components are Underwriter Laboratory (UL) UL Fire Prot Dir listed or Factory Mutual (FM) FM P7825 approved for their intended use and function.;

Contractor Readiness Affirmation; - For Preliminary Fire Alarm Testing; shall be submitted in accordance with the paragraph entitled. "Field Testing" of this specification;

KSC - Transfer of Responsibility; for the designated portion of the Fire Alarm System; shall be submitted in accordance with the paragraph entitled. "Field Testing" of this specification.

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals;

Provide one single .pdf format of the O&M Manual on a single CDconsisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to acceptance tests being performed.

1.3 GENERAL REQUIREMENTS

Section 16003 GENERAL ELECTRICAL PROVISIONS apply to work specified in this section.

Submittals shall be submitted for approval in the following sequence with each approved prior to the next submittal:

1. Contractor shall sign and submit the KSC Transfer of Responsibility form no later than 30days after notice to proceed.

2. Product Data (Catalog Data), Contractor's Certifications, and Quality Assurance Plan. Submit within 30days after notice to proceed.

3. Connection Drawings, Module Schematic Drawings, Design Analysis and Battery Calculations shall be submitted within 30days after notice to proceed.

4. New and revised Fire alarm control panel and network software program information shall be submitted no later than 14 days prior to the scheduled preliminary test. Two sets minimum of the As-Built drawings and documentation shall be complete and available for reference at the preliminary test.

5. Acceptance Test Procedures shall be submitted no later than 14 days prior to the scheduled preliminary test.

6. Contractor sign and submit the Readiness Affirmation form no later than 5days prior to the scheduled preliminary test.

7. As-Built Shop Drawings, Panel and Network software programs, and Battery Calculations shall be submitted for approval no later than 14 days prior to the scheduled final acceptance test. Two sets minimum of the AS-Built drawings and documentation shall be complete and available for reference at the final test.

8. Operation and Maintenance Manuals shall be submitted 14days after the final test has been complete and approved.

9. Record As-Built Drawings submittal shall include Shop Drawings, Panel and Network software programs, Battery Calculations, Completed Final Test Procedures, NFPA 72 Fire Alarm System Record of Completion form and shall be submitted within 14days after completion of the final acceptance test. This submittal shall include two (2) sets of CD ROM digital media of all the as-built drawings, Design Analysis, Battery Calculations and Program software information.

Connection drawings shall consist of point-to-point wiring diagrams of internal and external wiring including, but not limited to, all fire alarm field devices, panel wiring, and interconnection between other building systems and components and the fire alarm system. Wire label designations matching the field installation shall be indicated on these drawings.

Connection drawings shall include Floor Plan Drawings that indicate equipment locations, device locations with address designation, and conduit/wiring routing from the fire alarm control panel(s) to all field devices including looped Class A circuit routing requirements. Typical mounting requirements for each type initiation, signaling, notification and control device shall also be included. As-built and record drawings for installations with flame detectors shall show horizontal and vertical field of views for each detector and aiming point of detector with clear dimensions from fixed and readily identifiable structural references. Include riser diagram and sequence of operations in an input/output matrix format that clearly shows interaction of system components.

Module schematic drawings (minimum size 216 by 280 millimeter (8-1/2 by 11 inches) to be provided prior to system acceptance testing.

All drawings shall be computer aided design (CAD) generated. Digital medial compact disc (CD) submittals shall include .DWG or .DXF files for all drawings: Connection Diagrams, Module Schematics, Battery Calculations, Floor plans and Fire Service Floor Plans. Also on this CD provide a complete copy of the aforementioned drawings in PDF format on the same CD.

As-Built drawings shall include connection drawings, floor plan drawings, module schematics, software programs, fire service floor plans, design and Battery calculations, and all other data required to fully document the completed system. After final testing is complete, As-Built Record Drawings shall be submitted including digital media and hard copies of all new and revised software, drawings, and analysis/calculations incorporating approved comments and any changes.

As-Built Drawings shall document system configuration including, but not limited to location of the fire alarm control panel, all initiating (flame detectors) and auxiliary control devices (control relay), signaling line devices additional cabinets, power supplies,and all other equipment associated with the contract drawings and specifications. Also, annotate

the location and address setting for each multiplexed addressable device, deviations from and amendments to the as-built drawings, and all field installation changes, both concealed and visible.

Software Programs provide both hard copy and compact discs, for all new and/or existing programmable fire alarm control panels affected by the project. Provide system executable file and report file on the compact disc. Program information for fire alarm control panel including program listings, system point summary, and addressable device switch settings. Corrected program information shall include panel and network programs and sequence of operations in matrix format that clearly shows interaction of system components.

Fire Alarm System Acceptance Test Forms shall be prepared in accordance with the paragraph entitled, "Field Testing" of this specification. Prepare a test procedure and test record form for conducting complete tests on control panels, reporting systems, wiring systems, and field devices installed in accordance with the manufacturer's requirements and these specifications. Test procedure must identify each device and circuit to be tested, describe the initial condition, each step or function in the test, required test result, and equipment to be employed. Test procedures are to be written to minimally disrupt facility operations (minimize activation of evacuation notification appliances, AHU shutdown, etc.) in support of testing requirements. Test forms shall have suitable space for recording test results on all equipment, devices, and wiring to be tested. Test record forms also have identified spaces for verification signatures of official witnesses and dates of the test.

Fire Service Floor Plans must indicate location of the fire alarm control panel, all initiating and auxiliary control devices, signaling line devices, notification appliances, additional cabinets, detection systems, wet and dry pipe sprinkler risers, dry pipe control panel smoke and fire dampers, magnetic door holders and all other equipment associated with the fire alarm system(s). Also, annotate the location and address setting for each multiplexed addressable device (when used). There must be no borders or title blocks on the Fire Service Floor Plan. Provide a symbol legend, which clearly identifies each device shown on the Fire Service Floor Plan. Install a copy of the Fire Service Floor Plan, minimum size 457 millimeter x 610 millimeter (18 x 24 inches) in a painted metal frame with a plexiglass cover. The floor plan and its location must be submitted for approval to the Contracting Officer, prior to installation.

Submit .DXF or .DWG format computer generated connection drawings, schematics, As-Built drawings and Fire Service Floor Plans.

Design Analysis and Battery Calculations must be submitted for approval for the Fire-Alarm and Detection Systems consisting of the battery capacity and loading calculations in accordance with the paragraphs entitled, "Fire Alarm Control Panel"and "Flame Detectors."

Submit list of parts and components in accordance with the paragraph entitled, "SYSTEM REQUIREMENTS" of this section.

1.4 SYSTEM REQUIREMENTS

Fire-alarm system consists of a fully addressable, modular type, microprocessor based, Simplex 4100U networked fire alarm control panel. All new Class A initiating device, signaling line and control circuits must

use diverse routing in accordance with NFPA 72. The outgoing and return redundant circuit conductors must not be run in the same cable assembly, enclosure or raceway. The outgoing and return circuit conductors are permitted to be run in a single conduit or raceway for drops that enter or exit an initiating device, notification appliance, or control unit enclosure. Initiating, signal, and auxiliary control circuits must be 24 V(DC).

System must conform to all the applicable requirements of NFPA 70 and NFPA 72.

Fire alarm systems must contain all of the equipment, devices, programming and circuits required for system operation in accordance with NFPA Codes and KSC requirements, including remote reporting to and remote control from existing, Simplexbased equipment.

Provide all additional equipment, cabinets, conduit, and labor to meet the requirements and intent of this specification.

Components installed under this contract can not be more than one (1) year older than the date of installation.

1.5 QUALITY ASSURANCE PLAN

Equipment to be provided under this specification must be that manufactured fire-alarm equipment which meets the requirements of the section entitled, "System Requirements." It must be the latest standard design, and must be listed by Underwriters' Laboratories or approved by Factory Mutual and be suitable for its intended service. All devices installed must function with the control panel and not interfere with the operation of the control panel.

1.6 SERVICES OF A CERTIFIED FIRE ALARM SPECIALIST

Services of a Certified Specialist thoroughly experienced in fire detection and alarm work must be provided on site to perform or directly supervise the installation, make all necessary adjustments, make all adjustment and perform all tests on the fire alarm system at the site.

Fire Alarm specialist is considered certified when the specialist holds a valid Fire Alarm System, Level III Certification from the National Institute for Certification in Engineering Technologies NICET 1016-2 or a valid Level III Fire Alarm Engineering Technician Certification from the International Municipal Signal Association (IMSA) or is licensed by the State of Florida as a Fire Alarm Contractor I in accordance with Florida State Statute, Chapter 489, Part II.

Certification of other recognized agencies with equivalent requirements will be considered. Evidence of the Contractor's State Certification and the basis of certification must be provided to the Contracting Officer and be approved by the Contracting Officer prior to any work being performed at Kennedy Space Center.

PART 2 PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

The existing fire alarm control panel is a fully addressable system, Simplex model 4100U Panel construction is modular with solid state,

microprocessor based electronics. Addressable components to include but not limited to addressable monitor modules, control modules and power supplies. Modules must be equipped with transient surge suppression.

The existing fire alarm control panel (FACP) contains power-on, alarm, supervisory, and trouble indicating lights plainly visible when the cabinet is closed. It must also contain the following functions and must be accessible only by unlocking and opening the unit:

Alarm Silence

Trouble Silence

Supervisory Silence

Power On-Off (If standard by the manufacturer)

Alarm/Trouble/Supervisory Acknowledge

Maintenance By-pass Switches for Auxiliary Devices

DC Battery Disconnect Switch

System Reset

Fire alarm control panel must contain all components necessary to monitor and supervise all initiating device circuits. When the new triple IR detectors, and addressable modules, etc., connected to the fire alarm control panel are activated, the control panels visual alarm, alarm indicator and audible signal must be activated. This must cause all notification appliances to be activated, including all associated auxiliary control functions. The control panel must visually indicate the addressable device or zone in alarm and transmit an alarm condition to the remote Central Fire Monitoring System.

The new addressable modules required for installation of the triple IR detectors will be connected to the existing Simplex 4100U Style 6 addressable device network. Network utilizes polling methods and provides two-way Class A, Style 6 supervised communications between the fire alarm control panel and the addressable modules for the flame detectors and the addressable control modules for remote testing of the triple IR detectors. The fire alarm control panel must contain all components necessary to monitor and supervise all addressable device circuits.

Provide a single maintenance by-pass switch for all the new triple IR detectors. By-pass switches must be supervised to report supervisory signal when in the maintenance (by-pass) position. Switches used for by-pass functions shall be either toggle or soft key type and shall be listed for use with the control panel. In addition each switch shall also be provided with a positive visual indication to show the function is ON.

Panel must monitor and report as trouble, open supervised circuits, ground faulted supervised circuits, removal of detector or device, removal or failure of control panel module, loss of primary power, power supply trouble, low battery voltage and loss of battery voltage. All trouble signals must be identified by initiating, auxiliary control, or signaling line circuit. Trouble signals must activate the control panel trouble visual indication and trouble audible devices, and send a trouble signal to the remote Central Fire Monitoring System.

Alarm and trouble reset switches must reset a cleared device in alarm or trouble. Alarm or trouble signals must not be self-restoring without activating the switch.

Alarmand trouble silence switches must silence the alarm and trouble audibles. Either switch placed in other than the normal position must provide the following:

a. Report as an alarm, supervisory, or a trouble to the Central Fire Monitoring System.

b. Transfer audible signal to a panel lamp visual indication.

c. Re-ring the trouble audible if the problem has been cleared, but the switch has been left in the silence position.

When the alarm silencing switches are in the silence position, subsequent alarms must reactivate the notification appliance.

Fire alarm control panel must be suitable for use with and listed or approved for the detectors and other fire alarm devices specified in this section.

All relays must be continuous duty and have self-cleaning contacts of silver or an alloy of equivalent performance. Supervisory relays must be suitably protected against dust by individual covers. All relays that provide external functions, such as remote testing of the triple IR detectors must have at least one set of spare contacts. Permanently mark relays with the coil resistance, operating-current range, and internal pin connections using standard pin numbers.

Fire alarm zone addressable module cabinets, terminal cabinets, surge suppression cabinets and battery cabinets (when used) must be steel, provided with a hinged cover and an integral pin-tumbler cylinder lock (Mortise or Standard Rim Cylinderfrom Best Universal Lock Co.) with removable core that accepts the key presently in use with other control units existing in the area; lock core will be provided by the government. Cabinets must be painted with a prime coat and one or more finish coats of scratch-resistant baked enamel. Finish coat must be red unless otherwise indicated.

System must operate from a power supply with 120 grounded V(AC) input and 24 V(DC) output. System must operate satisfactorily with power input voltage varying from 85 to 110 percent of nominal value. Power supply output must be capable of powering all initiation, signaling, annunciation, and control devices during alarm condition with 25 percent minimum spare capacity.

All fire alarm control panels and auxiliary power supplies shall be provided with a DC power input and shall have a DC disconnect switch integral with the equipment provided (2P 30A switch) or a separate safety switch shall be provided. If supplied within the cabinet, the power on-off switch must disconnect all power sources to the control panel. The on-off switch must have DC rated contacts.

Batteries, charger, and power transfer equipment must provide the means of automatically supplying the entire fire alarm system with battery backup power in event of a primary power system failure. System must switch to

battery power in event of AC power failure and switch back to AC power upon return of primary power. Control panel(s) and auxiliary power supplies must be able to operate when the backup batteries are disconnected for any reason. System must control charging currents and floating voltage levels to maintain batteries in optimum condition. Provide capability to recharge batteries in event of discharge. Wiring must be fused to protect against battery over-current and polarity reversal. Primary power, battery, or charging equipment failure must result in a fire alarm control panel trouble signal and visual indication.

Battery modules must be sealed (no corrosive fumes) and spill-proof. Batteries must be listed for fire alarm service and must be suitable for high discharge currents required under alarm conditions. Batteries must be sized to operate the fire alarm and detection system (triple IR flame detectors where installed in normal supervisory condition for 72 hours, minimum, then operate the system in the alarm mode for 15 minutes, minimum.

2.2 CFMS REPORTING EQUIPMENT

Provide all FACP hardware and software required to digitally connect to existing Style 7 networked Simplex FACP's. These existing Simplex networks will provide the communications path back to existing Central Fire Monitoring System Equipment. Also, the FACP equipment provided must be able to silence its alarms and reset itself via digitally transmitted remote commands received by and sent through one of the other existing FACP's connected on these mini-networks. The FACP equipment provided must be capable of digitally communicating with existing networked Simplex FACP's in order to activate interconnected evacuation alarm schemes or for other purposes. Mini-network connections shall be via existing Style 7 communication circuits as indicated.

Updated programs, including EPROM, for new or modified fire alarm control systems shall be provided and installed in the existing fire alarm control panels and/or the Central Fire Monitoring System by the original equipment manufacturer. All EPROM modifications and programming changes to the color graphics units shall be approved by the Contracting Officer prior to installation.

Panel must include modules required for communication interface with the existing Simplex based Central Fire Monitoring System, including Style 7 module for operation of redundant remote reporting circuits. Communication interface must permit individual remote reporting of all monitor zones and remote control of the fire alarm control panel outputs from the Central Fire Monitoring System.

2.2.1 Color Graphics Screens

Updated programs for new or modified fire alarm control systems color graphic screens must be provided and installed into the existing Central Fire Monitoring System Simplex multiplexing system by EG&G Protective Systems prior to the start of the system acceptance testing Section 3.3 FIELD TESTING. All modifications and programming changes must be approved by the Contracting Officer, prior to installation.

2.3 ADDRESSABLE MODULES/DEVICES

Addressable modules must be solid-state compatible with the Fire Alarm Control panel. Modules must be suitable for individual outlet box mounting or group mounting within a control enclosure. Modules installed outdoors

must be installed in weatherproof enclosures with a neoprene gasket and must be protected from corrosion.

Modules must be field addressable to individually communicate with the fire alarm control panel using multiplexed communication techniques. Communication circuit wiring connections must be suitable for supervised Class A, Style 6 operation. Module power must be derived from the communication circuit or 24 V(DC) power supply supervised by the fire alarm control panel. Invalid address setting, component failure, or power failure must initiate a trouble signal at the fire alarm control panel.

Enclosures housing a single isolated module (not grouped with other modules or no other modules nearby) shall be manufacturer's standard outlet box mounting and cover. Enclosures housing more than one addressable module shall be hinged door type with back panel for module mounting. Hinged cover(s) shall be provided with an integral pin-tumbler cylinder lock (Mortise or Standard Rim Cylinder from Best Universal Best Lock Co.)with removable core that accepts the key presently in use with other fire alarm control units at KSC; lock core will be provided by the government. Enclosure shall be adequately sized to allow a minimum of 2-inch wiring space around the cabinet perimeter to include all module termination points. Additionally spare space for 2 future modules shall be provided. Provide terminal strips with 25-percent spare capacity for interfacing all module connections to field wiring. Paint enclosures with a prime coat and one or more finish coats of red enamel to provide a smooth, hard, and durable finish. Enclosures must include an engraved phenolic nameplate labeled, "FIRE ALARM ZAM CABINET,with mapnet Addresses below cabinet label."

Addressable modules for initiation circuits must be supervised 4-wire Class A type unless otherwise indicated. Two-wire Class B modules are acceptable when installed in the same box or enclosure as the connected initiating device.

Addressable relay modules for control and/or remote reporting circuits (addressable relays) must include 2 separate fused Form-C contacts rated at 2 Amperes for 28 V(DC) or 120 V(AC).

2.4 FLAME DETECTORS

2.4.1 Triple IR Flame Detectors

Triple IR flame detectors must be a unitized detector incorporating all sensory, signal processing, and alarm system interfacing components to provide fire detection by sensing within the CO2 emission bandwidth for IR radiation. Detector logic must require IR signal from all three (3) sensors present in the proper spectral signature as emitted by a hydrocarbon fire. The detector must retain alarm-initiating capability in the presence of modulated false alarm sources. Detector must not be activated by single sources of UV or IR radiation including sunlight (direct, intermittent, or reflected), quartz halogen lighting, electric discharge lighting, arc welding, lightning, radiant heat, hot engine exhaust, heating coils, etc. Unit must also be immune from radio frequency (RF)interference and electromagnetic frequency (EMF) interference. Detectors using guard band technology are not acceptable.

Detector must have a minimum field of view of 90 degrees along the horizontal axis and 70 degrees along the vertical axis. Detector must be

capable of detecting a 0.3 meter by .3 meter(80 feet) gasoline fire at a distance of 64 meters(210 feet) on axis, and 46 meters(150 feet) off axis. Detect a 0.6 meters by .6 meters(2 foot by 2 foot) JP5 pan fire at 30.5 meters(100 feet) on axis, and 24.4 meters off axis, as well as an atomized type fire at 15.2 meters(50 feet) on and off axis. Detector response time must be selectable to 500 msec with typical response under 5 seconds for initiating fire signal. Detector must include self-diagnostic features to monitor its sensors, power source, and internal circuitry.

Detector must incorporate separate single pole, double throw (SPDT) alarm and trouble contacts rated 5 amperes minimum at 30 V(DC). Alarm contacts must activate upon fire detection and must be programmable for latching or non-latching operation; program for non-latching operation unless otherwise indicated. Cycling detector power or momentarily (10ms) activating the manual test line must reset latching alarm contacts. Trouble contacts must be non-latching and activate upon loss of unit power or internal diagnostic failure. Wiring connections for all contacts must be suitable for Class A wiring and must be made on screw terminals capable of accepting No. 18 through No. 12 AWG solid copper conductors. Detectors shall be made individually addressable for alarm and trouble conditions by connection to addressable modules. Addressable modules shall be provided in accordance with the paragraph entitled, "Addressable Modules/Devices".

Detector must be powered from a 24 V(DC) source. Where a power supply other than the fire alarm control panel is used, the power supply must incorporate power supply, battery backup and power transfer equipment in accordance with the paragraph entitled, "Fire Alarm Control Panel". Detector power wiring connections must be on screw terminals suitable for No. 16 through No. 10 AWG diameter solid copper conductors. Include 25 percent spare capacity on the power circuit.

Enclosures and detectors mounted in hazardous locations must conform to the requirements of Underwriter's Laboratory or Factory Mutual for the hazardous location classification indicated. Install conduit seal-off fittings suitable for the hazardous location classification at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70. Enclosures must be aluminum, rated NEMA 4X, and must include threaded conduit connection. Mount enclosure on a aluminum swivel base, which allows 180 degree horizontal and vertical rotation from the pivot point.

Detector must have a calibrated integral optical integrity test feature, including individual test lamps for each IR sensor and generate a fault when 50 percent of the detection range is lost. Detectors must include calibrated self-test capabilities that generate an alarm when more than 50 percent of the detection range is retained.

Provide remote optical integrity test capabilities for each Triple IR detector from the addressable fire alarm control panel. The remote test feature for the triple IR detectors shall be capable of being activated either manually or automatically from the fire alarm control panel. Each control circuit must activate the internal IR test lamps simultaneously for each Triple IR detector connected to the control circuit. Include 25 percent spare capacity on each optical integrity test control circuit. Activation of the control circuit via the control addressable module must cause all of the associated Triple IR detectors to go into an alarm condition. When the optical integrity test switch is restored to its normal position all the affected Triple IR detectors must self restore. The addressable device monitoring the Triple IR detector must be a latching type so as to provide alarm identification.

2.5 REMOTE AUXILIARY CONTROL RELAYS

Remote control relays must have continuous duty coils rated 24 V(DC). Where relays are used on Class A parallel wired supervised circuits, coils must incorporate supervisory current blocking diode. Relays must have a minimum of 2 single pole, double throw contacts rated 5 amps at 28 V(DC) or 250 V(AC).

Mount remote auxiliary control relays in enclosures indicated or, if not indicated, in manufacturer's required enclosure. Relays installed outdoors must be installed in a weatherproof enclosure with NEMA 4x a neoprene gasket and must be protected against corrosion.

2.6 POWER SOURCE

Normal power to the local systems for all purposes, including separate powered indicating/alarm devices, must be 120 volts 60 hertz. System must operate satisfactorily between 85 and 110 percent of normal voltage.

2.7 WIRING

Provide wiring in accordance with NFPA 70 and NFPA 72. Conductors must be copper. Conductors for 120 V(AC) circuits must be No. 12 AWG minimum.

Conductors installed on fire alarm systems must be solid copper with an insulation rating of not less than 300 volts. Conductors must be marked with the size, voltage rating and manufacturer's name permanently marked on the conductor jacket at no less than 610 millimeter(2 feet) intervals. Conductor size and color are listed below. Where modifications are made to existing systems, the new or added conductors must match the size and color-coding of the existing system.

Conductors for multiplexed communication circuits, signaling line circuits, speaker audio circuits, remote phone circuits, and remote reporting circuits must be solid copper, shielded, twisted pairs meeting UL 2196. Cable must be listed as Type FPL, Power-Limited Fire Protective Signaling Cable. Conductor size must be not less than No. 16 AWG diameter for data circuits and No. 14 AWG diameter for audio circuits.

Direct current initiating device Triple IR Detector circuits must be a two loop circuit per NFPA 72, Class A. Conductor size must be not less than No. 16 AWG diameter. Conductor insulation must be Type TFN for No. 16 AWG diameter, and Type THHN/THWN for No. 14 AWG diameter and larger.

Power leads from the control panel for Triple IR Detectorsmust be sized accordingly, but not less than No. 14 AWG diameter. Conductor insulation must be Type THHN/THWN for No. 14 AWG diameter and larger.

Direct current auxiliary control device (relays) circuits must be parallel wired per NFPA 72, Class A . Conductor size must be not less than No. 14 AWG diameter. Conductor insulation must be Type THHN/THWN for No. 14 AWG diameter and larger.

2.7.1 Conduit

Provide ¾ inch to 2 inch rigid PVC coated conduit and rigid conduit fittings and couplings with a factory applied PVC coating for all exterior

fire alarm system conduit runs.

2.8 SURGE SUPPRESSORS

Provide line voltage and low voltage surge suppression devices to suppress all voltage transients which might damage the control panel components.

Install surge suppression in accordance with UL 497B on each conductor of fire alarm circuits which extend beyond a building. Locate protection as close as practical to the point where the circuits leave the building. Install protectors in surge suppression cabinets of adequate size with terminal strips for all wiring connections plus 25 percent spare. Paint enclosures with a prime coat and one or more coats of red baked enamel finish to provide a smooth, hard, and durable finish. Where installed outdoors, provide stainless steel NEMA 4X rated cabinets. Provide a copper ground bus inside the cabinet and connect protectors to an earth ground electrode system in accordance with the manufacturer's requirements and NFPA 70. An etched metal or engraved laminated plastic identification plate labeled, "Fire Alarm Cabinet," must be affixed to the cabinet door of the alarm-control unit to identify the cabinet as a fire-alarm cabinet. For cabinets painted red the identification plate must have white letters on a black background. For cabinets not painted red the identification plate must have white letters on a red background.

2.8.1 Line Voltage Surge Suppressors

Suppressor must be UL 1449 listed with a maximum 330 volt clamping level and a maximum response time of 5 nanoseconds. Suppressor must also meet IEEE C62.41 category B tests for surge capacity. Suppressor must be a multi-stage construction which includes inductors and silicon avalanche zener diodes. Suppressor must have a long-life indicating lamp (light emitting diode or neon lamp) which extinguishes upon failure of protection components. Fuses must be externally accessible. Wire in series with the incoming power source to the protected equipment using screw terminations.

2.8.2 Low Voltage Surge Suppressors

Provide for all circuits which leave the building shell and as shown on the contract drawings. When circuits interconnect two (2) or more buildings, provide an arrestor at the circuit entrance to each building. Suppressor must be UL 497B listed, with a maximum 30 volt clamping level and a maximum response time of 5 nanoseconds. Suppressor must have multi-stage construction and both differential/common mode protection.

PART 3 EXECUTION

3.1 SYSTEM SEQUENCE OF OPERATION

3.1.1 Normal Operation

All switches must be in the normal position. Available power lamp must be on and the trouble and detector identification lamps must be off. All circuits must be electrically supervised.

3.1.2 Supervisory Condition

System conditions identified in the paragraph entitled, "Fire Alarm Control Panel," must transmit a supervisory signal to the Central Fire Monitoring System, provide device indication, activate a supervisory signal in the

fire alarm control panel, and provide input to remote annunciators (when used). Supervisory signal in the alarm control unit must be comprised of visual and audible indications. The supervisory signals must be self-restoring.

3.1.3 Trouble Condition

System conditions identified in the paragraph entitled, "Fire Alarm Control Panel," must transmit a trouble signal to the remote reporting device of the Central Fire Monitoring System, provide zone indication, activate a trouble signal in the fire alarm-control panel, and provide input to remote annunciators (when used). Trouble signal in the alarm-control unit must be comprised of visual and audible indications.

3.1.4 Alarm Condition

Activation of any detectors, manual alarm stations, water flow switches, or other initiating devices must close a contact that activates the appropriate fire alarm control panel. Fire alarm control panel transmits a signal to the remote reporting device of the Central Fire Monitor System; activates the facility indicating appliances; provides zone identification; controls air handling and ventilating units; provides an input to remote annunciators (when used); and provides indication or control to devices or other systems.

3.2 INSTALLATION

Prior to performing any installation or modification work to existing Fire Alarm system(s), a Transfer of Responsibility Form must be completed by the COTR and signed by the Contractor and Institutional Services Contractor (ISC) Fire Protective Systems designee. The completed form will be turned over to the Contracting Officer by the COTR. A copy of the completed "Transfer of Responsibility" Form shall be permanently affixed to the affected fire alarm control panel throughout the construction period.

Install all equipment in accordance with contract drawings, manufacturer's recommendations, and this Section.

3.2.1 Fire Alarm Control Panels and Reporting Equipment

Install equipment in each protected building, located where indicated, and complete with all indicated accessories and devices. Install equipment in accessible locations in such a manner as to prevent damage from vibration or jarring. Equipment requires a minimum of 914 millimeter(3 feet) clearance directly in front of the panel for maintenance per NFPA 70. With multiple equipment, the 914 millimeter(3 feet) clearance is required directly in front of the complete configuration. In addition, a 711 millimeter(28 inch) clear aisle way must be provided for access to the equipment.

Wiring within fire alarm control panel(s) and reporting equipment must be in accordance with the paragraph entitled, "Installation in Cabinets and Boxes."

3.2.2 Addressable Modules and/or Devices

Install zone addressable modules at accessible locations indicated. Configure module address switches to settings indicated on approved shop submittals. Modules must be identified individually adjacent to their

mounting.

Mount control and monitor zone addressable modules used for triple IR flame detector monitoring and testing in an accessible location.

Where zone addressable modules are grouped within an enclosure, wiring must be in accordance with the paragraph entitled, "Installation in Cabinets and Boxes."

3.2.3 Flame Detectors

Flame detector location and general arrangement must be as indicated. Adjust location as required to prevent obstruction of the detector field of view, and provide coverage in all protected areas by at least one detector.

Where detectors are installed outdoors, arrange conduit systems to drain away from the detector. Aim detectors to accurately cover the field specified using a laser aimer recommended by the detector manufacturer. The aiming spot shall be clearly marked on the floor for each detector and the measurements of this spot from fixed structural elements shall be included on the as-built and record shop drawings.

3.2.4 Wiring

Wiring must conform to the requirements of NFPA 70 and the following special requirements:

Install fire alarm system circuits in a separate raceway system. Route each circuit type (Initiating, Notification, Signaling, and Control) through a dedicated separate conduit or raceway system configured to comply with NFPA 72 Class "A" conduit system requirements. 60-Hertz power circuits must not enter enclosures containing fire alarm circuits except where required to connect to the fire alarm system.

Conductors must be continuous from a terminal point at one device to a terminal point at the next device and from a device to the fire alarm (control) panel. Break wires at each terminal; wires must not be looped over a terminal. Approved explosion proof devices provided with pigtail wiring connection leads must be terminated on a field installed terminal strip installed in the box on which the device is mounted. Install solderless ring tongue terminal lugs with manufacturer's required tooling on the device wiring connection leads. This ring type lug is to be used on stranded wire only. Termination of solid wire must be made on compression or screw type terminals. When screw type terminals are used the conductor must be captured under 80 percent of the screw head surface. All circuit conductors shall be identified within each enclosure where a tap, splice, or termination is made. Conductor identification shall be by heat-shrink-type sleeves or other approved method. Conductor labels shall be point destination type to indicate cabinet, circuit board, terminal block and screw terminal location for each individual conductor.

Conductor colors are listed below and must be in accordance with FED-STD-595. Where modifications are made to existing systems, the new or added conductors must match the size and color-coding of the existing system.

Conductors for multiplexed communication circuits, must be marked with circuit designation, and consistent color-coding for the positive and negative loops must be maintained throughout the cable system.

Direct current initiating device circuits (flame detectors) must be a two loop circuit per NFPA 72, Class A with the positive loop conductor colored blue, Color No. 15102, and the negative loop conductor colored black, Color No. 17038.

Power leads from the control panel for product-of-combustion detectors must be one white, Color No. 17877 positive and one black, Color No. 17038 negative.

Direct current auxiliary device control device circuits (Triple IR Flame detector test relay) must be parallel wired per NFPA 72, Class A. Positive conductor must be colored yellow, Color No. 13591 and the negative conductor must be colored brown, Color No. 10055.

3.2.4.1 60-Hertz Power

60-hertz power to fire alarm control panels or separately powered devices must be 120 volts. There must be one black phase conductor, one white or gray solidly grounded neutral conductor and one green equipment grounding conductor. Conductor size must be as shown on the drawing with the minimum size No. 12 AWG copper. Install surge arrestors in accordance with NFPA 72 and NFPA 70. Circuit Breakers used to supply AC power to the fire alarm control panel shall be clearly identified. Provide a permanently label white background with red lettering adjacent to the circuit breaker.

3.2.4.2 Installation in Cabinets and Boxes

Install wiring in control cabinets and boxes in a neat and orderly manner with wire properly grouped, tie-wrapped, or laced parallel and perpendicular to the major axis, supported and identified. Control wiring must be continuous from device to device with no splices unless otherwise indicated. All wires entering or leaving control cabinets, boxes, and devices must be permanently marked and terminated on screw terminals. Marking must be consistent throughout the fire alarm system and must be the same as the identification shown on the connection drawings.

Wire labels shall correspond to the approved connection drawings and use a method indicating the destination of the other end of the wire. Labels in control panel equipment or between fire alarm terminal cabinets shall indicate the destination of the other end by cabinet number(or cabinet identifier),terminal strip designation,and terminal strip number.

3.2.5 Conduit and Raceways

Minimum size for fire alarm system initiating, notification, signaling line and control circuit conduits and raceways must be 12 millimeter(3/4-inch). Installation must be in accordance with NFPA 70. All Class A initiating device, signaling line, notification appliance and control circuits must use diverse routing in accordance with NFPA 72. The outgoing and return redundant circuit conductors must not be run in the same cable assembly, enclosure or raceway. The outgoing and return circuit conductors are permitted to be run in a single conduit or raceway for drops that enter or exit an initiating device, notification appliance, or control unit enclosure.

Install rigid galvanized steel conduit in all exterior locations where the conduit is exposed above grade, interior exposed locations from finished floor to 304 millimeter(1 foot) above finished ceiling unless otherwise

shown on the drawings. EMT with hexnut expansion gland-type fittings can be installed in all other locations. Use flexible metal conduit, maximum length 1828 millimeter(6 feet), as the final connecting raceway to a fire alarm device mounted on vibrating equipment or on a suspended ceiling.

Where devices, junction boxes, and cabinets are installed outdoors, arrange conduit systems to drain away from the boxes and cabinets; conduit shall enter the box or cabinet from the side or bottom only and drain type fittings shall be installed.

Conduit direct buried in earth must be schedule 80 PVC. Portions of underground raceway system that penetrate above finished grade must be rigid galvanized heavywall steel conduit with a 40-mil PVC coating or painted with a bitumastic compound.

Conduit in interior finished areas must be concealed. Conduit through fire-resistant rated walls, floors, ceilings, must be fire-stopped in a manner that maintains the fire-resistant rating of the wall, floor or ceiling.

Conduit installed in a vertical position must be parallel with walls and perpendicular with the floor and ceiling. Conduit installed in a horizontal position must be parallel with the floor and ceiling and be perpendicular with the walls. Changes in direction of runs must be made with symmetrical bends. Bends of over 25 millimeter (one inch) in diameter must be factory made elbows.

3.3 FIELD TESTING

After complete installation of the equipment and at such time as directed by the Contracting Officer, conduct tests to demonstrate that the installation requirements of this specification have been met and that the sequential functions of the system comply with the requirements specified herein. Tests covered in the following paragraphs must be done in two parts:

a. Contractor Checkout - This test shall be performed by the Contractor to remove all troubles, ground faults, ensure all devices are fully functional and operational, and test the programming to ensure the installation meets the contract drawings and specifications.

   For modification and rehabilitation work, the Contractor is not responsible for existing troubles and ground faults that are not in contract scope. The existing troubles and ground faults that are not in contract scope shall be clearly conveyed by the Contractor in the Transfer of Responsibility form. Upon successful completion of Contractor Checkout, the Contractor shall submit Contractor Readiness Affirmation prior to requesting the preliminary test.

b. Preliminary - This test shall be performed by the Contractor using the approved test procedure and witnessed by the Government construction inspectors. As-built fire alarm system drawings shall be verified against the system installed and all red-lines annotated and summarized on a single set of as-built drawings. The test procedures shall be followed as written and all red-lines annotated on a single Test Procedure. The summarized set of drawings and test procedures shall be initialed and dated by the

construction inspector and the fire alarm vendor. The Preliminary test shall not be complete until all steps in the test procedure have been satisfactorily completed. This includes any additional steps required to complete 100% testing of the fire alarm system and its associated functionality.

c. Final Acceptance - After the successful completion of the preliminary test, a Final Acceptance test shall be scheduled. The final acceptance test procedure and as-built drawings shall have incorporated all red lines from the preliminary test. The Contractor shall provide a copy of the consolidated redlines for the as-built drawings and preliminary test procedures from the preliminary test. The Contracting Officer and the Authority Having Jurisdiction or their designee(s) shall witness the final acceptance test for the fire alarm system. During the Final Acceptance Test, the Contractor shall have two corrected as-built drawings and Final Acceptance Test Procedures for use in conducting the final acceptance test. Upon completion of the Final Acceptance Test the following documentation shall be provided to the Contracting Officer; a copy of the Final Acceptance Test procedure (with all steps annotated as complete), a corrected set of as-built drawings and a signed and completed NFPA 72 Fire Alarm System Record of Completion form.

On both preliminary and final tests, follow the approved testing procedures.

3.3.1 External System Wiring

Perform the following tests on the external system wiring before connection to the control panel:

Check continuity of circuits with an ohmmeter. Insert temporary jumpers in appropriate sockets of missing detectors and install the end-of line resistor when this test is performed. Resistance reading for each circuit must be the value of the end-of-line resistor, plus or minus 10 percent.

Each wire must be checked for grounds with 300-volt and 500-volt insulation resistance test set. Resistance to ground must not be less than 20 megohms. Each wire tested shall be isolated from ground, and all other wires within the same conduit shall be grounded. The conduit system shall be verified grounded prior to insulation resistance testing by verifying a short circuit between the conduit and earth ground.

3.3.2 Fire Alarm System Acceptance Tests

After completion of the above tests, connect the external system wires to the appropriate terminals in the control panel and perform the following tests:

With the control panel energized, demonstrate the proper operation of all indicating lights and alarms.

Activate each flame detector in accordance with the manufacturer's recommendation; verify both alarm and trouble indications at the fire alarm control panel.

Activate each optical integrity test switch at the fire alarm control panel to verify that each flame detector on this circuit went into alarm and that all the addressable interface modules latched in the alarm condition. Restore the test switch and visually verify the flame detectors returned to normal operation.

Remove and ground one lead at each alarm initiating device, (flame detector, etc.), to demonstrate circuit trouble, ground fault, and then alarm over ground fault with an open circuit. Alternate between positive (+) and negative (-) leads during the device testing process.

Turn off power to each separately powered panel or device to simulate loss of power and to demonstrate operation of the trouble alarm.

Demonstrate each alarm control unit to operate in all modes.

Demonstrate capacity and the operation of the battery backup system to operate as required by these specifications by disconnecting the 120 volt, 60 Hz power from the fire alarm (control) panel and operating the system as specified for backup operation.

Demonstrate all circuits interconnecting with other systems fire protection, smoke control, HVAC, security and safety, elevators, etc., to operate as specified on alarm from the associated zone or zones.

All maintenance bypass functions shall be verified to operate as specified. Each device or circuit controlled by the bypass function shall be independently verified.

Test multiplex equipment, devices, and wiring in accordance with NFPA 70 and manufacturer's requirements. Remove and ground one lead at each addressable device to demonstrate open circuit trouble, ground fault trouble, and then operation over ground fault with an open circuit. Alternate between positive (+) and negative (-) leads during the device testing process.

3.3.3 Reacceptance System Tests

Perform reacceptance testing after system components are added or deleted; after any modification, repair, or adjustment to system hardware or wiring; or after any change to software. All components, circuits, systems operations, or site specific software functions known to be affected by the change or identified by a means that indicates the system operational changes must be 100 percent tested. In addition, also test 10 percent of the initiating devices that are not directly affected by the change and verify proper system operation.

Changes to all control units connected or controlled by the system executive software require a 10 percent functional test of the system, including a test of at least one device on each input and output circuit to verify proper system operation.

Upon completion of the modification, functionally test the existing devices that were reinstalled and test the devices that are on both sides of the point of connection of the new devices. All newly installed devices must be tested in accordance with the paragraph entitle, "Fire Alarm System Acceptance Tests."

After final acceptance testing has been successfully completed, submit test

data under the terms of the "GENERAL REQUIREMENTS" clause of this contract.

3.4 PAINTING

Manufacturer's standard finish equipment surfaces damaged during construction must be brought to as-new condition by touchup or repainting to the satisfaction of the Contracting Officer, or replaced with new undamaged equipment at no additional cost to the Government.

Paint all fire alarm equipment and appurtenances red, Color No. 11105 in accordance with FED-STD-595.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16003

GENERAL ELECTRICAL PROVISIONS

04/09

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS (Not Applicable)
1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS
1.4 CODES AND STANDARDS
1.5 COORDINATION
1.6 APPROVAL REQUIREMENTS
1.7 PREVENTION OF CORROSION

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES
2.2 WARNING SIGNS
2.3 ANCHOR BOLTS
2.5 PAINTING

PART 3 EXECUTION

3.1 INSTALLATION
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 --

SECTION 16003

GENERAL ELECTRICAL PROVISIONS
04/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2008) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS W-J-800	(Rev F) Junction Box: Extension, Junction Box; Cover, Junction Box (Steel, Cadmium, or Zinc-Coated)
FED-STD 595	(Rev B) Colors Used in Government Procurement

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2008) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2007; INT 2008) National Electrical Safety Code

U.S. DEPARTMENT OF DEFENSE (DOD)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA Z 535	(1991) Safety Color Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL-05	(1995) Electrical Construction Materials Directory

1.2 SUBMITTALS (Not Applicable)

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), Inc., the label of, or listing with re-examination, in UL-05 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

Metallic materials shall be protected against corrosion. Indoor equipment enclosures shall be given a rust-inhibiting treatment and the standard finish by the manufacturer when used for most indoor installations. 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 W-J-800 for interior locations.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

Identification plates shall be 3-layer white-black-white, engraved to show black letters on a white background. Letters shall be uppercase. Identification plates 1-1/2 inches high and smaller shall be 1/16-inch thick with engraved lettering 1/8-inch high. Identification plates larger than 1-1/2 inches high shall be 1/8-inch thick with engraved lettering not less than 3/16-inch high. Identification plates having edges of 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 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 NEMA Z 535.

2.3 ANCHOR BOLTS

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

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.

ITEM	FINISH COLOR
Circuit Breakers	No. 70 gray (FED-STD 595)
Substations	No. 70 gray (FED-STD 595)
Switchgear	No. 70 gray (FED-STD 595)
Transformers	No. 70 gray (FED-STD 595)
Safety Switches	Manufacturer's standard
Panelboards	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.

Due to the critical nature of this facility and the equipment fed from this facility, the Contractor shall remain in close contact with the Contracting Officer and plant maintenance personnel with regard to outages and equipment connections. Provide 10KW generator backup for control power.

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 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. Grout holes around conduit and paint surface to match existing conditions.

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. Provide evidence of calibration to Contracting Officer prior to initial tests.

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 6 months for analog equipment and 12 months for digital equipment at the time of field testing.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16065

SECONDARY GROUNDING

04/09

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL REQUIREMENTS
1.3 SUBMITTALS
1.4 DRAWINGS

PART 2 PRODUCTS

2.1 GROUND RODS
2.2 GROUND WIRES
2.3 CONNECTORS AND FASTENERS

PART 3 EXECUTION

3.1 BONDING AND GROUNDING
3.2 GROUNDING ELECTRODES
3.3 GROUND GRIDS
3.4 EQUIPMENT GROUNDING
3.5 GROUNDING CONNECTIONS
3.6 BONDING
3.6.1 Type of Bonds
3.6.1.2 Welding
3.6.1.3 Clamping
3.6.2 Cleaning of Bonding Surfaces
3.6.3 Bonding Straps and Jumpers
3.6.4 Equipment Enclosure Bonding
3.6.5 Bonding of Conduit and Raceway Systems
3.6.5.1 Rigid Metal Conduit and Terminations
3.6.5.2 Flexible Metal Conduit
3.6.6 Cable Tray Bonding
3.6.7 Protection of Finished Bonds
3.7 FIELD TESTS
3.7.1 Bond Resistance Test
3.7.2 Ground Resistance Tests
3.7.3 Ground Isolation Test
3.7.4 Continuity Isolation Test

-- End of Section Table of Contents --

SECTION 16065

SECONDARY GROUNDING
04/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM B 3	(2001; R 2007) Standard Specification for Soft or Annealed Copper Wire

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD 889	(Rev B, Notice 2) Dissimilar Metals

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Standard for Grounding and Bonding Equipment

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

As-Built Drawings shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

SD-03 Product Data

Equipment and performance data shall be submitted for the following items including life, test, system functional flows, safety features, and mechanical automated details.

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

Ground Rods
Ground Wires
Connectors and Fasteners
Bonding

SD-06 Test Reports

Test Reports shall be submitted for the following tests on grounding systems in accordance with the paragraph entitled, "Field Tests," of this section. Report shall include certified record of ground-resistance tests on each driven ground rod, ground rod assembly, and other grounding electrodes. Record shall include the number of rods driven and their depth at each location to meet the required resistance-to-ground measurements specified. A statement shall be included describing the condition of the soil at the time of measurement.

Bond Resistance Test
Ground Resistance Tests
Ground Isolation Test
Continuity Isolation Test

SD-08 Manufacturer's Instructions

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

1.4 DRAWINGS

As-Built Drawings shall indicate the location of ground rods, steel building columns, and other metal structures connected to the grounding system.

Location of each ground rod and ground-rod assembly and other grounding electrodes shall be identified by letter in alphabetical order and keyed to the record of ground-resistance tests.

PART 2 PRODUCTS

2.1 GROUND RODS

Ground rods shall conform to the requirements of NFPA 70.

Ground rods shall be copper-clad steel rods not less than 3/4 inch in diameter and not less than 10-feet long per section. Ground rods shall be clean and smooth and have a cone-shaped point on the first section and shall be die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in feet.

2.2 GROUND WIRES

Ground wires shall be in accordance with Section 16145, "Standard Wiring Systems."

Ground and bond wires for substations, main panels and distribution points shall be annealed bare copper conforming to ASTM B 3, stranded, with 98 percent conductivity. Wire size shall be in accordance with the grounding requirements of NFPA 70.

2.3 CONNECTORS AND FASTENERS

Grounding and bonding fasteners and connectors shall conform to the requirements of UL 467, and Section 16145, "Standard Wiring Systems."

Grounding and bonding fasteners shall be copper.

Bonding straps and jumpers shall be copper and shall have a cross-sectional area of not less than No. 6 AWG.

PART 3 EXECUTION

3.1 BONDING AND GROUNDING

Bonding and grounding requirements shall be in accordance with NFPA 70.

3.2 GROUNDING ELECTRODES

Grounding electrodes shall include ground rods installed expressly for grounding systems. Ground rods shall be installed using a water jetting procedure.

Minimum ground rod section shall be 10 feet. Sections shall be threaded together and exothermically fusion welded.

Ground rods shall be installed so that the top of the rod is not less than 12 inches below finished grade.

3.3 GROUND GRIDS

Ground grids shall consist of a series of ground rods installed with interconnecting grounding conductors between ground rods. Ground rods shall be spaced as noted.

Ground grid shall be buried not less than 12 inches below the finish grade. Grounding conductors shall be not less than No. 4/0 AWG and shall be exothermically fusion welded together at crossover points and to ground rods.

3.4 EQUIPMENT GROUNDING

Metal conduit, fittings, junction boxes and other raceways shall be effectively bonded together in accordance with NFPA 70. These bonded systems shall not be considered to serve as the sole equipment grounding conductor. A separate equipment grounding conductor shall be installed in each raceway for grounding connections.

Indoor substations, transformers, switchboard frames, switchgear assemblies, motor control centers, and panelboards shall be individually and directly connected and grounded to the building ground, using a supplementary grounding conductor that is in addition to the equipment grounding conductor in the equipment feeder. The supplementary grounding conductor shall be routed external to the feeder conduit and be bonded

directly to the equipment enclosure. Building ground shall be either building steel or the building grounding grid/loop (counterpoise). Current-carrying capacity of the supplementary grounding conductor shall be the same as the current-carrying capacity of the power conductors for circuits utilizing power lines size No. 2 AWG and smaller. For circuits with power wiring larger than No. 2 AWG, the supplementary grounding conductor shall be in accordance with NFPA 70, except that the grounding conductor shall be not smaller than No. 2 AWG.

3.5 GROUNDING CONNECTIONS

Ground connections shall be bonded connections in accordance with paragraph entitled, "Bonding."

Ground connections that are buried or in inaccessible locations shall be welded.

Connections in accessible locations shall be bolted. Connections to steel building columns in accessible locations shall be cast-copper-alloy clamp lugs exothermically fusion-welded to the structure.

Ground connection surfaces shall be cleaned and degreased and foreign matter removed. Clad material shall not be penetrated in the cleaning process. Connection shall be made between like metals where possible. Where dissimilar metals are welded, brazed, or clamped, the weld kit manufacturer's instructions shall be followed. Connections between dissimilar metals shall not produce galvanic action in accordance with MIL-STD 889.

3.6 BONDING

3.6.1 Type of Bonds

Bonding of metal surfaces shall be accomplished by welding or clamping.

3.6.1.2 Welding

Welding shall be by the exothermic process. Welding procedure shall include the proper mold and powder charge and shall conform to the manufacturer's recommendations.

Welding processes shall be of the exothermic fusion type that will make a connection without corroding or loosening. Process shall join all strands and shall not cause the parts to be damaged or weakened. Completed connection or joint shall be equal or larger in size than the conductors joined and shall have the same current-carrying capacity as the largest conductor. Buried ground connections shall be painted with a bitumastic paint.

3.6.1.3 Clamping

In external locations, clamping shall be used only where a disconnect type of connection is required. Connection device may utilize threaded fasteners. Device shall be constructed such that positive contact pressure shall be maintained at all times. Machine bolts with tooth-type lockwashers shall be used.

3.6.2 Cleaning of Bonding Surfaces

Surfaces that comprise the bond shall be thoroughly cleaned before joining. An appropriate abrasive shall be applied with a gentle and uniform pressure to ensure a smooth and uniform surface. Excessive metal shall not be removed from the surface. Clad metals shall be cleaned in such a manner that the cladding material is not penetrated by the cleaning process. Bare metal shall then be cleaned with an appropriate solvent to remove any grease, oil, dirt, corrosion preventives, and other contaminants. Cleaned area shall be made within one hour after cleaning. Joint shall be sealed and the exposed surfaces refinished within two hours to prevent oxidation. When additional time is required, a corrosion preventive compound shall be applied until the area can be refinished.

3.6.3 Bonding Straps and Jumpers

Jumpers shall be installed such that the vibration by the shock-mounted device shall not change its electrical characteristics.

Bonds shall be welded for outdoor locations unless a disconnect type of connection is required. When a disconnect is required, clamping with bolts shall be used. A tooth-type lockwasher shall be inserted between the strap and metallic member for each bolt.

Straps shall be bonded directly to the basic structure and shall not penetrate any adjacent parts. Straps shall be installed in an area that is accessible for maintenance.

Single straps shall be used for the bonds and shall be installed such that they will not restrict movement of structural members. Two or more straps shall not be connected in series.

Straps shall be installed such that they will not weaken structural members to which they are attached.

3.6.4 Equipment Enclosure Bonding

Any type of metallic electric equipment enclosure shall be bonded to ground.

3.6.5 Bonding of Conduit and Raceway Systems

Metal conduit, fittings, junction boxes, outlet boxes, armored and metal sheathed cable, and other raceways shall be bonded as listed below. Care shall be taken to ensure adequate electrical contact at the joints and terminations.

3.6.5.1 Rigid Metal Conduit and Terminations

Threaded connections must be wrench-tight and there shall be no exposed threads. All ends of the conduit shall be reamed to remove burrs and rough edges. Conduits entering boxes and enclosures shall be bonded to the box with locknuts and grounding-type bushings. Locknuts that gouge into the metal box when tightened are not acceptable.

Conduit systems that are interrupted by PVC dielectric links shall be bonded separately on either side of the link. Dielectric link shall not be jumpered.

3.6.5.2 Flexible Metal Conduit

Flexible conduit shall have an integral grounding conductor.

3.6.6 Cable Tray Bonding

Cable tray sections shall be bonded together. Cable tray sections in tandem assembly shall be considered as having electrical continuity when these sections are bonded with the appropriate bolts. Bond straps shall be installed across expansion joints. Cable trays shall be bonded to the building ground system.

3.6.7 Protection of Finished Bonds

Finished bonds shall be protected by painting to match the original finish after the bond is made.

3.7 FIELD TESTS

The following tests shall be performed by the Contractor in the presence of the Contracting Officer.

3.7.1 Bond Resistance Test

Resistance of any bond connection shall not exceed 0.5 milliohm. Bonds that exceed this resistance shall be reworked by the Contractor at no additional cost to the Government.

3.7.2 Ground Resistance Tests

Grounding systems shall be tested for ground resistance. Total resistance from any point on the ground network to the building counterpoise shall not exceed 50 milliohms.

Ground resistance and counterpoise tests shall be made during dry weather, and no sooner than 48 hours after rainfall. Tests shall be conducted using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Measurements shall be performed in accordance with IEEE Std 81.

Indicating instrument shall be self-contained and shall include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Direct-reading ohmmeter shall be calibrated for ranges of 0 to 20 ohms and 0 to 200 ohms.

Auxiliary grounding electrodes shall be placed in accordance with instrument manufacturer's recommendations but not less than 50 feet apart, in accordance with IEEE Std 81.

3.7.3 Ground Isolation Test

Ground systems shall be tested for isolation from other ground systems.

3.7.4 Continuity Isolation Test

Continuity test shall be performed on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16124

MEDIUM VOLTAGE CABLE

05/09

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.3 GENERAL REQUIREMENTS
1.4 SUBMITTALS
1.5 QUALIFICATIONS
1.6 CABLE VOLTAGE RATINGS AND USE
1.7 FACTORY TESTING
1.8 SHIPMENT

PART 2 PRODUCTS

2.1 CONDUCTORS
2.1.1 Material
2.1.2 Stranding
2.2 CABLE IDENTIFICATION
2.3 15 KV CABLES
2.3.1 General; 15 kV Cable
2.3.2 15 kV Cable Conductor Shielding
2.3.3 Insulation; 15 kV Cable
2.3.4 Non-metallic Insulation Shield; 15 kV Cable
2.3.5 Concentric Neutral Shield; 15 kV Cable
2.3.6 Jacket; 15 kV Cable
2.4 INSULATED MEDIUM VOLTAGE CONNECTORS
2.5 SPLICES
2.6 TERMINATIONS
2.7 CABLE SUPPORTS AND FITTINGS
2.8 CABLE TAGS IN MANHOLES AND AT TERMINATIONS
2.7.1 Polyethylene Cable Tags
2.8 FIREPROOF TAPE

PART 3 EXECUTION

3.1 DEMOLITION OR CABLE CUTTING
3.2 INSTALLATION
3.2.1 Protection During Splicing Operations
3.2.2 Duct Cleaning
3.2.2.1 PVC Duct
3.2.2.2 Existing Fiber (Orangeburg) Duct
3.2.3 Pulling Cables in Ducts and Manholes
3.2.4 Splices and Terminations
3.2.5 Splice and Termination Certification
3.2.6 Fireproofing
3.2.7 Cable Tag Installation
3.2.8 Jammed Cable Removal Procedure

3.3 FIELD TESTING

-- End of Section Table of Contents --

SECTION 16124

MEDIUM VOLTAGE CABLE
05/09

PART 1 GENERAL

1.1 REFERENCES

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 C119.1	(1986) Electric Connectors - Sealed Underground Connector Systems Rated 600

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2007) Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM B 8	(2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 746	(2007) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-94-649	(2004) Standard for Concentric Neutral Cable Rated 5 Through 46 KV

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 386	(2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 48	(1996; R 2003) Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
IEEE Std 404	(2006) Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V Through 500 000 V
IEEE Std 400.2	(2004) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2008) National Electrical Code

1.2 DEFINITIONS

Medium voltage power cables means all cables rated above 601 to 35,000 volts.

1.3 GENERAL REQUIREMENTS

Section 16003 GENERAL ELECTRICAL PROVISIONS applies to work specified in this section.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Pulling Plan

Submit Pulling Plan in accordance with the paragraph entitled, " Pulling Cables in Ducts and Manholes," of this section.

Splicer/Terminator Certifications

Submit Splicer Certifications in accordance with paragraph entitled "Qualifications" of this section.

SD-03 Product Data

Provide manufacturer's catalog data for the following items:

Single Conductor 15 kV Shielded Cable
Cable Supports and Fittings
Cable Tags
Fireproof Tape
Splice Kits (including splice grounding)
Terminations

SD-06 Test Reports

Submit Test Reports in accordance with the paragraph entitled, "Field Testing," of this section.

KSC Medium Voltage Cable Test Form

SD-07 Certificates

Provide certificates for the following showing that the cable manufacturer has made factory-conducted tests on each shipping length of cable. Certified copies of test data must show conformance with the referenced standards and must be approved prior to delivery of cable.

Conductor Resistance

Accelerated Water Absorption Test
Water Immersion Test
Ionization
High-Voltage
Partial Discharge Test
Qualification Test Report

SD-08 Manufacturer's Instructions

Provide manufacturer's instructions showing the recommended sequence and method of installation for the following:

Single Conductor 15 kV Shielded Cable
Terminations
Splice Kits (including splice grounding)

1.5 QUALIFICATIONS

Personnel performing Medium Voltage (MV) splicing or terminations shall have 5 years minimum experience in cable splicing and terminations of the type used in this project. In addition, the cable splicer shall submit Splicer/Terminator Certifications issued by the cable splice and termination manufacturer who has examined and tested a test test splice or termination of each type required by this contract for each cable splicer.The certification shall identify which splices and terminations it applies to. If the contractor does not have an individual with the manufacturer's certification as described, each individual with the required 5 years medium voltage splicing and terminating who is to perform cable splicing or terminating shall be required to perform a minimum of one splice or termination of each type in the presence of the manufacturers' representative. Each splice or termination shall be submitted to the manufacturer for testing and subsequent certification. Proof of certification will be verified by the NASA Contracting Officer's Technical Representative prior to installation of any splices or terminations. Certification shall not be required for load break elbows and dead break connectors.

Once a splice or termination has been started by a splicer, the same splicer shall complete that particular splice. Each termination and splice shall be started and completed in one continuous work period.

1.6 CABLE VOLTAGE RATINGS AND USE

Medium-voltage power cables must include single-conductor cables rated as follows, phase-to-phase, for grounded neutral systems:

Cables rated 15,000 volts, grounded neutral,shall be used on 13,800-volt, three-phase, 60-hertz distribution systems.

Install cables in a duct and manhole system which can be subject to continuous immersion in a coastal environment containing brackish water at depths of up to 15 feet.

1.7 FACTORY TESTING

Submit certified evidence that the cable manufacturer has made factory-conducted tests on each shipping length (reel) of cable; submit certified copies of test data in accordance with applicable provisions of the referenced standard. Tests on each length of cable must include

conductor resistance, ionization, high voltage, partial discharge test. Contracting Officer or designee must have the option of witnessing required factory testing at no additional cost. Provide a schedule of manufacturing and testing in advance to permit such witnessing, if desired.

Submit certified Qualification Test Report in accordance with AEIC CS8 made in accordance with the applicable referenced standards. Certified copies of test data must show conformance to the requirements of referenced standards and must be submitted for approval prior to shipment of the cable.

Prior to manufacturing, data regarding degradation of proposed insulating material and cable performance due to water immersion test as specified in this specification must be provided to Contracting Officer or designee. Information must indicate A.C. breakdown stress in kV/mm or V/mil versus immersion time. A complete cable description and condition under which cable was tested must accompany the test information. Also submit Accelerated water absorption test.

1.8 SHIPMENT

The shipment of cable must be made on reels in such a manner that the cable is protected from mechanical injury. Each end of each length of cable must be hermetically sealed using heat-shrinkable molded cable end caps to exclude moisture and securely attached to the reel.

The minimum diameter of the reel drum must be 14 times the overall diameter of the cable. Those reels less than 60 inches in diameter must have arbor holes sized for 2-1/2 inches spindles; those greater than 60 inches in diameter must have arbor holes sized for 3 inch spindles. Reel sizes must accommodate reel lengths specified in purchase order. Each reel must contain only one length of cable cut to order.

Each reel must have an arrow and appropriate wording stenciled in plain view on each side to indicate proper rotation of reels. Each reel must be plainly marked on each side, and on a tag attached to the cable end inside the lagging, with the following information:

a. Purchaser's order number;

b. Complete description of cable including manufacturer, cable size, voltage rating, percent insulation rating, insulating material, conductor size(s), year of manufacture;

c. Actual shipping cable (reel) length;

d. Reel number (e.g. 2 of 10);

e. Gross weight (i.e. with reel) and net weight (i.e. cable only).

Reels must be shipped in a vertical position, sufficiently blocked in the bed of shipping vehicle to preclude movement.

PART 2 PRODUCTS

2.1 CONDUCTORS

2.1.1 Material

Core (phase) conductor material must be annealed copper in accordance with

ASTM B 8.

2.1.2 Stranding

Conductors must be Class B stranded.

2.2 CABLE IDENTIFICATION

Cables must have printing on the outer jacket showing the cable type, name of the manufacturer, the year in which the cable was manufactured, sequential cable reel length markings and a unique number for identification purposes. Information must be closely grouped on the tape at 6 foot maximum intervals to permit complete identification.

2.3 15 KV CABLES

2.3.1 General; 15 kV Cable

Single conductor 15 kV shielded cable assemblies must consist of: Conductor core described above, an extruded semiconducting shield over the conductors, 220 mils of ethylene-propylene-rubber (EPR) insulation, an extruded semiconducting insulation shield, a concentric neutral, and a polyethylene (PE) jacket. The cable must be rated for minimum 90 degrees C continuous conductor temperature and 130 degrees emergency overload.

Single-conductor, ethylene-propylene-insulated, polyethylene-jacketed, shielded cable must conform to ICEA S-94-649 and AEIC CS8.

2.3.2 15 kV Cable Conductor Shielding

Conductors must have a stress control layer consisting of extruded material applied between the conductor and the insulation to form a conductor shield (strand screen). This material must have proven long-term chemical compatibility with both the conductor and overlying insulation materials. This stress control layer must meet the electrical and physical requirements of ICEA S-94-649.

2.3.3 Insulation; 15 kV Cable

Insulation material must be an ozone resistant, extruded thermosetting ethylene-propylene based polymer. Insulation must be capable of withstanding the continuous and emergency overload temperature ratings of the conductor.

2.3.4 Non-metallic Insulation Shield; 15 kV Cable

Extruded insulation shield must be an extruded thermoset material compatible with the insulation and jacket. Insulation shield must be applied directly over and bonded to the insulation, and must comply with AEIC CS8.

2.3.5 Concentric Neutral Shield; 15 kV Cable

Copper wires helically applied over the insulation shield. Minimum total cross sectional area of the shield wires is 1/3 of the core conductor for 350 Kcmil cable, and full core conductor for 4/0 cable, and no less than 20 No. 14 AWG, 13 No. 12 AWG or 9 No. 10 AWG. Minimum size of an individual shield wire is No. 14 AWG.

2.3.6 Jacket; 15 kV Cable

Polyethylene (PE) must be extruded over the concentric neutral to a minimum thickness of 80 mils.

2.4 INSULATED MEDIUM VOLTAGE CONNECTORS

IEEE Std 386. Connector must have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material Provide connectors as indicated.

a. 200 Ampere loadbreak connector ratings: Voltage: 15kV, 95kV BIL. Short time rating: 10,000 amperes rms, symmetrical for a time duration of 0.17 seconds.

b. 600 Ampere deadbreak connector ratings: Voltage: 15kV, 95kV BIL. Short time rating: 27,000 ampere rms, symmetrical for a time duration of 4.0 seconds.

Connections must be compatible with equipment bushings.

2.5 SPLICES

Splice kits must be the product of a single manufacturer, either heat shrink or cold shrink, meeting the requirements of the paragraph entitled "Splices and Terminations" under Part 3 of this specification.

2.6 TERMINATIONS

Terminations must be Class 1 per IEEE Std 48.

2.7 CABLE SUPPORTS AND FITTINGS

Cable supports, related fittings, and accessories for use in corrosive underground locations, such as manholes, shall be provided with a factory applied coating of polyvinylchloride (PVC) of at least .051 millimeter thick.

PVC coated items shall have a uniform thickness and be free of blisters, breaks, and holidays. PVC compound shall conform to ASTM D 746.

Cable racks, rack arms, cable tray supports, and related fittings shall be UL listed heavy-duty nonmetallic glass-reinforced nylon.

On existing galvanized cable racks, rack hooks shall be heavy duty, hot dipped galvanized, with rounded surfaces and the hook insulators shall be white glazed porcelain.

2.8 CABLE TAGS IN MANHOLES AND AT TERMINATIONS

Provide tags for each cable or wire located in manholes and at each termination. Tag all cables indicated to have tags.

2.7.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 4500 pounds per square inch; and that are 0.035-inch thick, non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 300 degrees F. Provide a one-piece

nylon, self-locking tie at each end of the cable tag. Ties must have a minimum loop tensile strength of 175 pound. The cable tags must have block letters, numbers, and symbols 1 inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags orientation.

2.8 FIREPROOF TAPE

Fireproof tape must be approximately 30 mils thick by 3 inches 3 inches wide. The tape must consist of a flexible, unsupported elastomer that expands in fire to provide a thick char buildup between the flame and the cable. The tape must not give off a smoke when subjected to flames or support combustion. The tape must not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

PART 3 EXECUTION

3.1 DEMOLITION OR CABLE CUTTING

Notify the Contracting Officer 14 working days prior to an outage for demolition or cable cutting of medium voltage electrical system.

The Government has established a mandatory inspection point prior to Contractor performing any medium voltage cable cuts or demolition. Notify the Contracting Officer 48 hours in advance of this mandatory inspection point.

As part of the mandatory inspection point, positively identify and label the medium voltage cable to be worked utilizing electronic cable identifier. Ensure the process of identifying and labeling the cable to be worked is witnessed by the Government. Cable cutting and demolition of any medium voltage cable can occur only after approval by the Contracting Officer.

3.2 INSTALLATION

Install medium-voltage cables in accordance with NFPA 70.

The Contractor shall notify the Contracting Officer 14 working days prior to an outage that will require testing for phasing and phase rotation of 15 KV medium voltage electrical systems. The Institutional Services Contractor shall identify and tag the phasing at equipment and shall provide to the Contractor, in writing, the results of phasing and phase rotation tests. The Contractor shall be responsible for maintaining the phasing and phase rotation tests. The Contractor shall be responsible for maintaining the phasing, and shall match the existing phase rotation and phasing when installing conductors in existing electrical systems.

Cable must be installed in underground duct banks; in conduit above and below grade; inside buildings; by open wire method; on insulator hooks; on racks; in wall and ceiling mounted cable trays; in manholes; and by direct burial.

Cable or conductors of a primary distribution system must be rejected when installed openly in cable trays or openly racked along interior walls; in the same raceway or conduit with ac/dc control circuits or ac power circuits operating at less than 600 volts; or in a manner allowing cable to support its own weight.

3.2.1 Protection During Splicing Operations

Blowers must be provided to force fresh air into manholes or confined areas where free movement or circulation of air is obstructed. Waterproof protective coverings must be available on the work site to provide protection against moisture while a splice is being made. Pumps must be used to keep manholes dry during splicing operations. Under no conditions must a splice or termination be made with the interior of a cable exposed to moisture. Moisture-test conductor insulation paper before the splice is made. Use a manhole ring at least 6 inches above ground around the manhole entrance to keep surface water from entering the manhole. Plug unused ducts and stop water seepage through ducts in use before the splice is started.

3.2.2 Duct Cleaning

Thoroughly clean ducts before installation of power cables. A standard flexible mandrel must be pulled through each duct to loosen particles of earth, sand, or foreign material in the line.

3.2.2.1 PVC Duct

Mandrel length must be not less than 12 inches long and must have a diameter 1/2 inch less than the inside diameter of the duct. A brush with stiff bristles must then be pulled through each duct to remove the loosened particles. Brush diameter must be the same or slightly larger than the diameter of the duct.

3.2.2.2 Existing Fiber (Orangeburg) Duct

Push rod through duct using accepted appropriate procedures and eqipment for this type of work and as approved by the Contracting Officer. Pull a series of four-2 inch wire brushes back and forth through the duct. Progressively increase the size of the four wire brushes until four-4 inch wire brushes can be pulled back and forth, and all of the debris has been removed. Next pull a flexible mandrel with two-4 inch heavy duty wire brushes on each side through the duct. The mandrel shall not be less than 12 inches long, and shall have a diameter that is 1/2 inch to 1 inch less than the inside diameter of the duct. Next, pull a 5 foot section of sample cable, equivalent to what is being used. Finally, make the final cable pull on the same day the sample cable was pulled.

3.2.3 Pulling Cables in Ducts and Manholes

The Contractor shall provide and submit a pulling plan including calculations of pulling tension and side wall pressure anticipated, and the maximum allowable pulling tension for each pull. No pull shall be performed until Government review and approval of pulling plan.

Medium-voltage cables shall be pulled into ducts with equipment designed for this purpose, including power-driven winch, jamb skid, cable-feeding flexible tube guide, long radius quadrant block cable pulling sheaves, pulling eyes, and lubricants. A sufficient number of trained personnel and equipment with two-way radio communication capability shall be employed to ensure the careful and proper installation of the cable.

Cable reel shall be set up at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Flexible tube guide shall be

installed through the opening in a manner that will prevent the cable from rubbing on the edges of any structural member (manhole frame, chimney, duct, etc.).

Two long-radius (30 inches minimum) quadrant block cable pulling sheaves and necessary jamb skid support shall be used at the pulling end to ensure that sidewall pressures during pulling will not be excessive. A dynamometer shall be used in the pulling line to ensure that the pulling force is not exceeded. The pulling force shall not exceed the smaller of: allowable tension on pulling device, allowable tension on cable, or the tension which produces the allowable sidewall pressure. The allowable tension on the pulling device is 6500 pounds for pulling eyes and 1000 pounds for pulling grip (where allowed). The allowable tension on cable must not exceed the value computed from the following equation:

TM = 0.036 X N X CM

Where: TM = maximum allowable pulling tension in pounds

N = number of conductors in the cable

CM = cross-sectional area of each conductor in circular mils

The allowable sidewall pressure is the smaller of 500 pounds per foot of bend radius or the cable manufacturer's recommended maximum value. The pulling plan submittal shall show the calculations for allowable tension and sidewall pressure as well as the anticipated tension and sidewall pressure for each pull in the project.

Cable shall be unreeled from the top of the reel. Payout shall be carefully controlled. Cable to be pulled shall be attached through a swivel to the main pulling wire by means of a pulling eye installed by the factory or approved cable splicer.

Attach pulling eyes to the cable conductors of the 3-1/C circuit to prevent damage to the cable structure. The entire 3-1/C circuit must be pulled simultaneously.

Minimum bending radius during cable pulling operations must be 30 inches. For permanent cable bending/racking the minimum bending radius must be 12 times cable diameter.
Cables shall be liberally coated with a suitable cable-pulling lubricant as it enters the tube guide or duct. Grease and oil lubricants shall not be used. Nonmetallic sheathed cables shall be covered with wire-pulling compounds,when required, which have no deleterious effects on the cable. Rollers, sheaves or tube guides around which the cable is pulled shall conform to the 30 inches minimum bending radius of the cable during the pulling operations.

Cables shall be pulled into ducts at a speed not to exceed 50 feet per minute and not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately with any indication of binding or obstruction and shall not be resumed until such difficulty is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.

Cable splices made up in manholes shall be firmly supported on cable racks as indicated. No cable splices shall be pulled in ducts. Cable ends shall

overlap at the ends of a section to provide sufficient undamaged cable for splicing. Cables to be spliced in manholes shall overlap the centerline of the proposed joint by not less than 2 feet

Cables cut in the field must have the cut ends immediately sealed to prevent entrance of moisture with heat-shrinkable molded cable end caps.

3.2.4 Splices and Terminations

Splices shall be made in manholes or direct buried as shown on the drawings. Cable terminations shall be made at equipment specifically indicated. Splicing and terminating of cables shall be expedited to minimize exposure and cable deterioration.

The cable concentric neutral/shield wires shall be connected across one side of the splice by split bundling the splice neutral wiring and connecting each bundle set to a continuous #4 AWG solid bare copper conductor via two compression conductors. The #4 AWG conductor shall be extruded from the cable splice jacket and connected to the manholes grounding system. All connections within the splice shall be made utilizing barrel-type compression connectors and appropriate compression tools with proper size dies to ensure a satisfactory mechanical and electrical joint. Bare connections of concentric neutral/shield wires must be either contained within the splice kit or shall be sealed via an additional outer covering. This outer covering shall consist of a heavy wall, heat-shrinkable tubing containing adhesive material (mastic) that melts as heat is applied and the outer tubing shrinks to form a moisture proof environmental seal. The outer tubing shall conform to ANSI C119.1. The splice shall meet the requirements of IEEE Std 404 for a 15kV rating and must be rated by the manufacturer for use on 15 kV class feeder cable systems. Optionally, the splice may be of a cold shrink design that does not require any additional heat source for installation. The Cold Shrink splice body must be of a molded design made of silicone rubber. The splice jacketing shall be of a cold shrink tubing make of EPDM rubber. Extra precautions shall be taken to seal around the exit area of the bare copper jumpers with an additional mastic per the splice manufacturer's recommendations.

Cables shall be terminated in approved cable terminations, rated Class 1 per IEEE Std 48. Dry terminations with medium voltage pennants, preformed, and hand wrapped stress cones can be used for terminating cables. Terminations must be provided with adequate means for making external connections to the cable conductors of single-conductor cables (phase and concentric neutral); protecting the cable insulation against moisture, oil, or other contaminant; physically protecting and supporting cables, and maintaining the insulation level of the cable.

Terminations shall be field fabricated from termination kits supplied by, and in accordance with, the termination manufacturer's recommendations for the type, size, and electrical characteristics of the cable.

Installation shall include built-up or prefabricated heat or cold shrink stress-relief cones at the terminals of all shielded cables and at the terminals of single-conductor lead-covered cables rated 15 kV and above.

Cable splices shall be field fabricated from pre-molded or heat-shrinkable splicing kits supplied by, and in accordance with, the cable manufacturer's recommendations for the type, size, and electrical characteristics of the cable specified. Cable splices in manholes shall be located midway between cable racks on walls of manholes and supported with cable arms at

approximately the same elevation as the enclosing duct.

Cable splices shall be installed on cable racks or by other approved methods which will minimize physical stress on the splice connections. Splices shall be supported at approximately the same elevation as the installed cable, except where space limitations or existing cable length limitations make this method impractical or impossible.

All universal demountable splices shall be supported in such manner so as to minimize physical stress on the splice connections. Each cable end termination shall be supported using a pair of saddle type supports under the cable end termination and/or cable with a minimum 12 inches and a maximum 30 inches separation between the supports. Cable end termination and cable shall be secured to the supports in such a manner as to prevent movement of termination or cable at the support. Saddle type supports shall be installed on galvanized steel framing channel anchored to the wall or securely fastened to the cable tray or installed by other approved methods.

3.2.5 Splice and Termination Certification

The Contractor shall secure the services of the manufacturer of the splice/termination kits being used during the installation of this project to witness,test, and examine test splices, and to certify the competence of the technicians performing splices and terminations. The splice/termination certification shall confirm in writing that the splicer has constructed the splices/terminations in accordance with the manufacturer's approved training and/or installation instructions. Certification shall not be required for loadbreak elbow and deadbreak connectors. Certification for various types of splices and terminations that may be used on the project shall include, but not be limited to, the following:

Single conductor 15 kV EPR with concentric neutral to single conductor 15 kV EPR with concentric neutral-straight splice.

Single conductor 15 kV EPR with concentric neutral terminations.

The certification shall be for a specific time period determined by the manufacturer.

3.2.6 Fireproofing

Provide fireproofing (Arc Proofing) for individual cable conductor in manholes, handholes and vaults which carry current at 2200 volts or more.

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Extend the tape 1 inch into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure-sensitive glass cloth tape.

3.2.7 Cable Tag Installation

Install cable tags in each manhole and at each termination as specified. Install cable tags over the fireproofing and position the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes and equipment.

3.2.8 Jammed Cable Removal Procedure

Cable shall be lubricated using a pressurized lubrication system that can push the lubricant along the entire conduit run to ensure full cable/lube contact. Next, an operator-controlled variable pulling tension rig will be used to initiate cable movement. Pneumatic vibration should be used, as necessary, to aid in the cable removal. Progressive Growth Electrically (phone (925)455-6227) is an available source to perform this work.

3.3 FIELD TESTING

After the installation of power cables has been completed, including splices, joints, and terminations, and before the cable is energized, each medium voltage cable shall be subjected to field testing in accordance with the following requirements.

The Contractor shall provide test equipment, labor, and trained technical personnel as necessary to perform the electrical acceptance tests.

The Contractor shall obtain KSC Medium Voltage Cable Test Form from the Contracting Officer prior to commencing Field Testing. All tests shall be recorded on forms provided.

Arrangements shall be made to have tests witnessed and approved by the Contracting Officer.

Each power-cable installation shall be completely isolated from extraneous electrical connections at cable terminations and joints. Safety precautions shall be observed.

Each power cable shall first be given an insulation resistance test using a megohmmeter with a voltage output of at least 2,500-volts. Test shall be applied for a long enough time to fully charge the cable (no less than one minute). Readings shall be recorded as indicated on forms provided. Minimum reading shall be 5000 megohms at an ambient temperature of 68 degrees F. Readings taken at other than 68 degrees F ambient temperatures shall be corrected accordingly.

Upon successful completion of the insulation resistance test, the cable shall be subjected to a Very Low Frequency (VLF) AC high potential test. General VLF testing measures, parameters, considerations, and results shall adhere to the following:

1) Test voltage duration shall be continuous duty for 30 minutes (non-interrupted)

2) The Contractor shall provide the test equipment to test the cable capacity in microfarads and record on the KSC Medium Voltage AC Hi-pot test form (VLF).

3) The Contractor shall provide the test equipment to generate the test voltages required for the 30 minute test duration and adhere to the following table:

VLF Test Voltage for sinusoidal waveform

Cable Rating phase to phase	Acceptance (phase to ground test values)	Acceptance (phase to ground test values)
	(New cable)	(Existing cable spliced to new cable)
(rms voltage, KV)	(peak voltage, KV)	(peak voltage, KV)
15	28	22; (EPR TO NON-EPR)

4) The sinusoidal test frequency shall be 0.1 Hertz.

5) The test shall not be performed on cable attached to equipment.

NOTE: Acceptance test values to include, but not limited to, peak voltage, frequency, and duration, with respect to the cable rating, shall be identified on the test submittal, with pass/fail results identified per cable installation. Reference IEEE Std 400.2. Notify Contracting Officer or Contracting Officer's Technical Representative 48 hours prior to test start. All testing will be witnessed by the Government.

Terminations shall be clean and dry and shall be tested per IEEE Std 48. Radiographic tests on all terminations at the discretion of the Contracting Officer to determine if voids exist in the termination. Unacceptable cable, splices or terminations shall be reworked at no additional expense to the Government.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16135

CABLE TRAYS

04/09

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL REQUIREMENTS
1.3 SUBMITTALS

PART 2 PRODUCTS

2.1 CABLE TRAYS
2.2 MATERIAL AND FABRICATION
2.3 SUPPORTS

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS
3.2 INSTALLATION DRAWINGS
3.3 GROUNDING

-- End of Section Table of Contents --

SECTION 16135

CABLE TRAYS
04/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM A 1008/A 1008M	(2008a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings
Installation Drawings

SD-03 Product Data

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

Cable Trays
Supports

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for cable trays in accordance with paragraph entitled, "Manufacturer's Instructions," of this section.

PART 2 PRODUCTS

2.1 CABLE TRAYS

Ladder cable trays shall consist of two longitudinal side members connected by individual transverse members.

2.2 MATERIAL AND FABRICATION

Cable trays shall be steel sheet in accordance with ASTM A 1008/A 1008M with a zinc coating applied after fabrication.

Fabrication drawings shall be submitted for cable trays consisting of fabrication and assembly details to be performed in the factory.

Prior to assembly, contact surfaces of trays shall be coated with an antioxidant compound. Edges, fittings, and hardware shall be finished free from burrs and sharp edges. Cable trays shall include splice and end plates, dropouts, and miscellaneous hardware.

2.3 SUPPORTS

Supports and hangers shall permit both vertical and horizontal adjustment, where possible. Horizontal and vertical tray supports shall provide an adequate bearing surface for the tray and shall have provisions for holddown clamps or fasteners. Vertical tray supports shall provide a secure means other than friction for fastening cable trays to supports.

Cable trays shall be supported at not more than 6-foot intervals. Supports for horizontal-elbow tray fittings shall be placed within 2 feet of each fitting extremity and as recommended by the cable-tray manufacturer.

When supported at 6-foot intervals, the cable trays shall be capable of carrying not less than 150 pounds per linear foot. Tray fittings shall have not less than the load-carrying ability of straight tray sections and shall have the manufacturer's minimum standard radius.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION DRAWINGS

Thirty days prior to shipment, installation drawings shall be submitted to the Contracting officer for approval. Drawings shall be coordinated with all other work in the immediate area that could come in conflict with the installation. Drawings shall include layout of cable tray work, including details of both horizontal and vertical supports. Both horizontal and vertical supports shall be as specified in paragraph entitled, "Supports," of this section.

3.3 GROUNDING

Cable trays shall be properly grounded by means of a low-resistance

conductor of sufficient capacity, but in no case smaller than AWG No. 2 copper for steel trays. Grounding conductor shall be bonded to cable-tray sections and fittings by compatible bolted connections. Effective grounding shall be permanent and continuous with an impedance sufficiently low to limit the potential above ground and to facilitate operation of overcurrent devices in the circuit. Grounding and bonding cable trays shall be in accordance with NFPA 70.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16145

STANDARD WIRING SYSTEMS

04/09

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL REQUIREMENTS
1.3 SUBMITTALS
1.4 FABRICATION AND ASSEMBLY DRAWINGS

PART 2 PRODUCTS

2.1 CONDUIT, RACEWAYS AND FITTINGS
2.1.1 Intermediate Metal Conduit
2.1.2 Rigid Steel Conduit
2.2 WIRE AND CABLE
2.2.1 Building Wire
2.2.5 Cable Tray Wire
2.2.7 Splices and Connectors
2.3 SAFETY SWITCHES
2.5 BOXES AND FITTINGS
2.5.3 Pull and Junction Boxes

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Installation of Rigid Metal Conduit
3.2 INSTALLATION OF WIRING
3.4 SAFETY SWITCHES
3.6 BOXES AND FITTINGS
3.7 IDENTIFICATION PLATES
3.8 FIELD TESTING

-- End of Section Table of Contents --

SECTION 16145

STANDARD WIRING SYSTEMS
04/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.1	(1990) Rigid Steel Conduit - Zinc Coated

ASTM INTERNATIONAL (ASTM)

ASTM D 2301	(1988; R 1993) Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 383	(2003) Standard for Qualifying Class 1E Electric Cables and, Field Splices for Nuclear Power Generating Stations 2004

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA FB 1	(2007) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA KS 1	(2001; R 2006) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1242	(2006; Rev thru Jul 2007) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 1581	(2001; Rev thru Jul 2008) Reference Standard for Electrical Wires, Cables, and Flexible Cords
UL 486C	(2004; Rev thru Aug 2006) Standard for Splicing Wire Connectors
UL 50	(2007) Standard for Enclosures for Electrical Equipment

UL 514A	(2004; Rev thru Aug 2007) Standard for Metallic Outlet Boxes
UL 514B	(2004; Rev thru Aug 2007) Standard for Conduit, Tubing and Cable Fittings
UL 6	(2007) Standard for Electrical Rigid Metal Conduit-Steel
UL 83	(1991; 10th Ed) UL Standard for Safety Thermoplastic-Insulated Wires and Cables

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

The following types of drawings shall be submitted to check for contract conformity:

Fabrication Drawings
Assembly Drawings

SD-03 Product Data

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

Conduit, Raceways and Fittings
Wire and Cable
Safety Switches
Boxes and Fittings

SD-06 Test Reports

Test Reports shall be submitted for standard wiring systems in accordance with the paragraph entitled, "Field Testing," of this section.

SD-07 Certificates

Certificates of compliance shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Conduit, Raceways and Fittings
Wire and Cable
Safety Switches
Boxes and Fittings

1.4 FABRICATION AND ASSEMBLY DRAWINGS

Fabrication Drawings shall be submitted for the standard wiring systems consisting of fabrication and Assembly Drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements for the contract documents.

PART 2 PRODUCTS

2.1 CONDUIT, RACEWAYS AND FITTINGS

Conduit shall be 3/4-inch diameter minimum, except where specifically shown smaller on the contract drawings, and except for exposed switch leg runs.

Conduit, connectors, and fittings shall be approved for the installation of electrical conductors.

2.1.1 Intermediate Metal Conduit

Intermediate metal conduit, including couplings, elbows, bends, and nipples, for use as a raceway for wire and cables in an electrical system shall conform to the requirements of UL 1242 as amended for thin or thick-wall types and shall also conform to NFPA 70. Interior and exterior surfaces of the conduit shall be protected with a metallic zinc coating.

2.1.2 Rigid Steel Conduit

Rigid steel conduit, including couplings, elbows, bends, and nipples, shall conform to the requirements of UL 6 and ANSI C80.1. Steel fittings shall be galvanized by the hot-dip process.

Fittings for rigid steel conduit shall be threaded and shall conform to NEMA FB 1.

Gaskets shall be solid for fittings sized 1-1/2 inches and less. 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.

2.2 WIRE AND CABLE

Insulated current-carrying wire and grounding conductors shall be copper and shall conform to NFPA 70 and UL 1581. Wire bundles with cable ties shall be secured to the enclosure with sheet-metal screws. Self-sticking adhesive attachments are not acceptable.

2.2.1 Building Wire

Building wire for use in conduits, raceways, and wireways shall be single-conductor, 600-volt, heat- and moisture-resistant insulated wire suitable for use in wet or dry locations.

Conductors AWG No. 10 and smaller shall be solid round copper wire. Conductors AWG No. 8 and larger shall be standard concentric stranded copper wire. Conductors shall be not less than AWG No. 12, except that AWG No. 14 shall be stranded copper wire and shall be used for control wiring.

Building wire shall be Type THHN/THWN with insulation of PVC and nylon jacket, with a minimum temperature rating of 90 degrees C.

2.2.5 Cable Tray Wire

Power and control wire installed in cable trays shall be Type TC cable 600 volts, with current-carrying capacity as determined by NFPA 70. Cable shall also comply with UL 83 and IEEE Std 383.

2.2.7 Splices and Connectors

Splices in building wire AWG No. 8 and smaller and multiple conductor cables shall be made with insulated Scotchlock, or equal, connectors or with indentor crimp-type connectors and compression tools to ensure a satisfactory mechanical and electrical joint.

Splices in building wire AWG No. 6 and larger and single-conductor cables shall be made with indentor crimp-type connectors and compression tools to ensure a satisfactory mechanical and electrical joint.

Connectors for single conductor building wire AWG No. 2 and larger connecting to bus bar stabs in switchboards and switchgear shall be made with long barrel, NEMA two-hole compression lugs. Two or more conductors may use mechanical terminals. Where mechanical terminals are used they shall have a minimum NEMA two-hole spade for two conductors and a minimum NEMA four-hole spade for three or more conductors. Torque allen-screws and bolts to manufacturer's recommendations.

Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor. Splices in rubber-insulated neoprene-jacketed wire and cables shall be watertight.

Vinyl-plastic electrical insulating tape shall meet the requirements of ASTM D 2301. Where pressure-sensitive tape is used, the surface shall be cleaned free of dust, sand, or other foreign material and a primer recommended by the tape manufacturer shall be applied prior to taping.

Where indicated and for building wire AWG No. 8 and larger, terminations shall utilize screw-set pressure terminal lugs.

Where indicated, building wire AWG No. 10 and smaller shall be terminated in pre-insulated crimp ring lugs on terminal blocks.

Solid wiring shall be terminated with terminal blocks specifically designed for solid wire. Crimp type shall not be used on solid wire for termination.

Stranded wire shall use crimp type lugs for termination on terminal blocks.

2.3 SAFETY SWITCHES

Switches shall comply with NEMA KS 1.

Safety switches shall be the heavy-duty type with 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 (screwdriver) must be used to open the cover. Provisions shall be made to lock the handle in the "OFF" position, but the switch handle shall not be capable of being locked in the ON

position.

Switches shall be the quick-make, quick-break type. Terminal lugs shall be approved for use with copper conductors. Where MTS (Manual Transfer Switch) is indicated, MTS shall be a 3-position, 4-pole safety switch. MTS shall be labeled NORMAL and ALTERNATE with OFF in the center position.

2.5 BOXES AND FITTINGS

Boxes shall have sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NFPA 70 and UL 514A. Boxes that are exposed to the weather or that are in normally wet locations shall be cast-metal with threaded hubs. Surface-mounted boxes on interior walls shall be cast-metal. Boxes in other areas shall be cadmium-plated or zinc-coated sheet metal.

2.5.3 Pull and Junction Boxes

Pull and junction boxes shall be fabricated from carbon steel and shall conform to UL 50. Box dimensions and conduit connections shall conform to NFPA 70.

Boxes shall be welded construction with flat removable covers fastened to the box with machine screws. Seams and joints at corners or back edges of the box shall be closed and reinforced with flanges formed of the same material from which the box is constructed or by other means such as continuous welding which provides a construction equivalent to integral flange construction.

Boxes intended for outdoor use shall be hot-dipped galvanized with threaded hubs and neoprene-gasketed covers.

Boxes intended for use in dry locations shall be sheet steel hot-dipped galvanized after fabrication conforming to UL 514A.

PART 3 EXECUTION

3.1 INSTALLATION

Power, control and all related components shall be installed in accordance with NFPA 70, and shall be enclosed in separate conduit or separate conduit systems.

Any run of intermediate, or rigid conduit 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. Field bends shall be made in accordance with the manufacturer's recommendations, which normally require use of a one-size-larger bender than would be required for uncoated conduit. Installed conduit and fittings shall be free of dirt and trash and shall not be deformed or crushed. Empty conduit shall have a pull rope installed.

Conduit shall be installed with a minimum of 3 inches of free air space separation from mechanical piping.

Conduit passing through masonry or concrete walls shall be installed in sleeves.

Conduit shall be securely clamped and supported at least every 10 feet vertically and 8 feet horizontally. Galvanized pipe straps shall be fastened to structure with bolts, screws, and anchors. Wooden masonry plugs shall not be used.

Conduit and boxes shall not be supported from T-bar ceiling wires.

Conduit connections to boxes and fittings shall be supported not more than 36 inches from the connection point. Conduit bends shall be supported not more than 36 inches from each change in direction. Conduit shall be installed in neat symmetrical lines parallel to the centerlines of the building construction and the building outline. Multiple runs shall be parallel and grouped whenever possible on common supports.

Conduit and raceway runs in or under concrete, in damp, corrosive, or outdoor locations, in hazardous areas, where subject to mechanical damage, or intended for conductors rated over 600 volts, shall be rigid steel conduit unless otherwise noted.

Ends of conduit extending from the interior to the exterior of the building and portions of interior conduit exposed to widely varying temperatures shall be sealed to prevent the passage of air within the conduit.

Expansion fittings with flexible ground strap shall be provided in conduit runs crossing building expansion joints.

Exposed ends of conduit without conductors shall be sealed with watertight caps or plugs.

Bushings shall be provided on the open ends of conduit containing conductors. Insulated bushings shall be provided for conduits containing conductors AWG No. 4 or larger with an insulating ring an integral part of the bushing.

Wire or cable shall not be installed in conduit until the conduit system is completed; the inner surfaces of conduit shall be clean and dry.

A polypropylene pull rope with a tensile strength not less than 130 pounds shall be installed in empty conduit.

3.1.1 Installation of Rigid Metal Conduit

Ends of conduit shall be cut square, reamed and threaded, and joints shall be brought butt-to-butt in the couplings. Joints shall be mechanically tight. Conduit shall be protected against damage and the entrance of water or foreign material during construction.

Ninety-degree bends of conduit with a diameter larger than 1 inch shall be made with factory-made elbows. Conduit elbows larger than 2-1/2 inches shall be long radius. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Changes in directions of runs shall be made with symmetrical bends or cast-metal fittings.

At connections to sheet metal enclosures and boxes, a sufficient number of threads shall project through to permit the bushing to be drawn tight against the end of the conduit, after which the locknut shall be pulled up sufficiently tight to draw the bushing into firm electrical contact with the box. Conduit shall be fastened to sheet metal boxes and cabinets with two locknuts where required by NFPA 70 where insulating bushings are used,

where bushings cannot be brought into firm contact with the box, and where indicated.

Conduit joints shall be made with tapered threads set firmly. Each length of conduit cut in the field shall be reamed before installation. Where conduit is threaded in the field, each threaded end shall consist of at least five full threads. Corrosion-inhibitive compound shall be used on conduit threads in exterior areas.

Conduit stubbed-up through concrete floors for connections to free-standing equipment except motor-control centers, cubicles, and other such items of equipment shall be provided with a flush coupling if the floor slab is of sufficient thickness; if not, 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.

3.2 INSTALLATION OF WIRING

Raceways shall be completely installed, with interiors protected from the weather, before proceeding with the installation of wires and cables. Conductors shall be continuous with splices and connections made in outlet, junction, or pull boxes only. All control wiring shall be continuous between components and/or terminal boards.

Phase conductors and the neutral conductor of each branch or feeder circuit shall be contained in a single enclosure or paralleled in separate enclosures to avoid overheating the raceway by electromagnetic induction. Conductors and conduit in parallel shall be the same length and size, shall have conductors of the same type of insulation, shall be terminated at both ends in a manner to ensure equal division of the total current among conductors, and shall have a separate neutral conductor in each conduit.

Sharing of a common neutral between single phase circuits, connected to different phases, shall not be permitted.

Conductors installed in heavy-wall rigid steel conduit and EMT shall have allowable current-carrying capacity and ampere ratings in accordance with NFPA 70. Larger-sized conductors shall be used to compensate for derating factors when more than three current-carrying conductors are installed in raceways and when conductors are installed in wet locations.

Conductors 600 volts and below shall be color coded in accordance with the following:

CONDUCTOR	120/208 COLOR	480/277 COLOR
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	White/Gray
Equipment Grounds	Green	Green

Conductors up to and including AWG No. 2 shall be manufactured with colored insulating materials. Conductors larger than AWG No. 2 shall have ends identified with colored plastic tape in outlet, pull, or junction boxes.

Control circuit conductors shall be identified at each connection point.

Connectors and splices shall conform to UL 486C and shall be made in approved enclosures utilizing solderless pressure connectors and adequate insulation with vinyl-plastic electrical insulating tape. Conductors and materials used in a splice, tap, or connection shall be thoroughly cleaned prior to makeup to ensure good electrical and mechanical connections. 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 that shown on approved shop drawings. Hand lettering or marking is not acceptable. Control-circuit terminals of equipment shall be properly identified by color-coded insulated conductors, number-coded plastic self-sticking printed markers, or permanently attached metal-foil markers. Cable fittings shall conform to UL 514B; insulating tape shall conform to ASTM D 2301.

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

Grounding shall be provided in accordance with NFPA 70. Noncurrent-carrying parts of electrical equipment shall be bonded and grounded together.

3.4 SAFETY SWITCHES

Switches shall be securely fastened to the supporting structure or wall utilizing a minimum of four 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 5 feet above floor level, when possible.

3.6 BOXES AND FITTINGS

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

Bonding jumpers shall be used around concentric or eccentric knockouts.

3.7 IDENTIFICATION PLATES

Red identification plates reading CAUTION: 480/277 VOLTS shall be provided in switch and outlet boxes containing 277- or 480-volt circuits. An identification plate marked DANGER: 480 VOLTS shall be provided on the outside of 480-volt enclosures. Identification plate shall use white lettering on a red laminated plastic.

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

DANGER - EXTERNAL VOLTAGE SOURCE

3.8 FIELD TESTING

Test reports shall be submitted in accordance with referenced standards in this section.

After completion of the installation and splicing, and prior to energizing the conductors, wire and cable shall be given continuity and insulation tests as herein specified before the conductors are energized.

Necessary test equipment, labor, and personnel shall be provided by the Contractor to perform the tests, as herein specified. Continuity tests shall be conducted using a dc device with bell or buzzer.

Wire and cable in each voltage classification shall be completely isolated from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices shall be used to isolate the circuits under test.

Insulation tests on circuits rated 480-volts and less shall be conducted using a 1,000-volt insulation-resistance test set. Readings shall be taken every minute until three equal and consecutive readings are obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Insulation tests on circuits rated 240 volts or less, with conductor sizes 2 AWG and larger, shall be conducted using a 1,000-volt insulation-resistance test set. Readings shall be taken after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Phase-rotation tests shall be conducted on all three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical connections to connected equipment shall be clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. No conductor shall be energized until the installation is approved.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16275

TRANSFORMERS

05/09

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL REQUIREMENTS
1.3 SUBMITTALS
1.3.1 Additions to Operation and Maintenance Manuals
1.4 QUALIFICATION TESTING
1.5 DRAWINGS

PART 2 PRODUCTS

2.1 EQUIPMENT STANDARDS
2.1.1 Pad-Mounted Liquid-Filled Distribution Transformers
2.1.1.1 High Voltage
2.1.1.2 Low Voltage
2.1.1.3 Transformer
2.1.1.4 Insulating Liquid
2.2 FACTORY FINISH
2.2.1 Pad-Mounted Liquid-Filled Distribution Transformers

PART 3 EXECUTION

3.1 INSTALLATION
3.2 FIELD TESTING
3.2.1 Insulating Liquid Dielectric Test
3.2.2 Insulation-Resistance Tests
3.2.3 Transformer Turns-Ratio Tests
3.2.4 Acceptance

-- End of Section Table of Contents --

SECTION 16275

TRANSFORMERS
05/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C37.47	(2000) Distribution Switches, Fuse Supports-Current-Limit
ANSI C57.12.29	(1999) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
ANSI C62.11	(1999) Metal-Oxide Surge Arresters for Alternating Current Power Systems

ASTM INTERNATIONAL (ASTM)

ASTM D 117	(2002) Standard Guide for Sampling, Test Methods, Specifications and Guide for Electrical Insulating Oils of Petroleum Origin
ASTM D 877	(2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D 3487	(2008) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev B; Am 1) Colors Used in Government Procurement

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(1995) Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE C57.12.25	(2000) Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors (34 500-Grd Y/19 920 Volts and Below; Low Voltage, 240/120; 167 kVA and Smaller)
IEEE C57.12.26	(1992) Transformers - Pad-Mounted Compartmental-Type, Self-Cooled,

	Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High Voltage, (34 500 Grd Y/19 920 and Below; 2500 kVA and Smaller)
IEEE C57.12.80	(2002) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2006) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TP 1	(2002) Guide for Determining Energy Efficiency for Distribution Transformers
NEMA TP 2	(1998) Standard Test Method for Measuring the Energy Consumption of Distribution Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Acceptance Testing Specifications

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Certificates of previous tests on similar units under actual conditions may be submitted for impulse tests, temperature rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

Equipment and performance data shall be submitted for distribution transformers including resistance measurements, impedance, and voltage and load losses at rated currents.

Equipment foundation data for distribution transformers shall include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

The following shall be submitted for distribution transformers:

Connection Diagrams
Fabrication Drawings
Installation Drawings

SD-03 Product Data

Equipment and Performance data and Equipment Foundation Data shall be submitted for distribution transformers.

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

Pad-Mounted Liquid-Filled Distribution Transformers

SD-06 Test Reports

Test reports shall be submitted for the following tests on distribution transformers in accordance with the paragraph entitled, "Field Testing," of this section.

Insulating Liquid Dielectric Test
Insulation Resistance Tests
Acceptance Test
Transformer Turns-Ratio Tests

SD-07 Certificates

Certificates shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Pad-Mounted Liquid-Filled Distribution Transformers

1.3.1 Additions to Operation and Maintenance Manuals

Include the following on the actual pad-mounted transformer provided:

a. An instruction manual with pertinent items and information highlighted
b. An outline drawing, front, top, and side views
c. Prices for spare parts and supply list
d. Routine and field acceptance test reports
e. Fuse curves for primary fuses
f. Actual nameplate diagram
g. Date of purchase

1.4 QUALIFICATION TESTING

Tests on transformers shall comprise the manufacturer's standard tests including resistance measurements of all windings; ratio tests; polarity and phase-relation tests; no-load loss at rated voltage; impedance; voltage and load loss at rated current and dielectric tests.

1.5 DRAWINGS

Connection diagrams shall be submitted for distribution transformers indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system or portion of system with another, and internal tubing, wiring,

and other devices.

Fabrication drawings shall be submitted for distribution transformers consisting of fabrication and assembly details to be performed in the factory.

Installation drawings shall be submitted for distribution transformers in accordance with the paragraph entitled, "Installation," of this section.

PART 2 PRODUCTS

2.1 EQUIPMENT STANDARDS

Transformers shall be low loss type with minimum efficiencies per NEMA TP 1 when operated at 35 percent of full load capacity for dry-type transformers and at 50 percent of full load capacity for liquid-filled transformers. Efficiency shall be tested in accordance with NEMA TP 2. All transformer windings shall be copper.

2.1.1 Pad-Mounted Liquid-Filled Distribution Transformers

Pad-mounted liquid-filled distribution transformers with primary connections to underground high-voltage lines and secondary connections to underground low-voltage distribution feeder circuits shall be two-winding, single- or three-phase, as indicated, 60-hertz, oil-immersed, 65-degree C rise, self-cooled, Class OA, outdoor type, conforming to IEEE C57.12.25, IEEE C57.12.26, IEEE C57.12.80, and IEEE C57.12.90. Primary windings of three-phase pad-mounted transformers shall be copper, delta connected.

2.1.1.1 High Voltage

High-voltage compartment shall contain the incoming line, insulated high-voltage load-break connectors, bushing well inserts, six high-voltage bushing wells, surge arresters, access to oil-immersed fuses, tap changer handle, connector parking stands with insulated standoff bushings, protective caps, and ground bus.

a. Insulated high-voltage load-break connectors: IEEE 386, rated 15kV, 95 kV BIL. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

b. Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, current-limiting fuses. Coordinate protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults.

   Oil-immersed current-limiting fuses: ANSI C37.47; 150 kV BIL; 50,000 amperes symmetrical interrupting rating.

c. Surge arresters: ANSI C62.11, rated 10kV, fully shielded, dead-front, metal-oxide-varister, elbow type with resistance-graded gap, suitable for plugging into bushing well inserts. Provide three arresters for radial feed circuits.

2.1.1.2 Low Voltage

Low-voltage compartment shall contain low-voltage bushings with NEMA spade terminals, accessories, stainless steel diagrammatic transformer nameplate, and ground bus.

a. Accessories shall include drain valve with sampler device, fill plug, pressure relief device, liquid level gage, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator.

2.1.1.3 Transformer

a. Oil-insulated, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type. Transformer windings shall be copper.

b. Transformer shall be rated as indicated, 95 kV BIL.

c. Transformer voltage ratings:
Primary 13.8 kV
secondary as indicated.

d. Tap changer shall be externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Tap changers shall clearly indicate which tap setting is in use.

e. Minimum tested impedance shall be 5 percent nominal.

f. Audible sound levels shall comply with the following:

kVA	DECIBELS (MAX)
1500	60

g. Transformer shall include lifting lugs and provisions for jacking under base. The transformer base construction shall be of the fabricated type and suitable for using rollers or skidding in any direction. Provide transformer top with an access handhole. Transformer shall have its kVA rating conspicuously displayed on its enclosure. The transformer shall have an insulated low-voltage neutral bushing with lugs for ground cable, and with removable ground strap.

2.1.1.4 Insulating Liquid

Mineral oil: ASTM D 3487, Type II, tested in accordance with ASTM D 117. Provide identification of transformer as "non-PCB" and "Type II mineral oil" on the nameplate.

2.2 FACTORY FINISH

2.2.1 Pad-Mounted Liquid-Filled Distribution Transformers

Transformers shall be provided with the frame, base, radiators, and tank made of Type 304 stainless steel.

The transformers shall have the manufacturer's standard finish for highly corrosive ares. The finish shall meet the requirments of ANSI C57.12.29

and shall be No. 70 light gray in accordance with FED-STD-595.

After the final coating, on the bottom and the bottom 6-inches of the transformer, a rubberized or coal tar protective coating at least 1/32-inch thick shall be applied on top of the final coating.

PART 3 EXECUTION

3.1 INSTALLATION

Pad-mounted distribution transformers shall be installed on precast, poured-in-place concrete pads, or as indicated and shall be grounded to a ground grid.

Voltage and kilovolt-ampere (kVA) ratings shall be as noted.

Each pad-mounted distribution transformer shall have its kVA rating conspicuously displayed in 3-inch high yellow letters on its tank or enclosure in addition to the complete manufacturer's standard identification plate.

3.2 FIELD TESTING

Final acceptance test shall be in accordance with NETA ATS and electrical tests limited to the following.

3.2.1 Insulating Liquid Dielectric Test

Transformers filled with non-PCB insulation liquid shall have the insulating liquid dielectrically tested after installation and before being energized. Insulating liquid shall be tested in accordance with ASTM D 877, and breakdown voltage shall be not less than 30,000 volts.

3.2.2 Insulation-Resistance Tests

Transformer windings shall be given an insulation-resistance test using the following test set versus voltage level criteria:

0 to 600-volt transformers - 1,000-volt test set

5,001 volt and above transformers - 5,000-volt test set

Tests shall be applied for not less than 10 minutes. Record reading every 15 seconds for the first minute and every minute thereafter. Minimum acceptable resistance after one minute shall be as calculated by the following formula:

IR = CE/SQRT (KVA)
where
IR = Minimum recommended one minutes installation resistance in megohms
C = Constant
E = Phase-to-phase voltage for delta connected windings;
phase-to-neutral voltage for star connected windings.
kVA = Rated kVA of transformer

Values of C @ 20 degrees C 60 hertz transformers
Oil-filled C = 1.5
Dry-type C = 30

3.2.3 Transformer Turns-Ratio Tests

Perform transformer turns-ratio tests at all tap positions.

3.2.4 Acceptance

Final acceptance shall depend upon the successful performance of the equipment under test. Transformers shall not be energized until recorded test data have been approved by the Contracting Officer.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16286

OVERCURRENT PROTECTIVE DEVICES

05/09

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 GENERAL REQUIREMENTS

PART 2 PRODUCTS

2.1 MOTOR CONTROL
2.1.2 Magnetic Motor Controllers
2.1.2.1 Full-Voltage Controllers
2.1.3 Combination Motor Controllers
2.1.3.1 Nonreversing Combination Motor Controllers
2.2 INSTRUMENT TRANSFORMERS
2.2.1 Current Transformers
2.2.2 Potential Transformers
2.3 ENCLOSURES
2.3.1 Equipment Enclosures
2.4 CIRCUIT BREAKERS
2.4.1 Molded-Case Circuit Breakers
2.4.2 Power Circuit Breakers
2.4.2.1 Digital Solid State Trip Units
2.5 FUSES
2.6 CONTROL DEVICES
2.6.1 Magnetic Contactors
2.6.2 Control-Power Transformers
2.6.3 Magnetic Control Relays
2.6.4 Pushbuttons and Switches
2.6.4.1 Pushbuttons
2.6.4.2 Selector Switches
2.7 PROTECTIVE RELAYS
2.7.1 Multi-function Voltage Relays - Low Voltage Application
2.7.2 Synchronization Check Relay
2.8 INDICATING INSTRUMENTS
2.8.1 Multi-Function Power Monitor
2.8.1.1 Monitoring Functions
2.8.1.2 Inputs
2.8.1.3 Outputs
2.8.1.4 Case
2.8.1.5 Test Blocks
2.9 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)
2.9.1 Level One TVSS
2.9.2 Level Two TVSS
2.10 COMMUNICATION
2.11 FACTORY TESTING
2.12 INDICATING LIGHTS

PART 3 EXECUTION

3.1 INSTALLATION
3.2 FIELD TESTING
3.3 TRAINING

-- End of Section Table of Contents --

SECTION 16286

OVERCURRENT PROTECTIVE DEVICES
05/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C37.16	(2000) Switchgear - Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations
ANSI C37.17	(1997) Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(1999) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 443	(1985) Solid State Relays, EIA/NARM, Standard for

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C12.1	(1988; 8th Ed) Code for Electricity Metering
IEEE C37.13	(1990) Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.90	(2005) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.13	(2008) Standard Requirements for Instrument Transformers
IEEE C62.41	(1991; R 1995) IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE C63.2	(1996) Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz - Specifications

IEEE C63.4	(2003) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Acceptance Testing Specifications

JOINT INDUSTRIAL COUNCIL (JIC)

JIC-01	(1967) Electrical Standards for Mass Production Equipment

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 107	(1987; R 1993) Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus
NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 3	(2001) Molded Case Circuit Breakers and Their Application
NEMA FU 1	(2002; R 2007) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2005) Industrial Control and Systems: General Requirements
NEMA ICS 2	(1996; R 2004) Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 3	(2005) Standard for Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC
NEMA ICS 6	(1993; R 2001) Industrial Control and Systems: Enclosures
NEMA SG 2	(1993) Standard for High-Voltage Fuses

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489	(2002; Rev thru Jun 2006) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

UL 1449	(2006) Surge Protective Devices
UL 50	(2007) Standard for Enclosures for Electrical Equipment
UL 508	(2008) Standard for Industrial Control Equipment

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Connection Diagrams and Fabrication Drawings shall be submitted for the following items in accordance with paragraph entitled, "General Requirements," of this section.

Installation drawings shall also be submitted for the following items in accordance with the paragraph entitled, "Installation," of this section.

Control Devices
Protective Devices
KCCS Communication Drawings

SD-03 Product Data

Equipment and performance data shall be submitted for the following items including use life, system functional flows, safety features, and mechanical automated details.

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

Magnetic Contactors
Magnetic Control Relays
Motor Control
Instrument Transformers
Enclosures
Circuit Breakers
Trip Units with complete register list
Fuses
Control Devices
Protective Relays
Indicating Instruments
Indicating Lights
Transient Voltage Surge Suppression (TVSS)
EGX Gateway

SD-06 Test Reports

Test reports shall be submitted for the following tests on control and protective devices in accordance with the paragraph entitled, "Factory Testing, of this section.

Short-Circuit Tests

Test reports shall be submitted for the following tests on control and protective devices in accordance with the paragraph entitled, "Field Testing, of this section.

Operation and Acceptance Tests

SD-08 Manufacturer's Instructions

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

Control Devices
Protective Devices

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Magnetic Motor Controllers
Combination Motor Controllers
Circuit Breakers
Protective Relays
Indicating Instruments

1.3 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Connection Diagrams shall be submitted showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, interconnection of the substation control and monitoring system with KCCS,and internal tubing, wiring, and other devices.

Fabrication Drawings shall be submitted for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

PART 2 PRODUCTS

2.1 MOTOR CONTROL

Motor controllers shall conform to NEMA ICS 1, NEMA ICS 2, and UL 508. Controllers shall have thermal overload protection in each phase.

2.1.2 Magnetic Motor Controllers

2.1.2.1 Full-Voltage Controllers

Magnetic motor controllers for the control and protection of single- and three-phase, 60-hertz, squirrel-cage induction motors shall be full-voltage, full magnetic devices in accordance with NEMA ICS 1, NEMA ICS 2, and UL 508.

Operating coil assembly shall operate satisfactorily between 85 and 110 percent of rated coil voltage. Motor control circuits shall be 120 volts, 60 hertz.

Controller shall be provided with two normally open and two normally closed auxiliary contacts rated per NEMA ICS 1 and NEMA ICS 2 in addition to the sealing-in contact for control circuits.

Solderless pressure wire terminal connectors shall be provided for line-and load-connections to controllers.

Overcurrent protection shall include three manual reset thermal overload devices, one in each pole of the controller. Thermal overload relays shall be bimetallic nonadjustable type with continuous current ratings and service-limit current ratings and shall have a plus or minus 15 percent adjustment to compensate for ambient operating conditions.

An externally operable manual-reset button shall be provided to re-establish control power to the holding coil of the electromagnet. After the controller has tripped from overload, resetting the motor-overload device shall not restart the motor.

2.1.3 Combination Motor Controllers

Following requirements are in addition to the requirements specified for magnetic motor controller:

Combination motor controllers for the control and protection of single-and three-phase 60-hertz alternating-current squirrel-cage induction motors with branch-circuit disconnecting and protective devices shall be in accordance with NEMA ICS 1, NEMA ICS 2, and JIC-01.

Combination motor controllers shall include magnetic motor controllers and molded-case circuit breakers or MCP in metal enclosures in accordance with NEMA 250 or motor-control center draw-out assemblies with control-power transformers, selector switches, pushbuttons, and indicating lights as follows:

Magnetic motor controllers and enclosures shall be full-voltage, full-magnetic devices.

Molded-case circuit breakers shall be thermal-magnetic breakers. Manufacturer's standard MCP may be used in lieu of molded-case circuit breakers.

Control-power transformers 120-volt ac maximum selector switches, pushbuttons, and pilot lights shall be as required.

Combination motor controllers shall be identified with identification plates affixed to front cover of the controller.

2.1.3.1 Nonreversing Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

Nonreversing combination motor controllers for the control and protection of single-speed squirrel-cage induction motors shall

include a magnetic controller with molded-case circuit breaker or MCP with selector switch or start/stop pushbutton and indicating light in the cover of the enclosure.

Rating of three-phase single-speed full-voltage magnetic controllers for nonplugging and nonjogging duty shall be in accordance with NEMA ICS 1 and NEMA ICS 2.

Wiring and connections for full-voltage single-speed magnetic controllers shall be in accordance with NEMA ICS 1 and NEMA ICS 2.

2.2 INSTRUMENT TRANSFORMERS

Instrument transformers shall comply with the interference requirements listed below, measured in accordance with IEEE C63.2, IEEE C63.4, and NEMA 107.

Influence		Preferred			Radio	
Insulation Class, kV	Basic Insulation Level, kV	Nominal System Voltage, kV	Test Voltage for Potential Transformers, kV	Test Voltage for Current Transformers, kV	Voltage Level, Microvolts Dry Type	Voltage Level, Microvolts Oil Filled
0.6	10	.....	.....	0.76	250	250
8.7	75	7.20 8.32	4.57 5.28	5.77	250	250

2.2.1 Current Transformers

Current transformers shall conform to IEEE C57.13 for installation in metal-clad switchgear. Standard 5-A secondary transformer shall be used.

Transformers shall have single secondary winding.

Transformers shall be complete with secondary short-circuiting device. Multi-ratio transformers (5 taps per CT), shall have all taps wired out to shorting blocks. Each transformer shall be wired to an individual shorting block in the respective auxiliary compartment.

Transformers shall be single or multi-ratio as indicated. Unless otherwise noted, transformers shall have an ANSI class of 10C100 with a B-1 burden and a continuous thermal current rating factor of 2.0. Thermal rating shall be based on 30 degrees C average ambient air temperature.

Transformers shall be single window type. Multi window current transformers shall not be allowed.

Window-type current transformers shall be indoor dry type construction with secondary current ratings of 5 amperes on all taps unless otherwise noted.

2.2.2 Potential Transformers

Potential transformers shall conform to IEEE C57.13 for installation in metal-clad switchgear. Standard 120-volt secondary transformers shall be used.

Transformers shall have single secondary.

Burden, frequency, and accuracy shall be as required.

Disconnecting potential transformers with integral fuse mountings and current-limiting fuses shall be indoor dry type two-winding construction with primary and secondary voltage ratings as required.

2.3 ENCLOSURES

2.3.1 Equipment Enclosures

Enclosures for equipment shall be in accordance with NEMA 250.

Equipment installed inside, clean, dry locations shall be contained in NEMA Type 1, general-purpose sheet-steel enclosures.

Equipment installed in outdoor locations shall be contained in NEMA 3R enclosures to protect against falling rain and sleet. Enclosure shall be constructed from galvanized sheet steel unless otherwise noted.

Where indicated equipment shall be NEMA Type 4 watertight, corrosion-resistant sheet-steel enclosures, constructed to prevent entrance of water when tested in accordance with NEMA ICS 6 for Type 4 enclosures.

Equipment installed in industrial locations shall be contained in NEMA Type 12 industrial use, sheet-steel enclosures constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Steel enclosures shall be fabricated from corrosion-resistant, chromium-nickel steel sheet conforming to ASTM A 167 Type 300 series with ASM No. 4 general-purpose polished finish. Box dimensions and thickness of sheet steel shall be in accordance with UL 50.

All exterior enclosures shall be painted in accordance with Section 16003 "GENERAL ELECTRICAL PROVISIONS", paragraph entitled "Prevention of Corrosion".

2.4 CIRCUIT BREAKERS

Circuit breakers shall conform to UL 489 and NEMA AB 3.

2.4.1 Molded-Case Circuit Breakers

Circuit breakers shall be molded case, manually operated, trip-free, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection as required. Circuit breakers shall be completely enclosed in a molded case, with the calibrated sensing element factory-sealed to prevent tampering.

Thermal-magnetic tripping elements shall be located in each pole of the circuit breaker and shall provide inverse-time-delay thermal overload protection and instantaneous magnetic short-circuit protection. Instantaneous magnetic tripping element shall be adjustable and accessible from the front of the breaker on frame sizes larger than 100 amperes.

Breaker size shall be as required for the continuous current rating of the circuit. Breaker class shall be as required.

Interrupting capacity of the panel and lighting branch circuit breakers shall be sufficient to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Circuit breaker interrupting capacities shall be a minimum of 10,000 amperes for 208V and 18,000 amperes for 480V unless otherwise indicated, and shall conform to NEMA AB 3. The use of series-rated breakers to achieve the required AIC rating shall not be permitted.

Multipole circuit breakers shall be of the common-trip type having a single operating handle and shall a have two-position on/off indication. Circuit breakers shall have temperature compensation for operation in an ambient temperature of 104 degrees F. Circuit breakers shall have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective type tripping (time delay, magnetic, thermal, or ground fault).

Molded case circuit breakers with a trip rating of 400A and above, shall have solid state trip units with 1-normally open and 1-normally closed contact for remote indication. Unless otherwise noted, all trip units shall have long time, short time and instantaneous trip functions. Provide programming device(s) and test set(s) compatible with each new type of solid state trip unit.

Breaker body shall be of phenolic composition. Breakers shall be capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required.

Circuit breakers used for motor-circuit disconnects shall meet the applicable requirements of NFPA 70 and shall be of the motor-circuit protector type.

2.4.2 Power Circuit Breakers

Power circuit breakers rated below 600 volts shall be the air-break type enclosed in ventilated housings. Current and voltage ratings shall be as required. Interrupting rating shall not be less than 65,000 amperes symmetrical

Power circuit breakers shall comply with ANSI C37.16 and IEEE C37.13.

Power circuit breakers shall be equipped with static trip (solid-state) devices with long-time/short-time on mains and ties and long-time/short-time instantaneous elements on feeders. Main and tie breakers shall be electrically operated. Feeder breakers shall be manually operated only, unless otherwise noted. Breakers shall be electrically and mechanically trip-free in any position of the closing stroke. Ground fault protection shall be included where indicated. Main contacts shall be silver-plated. Arcing contacts shall be sintered tungsten alloy. Tripping shall be accomplished by a shunt-trip device. Closing shall be by manual or electrical operation as indicated.

Provide overcurrent lockout device on mains and tie breaker to prevent remote re-closure after a fault. Lockout device shall be resettable from the front of the breakers.
Breakers installed in metal housings such as unit substations shall be the drawout type.

Metal-clad air circuit breakers shall be mounted on a mobile frame with primary and secondary disconnecting devices, automatic shutters, and

mechanical interlocks to allow complete removal of the unit for inspection and maintenance. Circuit breakers shall be three-pole, single-throw, electrically operated where indicated, with a motor-charged spring, stored-energy mechanism, and electric release coils for tripping and closing operations.

A crank-operated position-changing mechanism shall be provided that will move the breaker between the test and operating position by means of a levering device. Interlocks shall be provided to prevent the complete withdrawal of the circuit breaker from its compartment when the stored-energy mechanism is in the fully charged position. Circuit breakers shall be designed to prevent the release of stored energy unless the mechanism is fully charged. Provide mechanical open and close buttons on face of breaker.

Circuit breakers shall have mechanically trip-free mechanisms with direct-current potential trip coils of the voltage indicated, auxiliary switches, latch-checking switches, control relays, and operation counters.

Alarms, auxiliary switches, interlocks, and similar devices shall be supplied.

Breakers shall have a removable operating handle, provision for padlocking, and position indicator.

Arc chutes shall be asbestos free.

2.4.2.1 Digital Solid State Trip Units

Digital solid-state trip units (Square D PZ4 or approved equal) for low-voltage power circuit breakers shall be in accordance with EIA 443 and ANSI C37.17. Trip unit electronics modules shall be interchangeable between breaker frame sizes without replacing current sensors or flux trip devices already installed (required changing of rating plugs will be acceptable). Rating plugs shall be frame size unless otherwise noted. Trip units shall be solid state and microprocessor based for reliability. The units shall be powered from current sensors only. Current sensors shall be based on frame size unless otherwise noted. Batteries shall only be used to power indicator lights and display after the unit trips. Trip settings shall be adjustable. Trip settings shall not rely on rheostats, dip switches, jumpers or pins to maintain their present adjustments. The units shall not rely solely on any volatile or nonvolatile electronic memory to maintain their present settings. The trip settings shall be clearly visible when the unit is installed. The unit shall be designed so that no cover plate that exposes any electrical or electronic devices is required to be removed in order to adjust the settings. Each setting position shall be clearly marked. A sealable, transparent cover shall be provided to avoid tampering. The trip setting shall be based on true RMS current sensing. Trip units shall be mounted so that no modifications to the existing compartment doors are required.

The units shall visually indicate which of the following limits caused the unit to trip:

Long time
Short time
Instantaneous

This indication shall remain until the unit is reset.

The units shall have the following trip settings unless specified otherwise:

Long time pickup
Long time delay
Short time pickup
Short time delay
Instantaneous pickup

The units shall have selectable flat or I-squared T-response for the short time trip and ground fault. Provide communications interface to allow the trip unit to communicate using the communication system described in Section 16445 paragraph entitled "Switchgear Monitoring and Control System". The Digital Solid State Trip Units shall be capable of clearly communicating all data to KCCS via a Modbus TCP/IP communications protocol using a maximum of one hardware conversion and no software conversions. The breaker status data shall include, but not be limited to, the following: breaker status, current, time of trip, operational history, cause of trip, current date and time, power (KW), energy (KWH), peak demand, self diagnostic information and set points.

Trip units shall be factory installed as cataloged feature of the breaker.

The digital solid state trip unit shall be provided by the breaker manufacturer. Products shall have been in satisfactory commercial or industrial use for 2 years prior to the bid opening. The 2-year period shall be satisfactorily completed by a product for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures.

Provide submittals of the KCCS Communication Drawings. Provide two licensed copies of all software and all hardware necessary to modify and download the programs to interface with the Digital Solid State Trip Units. Citect programming shall be provided for screens on the existing KCCS system. Existing Citect screens for the solid state trip units will be provided as guides for the new screens. The new screens shall match existing screens. Provide trip units with complete register list.

Trip units shall be provided with test jacks on circuit breaker face for in service functional testing of each trip function using a small test kit for secondary injection. Provide one test kit. The test kit shall be the product of the breaker manufacturer. Units shall have alpha-numeric display showing modes of trip, trouble indication and basic instrument functions.

2.5 FUSES

A complete set of fuses for all switches and switchgear shall be provided. Fuses shall have a voltage rating not less than the circuit voltage.

Fuses rated 30 amperes, 125 volts or less shall be the nonrenewable cartridge type. Fuses rated above 30 amperes 600 volts or less shall be the renewable cartridge type with time-delay dual elements, except where otherwise indicated. Fuses shall conform to NEMA FU 1.

Special fuses such as extra-high interrupting-capacity fuses, fuses for welding machines, and capacitor fuses shall be installed where required. Plug fuses are not permitted.

Power fuses on ac systems above 600 volts shall be in accordance with

NEMA SG 2.

Fuses shall be labeled showing UL class, interrupting rating, and time-delay characteristics, when applicable.

Fuse holders field-mounted in a cabinet or box shall be porcelain. Field installation of fuse holders made of such materials as ebony asbestos, Bakelite, or pressed fiber shall not be used.

2.6 CONTROL DEVICES

2.6.1 Magnetic Contactors

Magnetic contactors for the control of low-voltage, 60-hertz, tungsten-lamp loads, fluorescent-lamp loads, resistance-heating loads, and the primary windings of low-voltage transformers shall be in accordance with NEMA ICS 1 and NEMA ICS 2 as required.

Core-and-coil assembly shall operate satisfactorily with coil voltage between 85 and 110 percent of its voltage rating.

Contactor shall be designed with a normally open holding circuit auxiliary contact for control circuits. Rating of the auxiliary contact shall be in accordance with NEMA ICS 1 and NEMA ICS 2.

Solderless pressure wire terminal connectors shall be furnished or made available for line-and-load connections to contactors in accordance with NEMA ICS 1 and NEMA ICS 2.

Rating of magnetic contactors shall be in accordance with NEMA ICS 1and NEMA ICS 2.

2.6.2 Control-Power Transformers

Control-power transformers shall be provided within the enclosure of switchgear when the line voltage is in excess of 120 volts. Transformer shall be encapsulated dry type, single-phase, 3-wire, 60-hertz, with a 240/120-volt isolated secondary winding.

Rated primary voltage of the transformer shall be not less than the rated voltage of the controller. Rated secondary current of the transformer shall be not less than continuous-duty current of the control circuit.

Voltage regulation of the transformer shall be such that, with rated primary voltage and frequency, the secondary voltage shall not be less than 95 percent nor more than 105 percent of rated secondary voltage.

Source of supply for control-circuit transformers shall be the load side of the main disconnecting device. Secondary winding of the transformer and control-circuit wiring shall be protected against overloads and short circuits with fuses selected in accordance with JIC-01. Secondary winding of the control-circuit transformer shall be grounded in accordance with JIC-01.

2.6.3 Magnetic Control Relays

Magnetic control relays for energizing and de-energizing the coils of magnetic contactors or other magnetically operated devices in response to variations in the conditions of electric control devices shall be in

accordance with NEMA ICS 1, and NEMA ICS 2.

Core-and-coil assembly shall operate satisfactorily with coil voltages between 85 and 110 percent of their voltage rating.

Relays shall be designed to accommodate normally open and normally closed contacts.

Magnetic control relays shall be 120-volt, 60-hertz, Class AIB devices with a continuous contact rating of 10 amperes and with current-making and -breaking ability in accordance with NEMA ICS 1 and NEMA ICS 2, two normally open and two normally closed.

2.6.4 Pushbuttons and Switches

2.6.4.1 Pushbuttons

Pushbuttons for low-voltage ac full-voltage magnetic controllers shall be heavy-duty oiltight NEMA 250, Type 12, momentary-contact devices rated 600 volts, with pilot light, and with the number of buttons and the marking of identification plates as shown. Color code for pushbuttons shall be in accordance with JIC-01.

Pushbuttons shall be designed with a sufficient number of normally open, circuit-closing contacts; normally closed circuit-opening contacts to obtain control indicated; and one spare circuit normally open and normally closed circuit-closing and -opening contacts wired to terminal blocks. Pushbutton-contact ratings shall be in accordance with NEMA ICS 1 and NEMA ICS 2 with contact designation A600.

Pushbuttons in remote control stations shall be identified with identification plates affixed to front cover in a prominent location. Identification plate shall carry the identification of the system being controlled.

2.6.4.2 Selector Switches

Selector switches for low-voltage control circuits shall be heavy-duty oiltight maintained-contact devices with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Selector switches in remote control stations shall be identified with engraved identification plates affixed to front cover in a prominent location. Identification plate shall carry the identification of the system being controlled.

2.7 PROTECTIVE RELAYS

2.7.1 Multi-function Voltage Relays - Low Voltage Application

Multi-function voltage relays shall conform to IEEE C37.90.

Multi-function voltage relays shall be three-phase microprocessor electronic type inverse timing with adjustable high- and low-voltage contacts and calibrated scale for protection against phase voltage imbalance, loss of voltage, undervoltage, overvoltage, under frequency and over frequency. Relays shall be equipped with indicating display and voltage contacts to provide electrically separate contact circuits for each

function. Relays shall be suitable for operation on 120-volt ac circuits. Contacts shall be suitable for operation on dc or ac control circuits. Upon failure of the multi-function relay, no erroneous open or close commands shall be sent by relay to the PLC.

Phase Balance trip point shall be adjustable from 5 to 100 volts in 1 volt increments with an initial setting of 20% of the system voltage. The trip timing shall be adjustable from 0 to 20 seconds with an initial setting of 10 seconds.

Undervoltage trip point shall be adjustable from 70 to 600 volts in 1 volt increments with an initial setting of 80 percent of the system voltage. Undervoltage reset point shall be adjustable from 70 to 600 volts in 1 volt increments with an initial setting of 90% of the system voltage. The trip timing shall be adjustable from 0 to 20 seconds with an initial setting of 10 seconds.

Overvoltage trip point shall be adjustable from 70 to 600 volts in 1 volt increments with an initial setting of 115% of the system voltage. Overvoltage reset point shall be adjustable from 70 to 600 volts in 1 volt increments with an initial setting of 110% of the system voltage. The trip timing shall be adjustable from 0 to 20 seconds with an initial setting of 10 seconds.

Under/Over frequency trip points shall be adjustable from 35 to 75 Hz in 0.1 Hz steps. Reset setpoints shall be from 35 to 75 Hz in 0.1 Hz steps. The trip timing shall be 0-20 seconds in 1 second steps.

2.7.2 Synchronization Check Relay

Synchronization check relay shall conform to IEEE C37.90.

The synchronization check relay shall be solid state electronic and shall be designed to be set to enable or disable the synchronization output based on each the following conditions:

Live Line - Dead Bus
Live Line - Live Bus
Dead Line - Dead Bus
Dead Line - Live Bus

The relay shall be designed to accept 120 volt voltage transformer inputs and shall have the capacity to handle 160% of nominal input voltage. The dead line and dead bus voltage shall be adjustable from 10 to 135 volts. Time delay shall be adjustable from 0.1 to 99 seconds. The unit shall check phase angle difference and shall be adjustable from 1 to 99 degrees. Upon failure of the synchronization check relay, no erroneous open or close commands shall be sent.

2.8 INDICATING INSTRUMENTS

2.8.1 Multi-Function Power Monitor

Multi-function power monitor shall be Square-D CM-4000, having the features and functions specified below. Each meter shall be provided with either an Ethernet Communication Card (ECC) or an EGX Gateway for communications and an input/output card (IOC) as shown on the drawings. The device shall be UL recognized, CSA certified and also meet IEEE C37.90.

2.8.1.1 Monitoring Functions

The device shall provide direct reading metered or calculated values of the items listed below and shall auto range between units, kilo-units, and mega-units for all metered values. Unit shall meet or exceed accuracy listed below. Accuracy indicated below to be of read or calculated values.

AC Amperes in each phase,0.2 percent accuracy.
AC Voltage, phase-to-phase, phase-to-neutral, 0.2 percent accuracy.
Watts, 0.2 percent accuracy.
Vars, 0.2 percent accuracy.
Power Factor, 0.2 percent accuracy.
Frequency, 0.2 percent accuracy.
Watt Demand (5, 10, 15, 30 minutes interval programmable or from utility synchronizing pulse), 0.2 percent accuracy.
Watt Hours, 0.2 percent accuracy.
THD
Waveform Capture

2.8.1.2 Inputs

Input ranges of the device shall accommodate external current transformers with ranges from 100/5 through 5000/5 amperes. Potential input transformer ratios shall be field settable. Synchronous pulse input shall be provided and when activated shall override the preset watt demand interval and let the utility control the demand window.

2.8.1.3 Outputs

Outputs shall have separate trip and alarm contacts with ratings of 10 amperes at 115/240 volts AC or 30 volt DC resistive. The contacts shall be Form C (NO/NC). In addition, provide a separate Form C (NO/NC) contact to provide a kilowatthour pulse output. KWH/pulse shall be field programmable. Provide communication output compatible with Square D "Powerlogic" communication system.

2.8.1.4 Case

Case shall be semiflush-mounted to the hinged instrument panel and shall have a matching cover.

2.8.1.5 Test Blocks

Provide four pole current and four pole potential test blocks, ABB Type FT-1 with clear covers or approved equal in line after the power monitor for additional metering or testing.

2.9 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)

Provide Level One or Level Two TVSS where indicated on the drawings. TVSS shall have seven(7) mode protection for 3-phase, wye configuration and four (4) mode protection for 3-phase delta configurations. TVSS shall be an integral part of a new panel if mounted directly to the bus. TVSS provided for new switchgear shall be an integral part of the switchgear and mounted in the auxiliary compartment, dead-front design and front accessible.

TVSS shall be mounted internal to the new equipment being protected, and external to existing equipment being protected. The mounting position of the TVSS shall permit a straight and short lead length connection between

the TVSS and the point of connection to the equipment. The interconnecting leads between the TVSS and the point of connection to the bus should be kept as short as possible, 0.5 m (20 in) or less, and should be twisted to minimize lead reactances. Bends should be avoided if possible. Provide overcurrent protection as recommended by the TVSS manufacturer.

2.9.1 Level One TVSS

TVSS shall meet or exceed the following criteria.

1) Maximum single impulse current rating: 100,000 amperes per mode(8X20 usec current waveform).

2) Pulse life rating (IEEE C62.41-1991, Table 4, Category C3 transient): 1000 occurrences min./mode, based on the highest voltage mode of the device. (20KV/10KA - 8X20usec/1.2X50usec waveform)

Suppression Voltage Ratings (SVR): The maximum UL 1449, Second Edition SVR for the device should not exceed the following:

Nominal Voltage	Configuration	L-N	N-G	L-G	L-L
120/240	Grd. Neutral	400	400	400	700
120/208	Grd. Wye	400	400	400	700
277/480	Grd. Wye	800	800	800	1500
240	Delta			700	700
480	Delta			1500	1500

2.9.2 Level Two TVSS

TVSS shall meet or exceed the following criteria.

1) Maximum single impulse current rating: 50,000 amperes per mode (8x20 usec current waveform).

2) Pulse life rating (IEEE C62.41-1991, Table 4, Category C3 transient): 1000 occurrences minimum per mode, based on the highest voltage mode of the device. (6KV/3KA - 8X20usec/1.2X50usec waveform)

Suppression Voltage Ratings (SVR): The maximum UL 1449, Second Edition SVR for the device should not exceed the following:

Nominal Voltage	Configuration	L-N	N-G	L-G	L-L
120/240	Grd. Neutral	400	400	400	700
120/208	Grd. Wye	400	400	400	700
277/480	Grd. Wye	800	800	800	1500
240	Delta			700	700
480	Delta			1500	1500

2.10 COMMUNICATION

For communication requirements refer to specification sections 16361 and 16445.

2.11 FACTORY TESTING

Factory tests on control and protective devices shall be performed in accordance with the manufacturer's recommendations.

Short-circuit tests shall be in accordance with Section 2 of NEMA ICS 1.

Factory witness testing, at Government's option, shall take place at vendor's facility for circuit breakers. Provide documentation on successful completion of factory tests for the above equipment before final activation at KSC.

2.12 INDICATING LIGHTS

Indicating lights shall be the manufacturer's standard transformer type units 120-volt input utilizing low-voltage cluster type light emitting diodes (LED) of the colors indicated. Indicating lights shall be capable of being relamped from the switchboard front. Indicating lights utilizing resistors in series with the lamps are not permitted except in direct-current control circuits. Lights shall be rated NEMA 250 Type 13 and 4 and provide open, close and trip indicating lights for all drawout circuit breakers.

PART 3 EXECUTION

3.1 INSTALLATION

Control devices and protective devices not factory installed in equipment shall be installed in accordance with the manufacturer's recommendations and shall be field adjusted and operation tested. Installations shall conform to NFPA 70, NEMA ICS 1, NEMA ICS 2, and NEMA ICS 3 requirements for installation of control and protective devices.

3.2 FIELD TESTING

Control and protective devices not factory installed in equipment shall be demonstrated to operate as indicated. Operation and acceptance tests shall be in accordance with NETA ATS and shall include low resistance testing, insulation resistance testing, primary and secondary injection testing.

Reduced-voltage starting devices shall be field adjusted to obtain optimum operating conditions. Test meters and instrument transformers shall conform to IEEE C12.1 and IEEE C57.13.

3.3 TRAINING

Provide eight (8) hours of on-site hands-on training on how to setup and program the digital trip units, and the multi-function relays. This shall include information on how to extract all information from the trip units and multi-function relays and map these functions into Citect.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16345

MOTOR CONTROL

05/09

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL REQUIREMENTS
1.3 SUBMITTALS
1.4 SHIPPING

PART 2 PRODUCTS

2.1 EQUIPMENT
2.2 CONFIGURATION
2.3 CONSTRUCTION
2.4 COMBINATION MOTOR-CONTROL UNITS

PART 3 EXECUTION

3.1 INSTALLATION
3.2 FIELD TESTING

-- End of Section Table of Contents --

SECTION 16345

MOTOR CONTROL
05/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1996; R 2004) Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Acceptance Testing Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 845	(2005; Rev thru Aug 2006) Standard for Motor Control Centers

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Connection Drawings shall be submitted showing the relations and connections of the following items by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices. Provide full point-to-point wiring diagrams.

Certificates shall be submitted for circuit tests on similar motor-control or motor-circuit protector (MCP) units. Tests on units under actual conditions may be submitted in lieu of factory tests on the actual units provided.

Contractor shall identify all circuits leaving the MCCs and all control wiring entering and leaving the MCCs and shall be responsible to re-connect all active circuits, including all motor control wiring, to new MCCs. Contractor shall submit a set of initial as-built drawings of the MCCs to the Contracting Officer for approval prior to beginning any demolition. Contractor to label existing MCC control wiring at each MCC termination point and at the auxiliary terminal box. Identify each termination point using black block type letters/numbers on a white background, with clear

heatshrink tubing over the ID's.Contractor shall demonstrate to Contracting Officer satisfactory operation of new MCCs.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Connection Drawings shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

Installation drawings shall also be submitted for the following items in accordance with the paragraph entitled, "Installation," of this section.

Motor Control Units
Protective Devices

SD-03 Product Data

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

Motor-Control Centers
Motor Control Units

SD-07 Certificates

Certificates shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for the following including special provisions required to install equipment components and system packages. Special notices shall detail hazards and safety precautions.

Motor Control Units
Protective Devices

SD-09 Manufacturer's Field Reports

A Commissioning Document shall be submitted in accordance with the paragraph titled "Field Testing" in this section.

1.4 SHIPPING

Motor-control centers longer than 8 feet shall be shipped in coordinated subassemblies for field connection. Maximum shipping length shall be as approved.

PART 2 PRODUCTS

2.1 EQUIPMENT

Motor-control centers shall conform to NEMA ICS 2, UL 845 and NFPA 70.

2.2 CONFIGURATION

Motor-control centers shall be NEMA ICS 2, Class I, Type C, totally enclosed, free-standing, dead-front distribution type with one or more vertical sections in which combination motor-control units, transformers, panels, and associated control equipment units are group-mounted in an integrated assembly. The Motor Control Centers shall have the capability of having both top and bottom cable entry.

2.3 CONSTRUCTION

Motor-control centers shall be accessible from the front and rear.

Provisions shall be made for leveling the entire assembled motor-control center sections and bolting them together so that they form a contiguous structural enclosure.

Motor-control centers shall contain electrical interlocks, unit control terminal blocks, master control terminal blocks, unit wiring to terminal blocks and unit interconnections, and power connection terminal blocks as required.

Covers for motor-control centers shall be fabricated from cold-rolled carbon-steel sheets of commercial quality with stretcher-level flatness. Vertical sections shall be reinforced to form a rigid structure.

Lifting angles shall be 7 gage, and shall be provided on the top of each section, and shall extend the entire width of the section, and shall be capable of supporting the entire weight of the motor-control center section without distortion. Base channels shall be provided with holes to facilitate floor mounting and leveling.

Design of the motor-control centers shall allow addition of sections with the same height and width without major modifications. Top cover shall not sag or be deformed.

Top and sides shall have removable covers secured with bolts or fasteners. Hinged Covers shall permit access from the rear to the main bus and bus-tap connections in each vertical section. Access doors to motor-control drawout units, wiring channels, and the protective cover of the main horizontal bus shall provide dead front construction.

Horizontal wiring channels shall be provided in the top and bottom of motor-control centers for wiring between vertical sections. In the top horizontal wiring section of each motor-control center provide 3 10 point, double row, 20 amp terminal blocks mounted in the center of the wiring section. Wiring channels shall extend the entire length of the motor-control center and shall allow space for duct and conduit entrances. Vertical wiring channels shall be provided in each vertical section for side wiring to individual motor-control units. Vertical wiring channels shall extend the entire length of each vertical section. Covers of motor-control units and vertical wiring channels shall be side-hinged to the vertical section and fastened in the closed position with captive

bolts, screws, or latches. Horizontal wiring channels shall be removable and fastened in place with captive bolts or screws. A removable steel-plate barrier shall be provided at the tip of each vertical structure to isolate the main horizontal bus from the horizontal wireway.

Horizontal bus structure shall extend the entire length of the motor-control center and shall be tinned copper with a continuous rating of 800 amperes.

All vertical sections shall be completely bused (800-ampere rating)and electrically interconnected with silver-plated solid copper busbars to accommodate plug-in starter units with main horizontal and vertical buses uniformly positioned and phase sequenced. Main horizontal buses shall be readily accessible for connection of future vertical sections at either end.

Vertical sections shall have a width not less than 20 inches and a depth not less than 20 inches.

Buses shall be supported and braced to withstand the short-circuit currents indicated. Contact surfaces of main buses shall be silver plated and bolted together to ensure conductivity.

Main incoming lug compartments shall be provided.

A continuous rigid tin-plated copper ground bus shall extend through the bottom of the entire assembly and shall ground the stationary structure and equipment. Ground bus shall be capable of carrying the rated short-circuit current available in the motor-control center.

After fabrication, steel surfaces of motor-control centers shall be cleaned and phosphatized prior to the application of paint. External and internal surfaces shall be finished with baked enamel or a fast air-drying enamel. Color of internal and external finishes shall be the manufacturer's standard. Nonpainted parts shall be cadmium plated or coated with zinc chromate.

2.4 COMBINATION MOTOR-CONTROL UNITS

Combination motor-control units for the control and protection of single-and three-phase, 60-hertz squirrel-cage induction motors with branch-circuit disconnection and protective devices shall include magnetic motor-controllers, molded-case circuit breakers, or motor-control circuit protectors in compartmentalized draw-out unit construction with fused control-power transformers, selector switches, pushbuttons, and indicating lights, as indicated. Motor control and protective devices shall conform to the requirements of Section 16286, "Overcurrent Protective Devices."

Unit spaces in vertical sections shall be provided with guide rails for the support and alignment of motor-control draw-out units. Latches shall be provided to ensure complete electrical connection of the draw-out unit with the main bus and to allow removal of the draw-out unit from the motor-control center. Plug-in units shall be interchangeable.

Draw-out unit shall be provided with spring-loaded, silver-plated, plug-in stabs for connection to the main bus on the line side of the motor-control unit and fixed terminal blocks for the load-side connections. Wiring shall be accessible from the front. No wiring shall extend into the bus compartment. Unit terminal blocks shall be the split type, allowing unit removal without disturbing outgoing wires.

Motor-control units shall be provided with a single separate hinged door interlocked with its associated disconnecting device to prevent access to draw-out units when the circuit breaker contacts are closed and the operating handle is in the "ON" position. Doors shall swing open a minimum of 112 degrees. An interlock release shall be provided, however, to defeat the interlocking mechanism and permit access to the draw-out unit using a simple hand tool.

Doors shall be provided with openings for the operating handle of molded-case circuit breakers, thermal-overload relay reset buttons, indicating lights, selector switches, and pushbuttons as required.

Disconnect switch overload reset button, selector switches, and any indicating lights and pushbuttons shall be operable with the compartment door closed. The ON-OFF position of the main disconnect method shall be clearly indicated with the door closed. Motor/starter units with auto-control shall have a Hand-Off/Auto switch, and motor/starter units without auto-control shall have a Hand-Off switch. Red lights shall indicate "on", and green lights shall indicate "off".

Feeder tap units shall include externally operable molded-case circuit breakers in combination motor-control unit enclosures for the protection of non-motor loads or remotely located magnetic motor-controllers. Not more than two molded-case circuit breakers shall be contained in feeder tap units.

Compartments for future combination motor-control units shall be complete with hardware, buses, and hinged doors ready to receive future draw-out units. Compartments for spare combination motor-control units shall be complete with buses, hinged doors, and draw-out units but without load terminal connections. Spare spaces shall be complete with buses and screwed-on front cover plates.

Combination motor-control units shall be identified with identification plates affixed to the front hinged door or cover plate of each compartment. Identification plate shall identify the connected load. Provide auxilliary contacts, as indicated, wired to terminal blocks.

PART 3 EXECUTION

3.1 INSTALLATION

Complete assembly shall be electrically and mechanically connected and assembled from coordinated subassemblies shipped in complete sections from the manufacturer. Installation shall be aligned, leveled, and secured to the supporting construction in accordance with the manufacturer's recommendations.

3.2 FIELD TESTING

All testing shall be in accordance with NETA ATS.

Motor-control centers shall be commissioned by a certified equipment manufacturer technician. A Final Commissioning Document containing test results shall be forwarded to the Contracting Officer for approval prior to entergizing the MCCs. All controls, switches, trip devices, and breakers shall be verified to work as designed. Commissioning shall also include verifying the breaker size and trip settings are correctly matched to the

load being serviced. The motor-control centers shall be subjected to continuity and insulation tests after the installation has been completed and before the motor-control center is energized.

Contractor shall provide test equipment, labor, and personnel to perform the tests required. Continuity tests shall be conducted using a dc device with bell or buzzer.

Motor-control centers shall be completely isolated from extraneous electrical connections. Substation feeder breakers, circuit breakers in switchboards, and other disconnecting devices shall be used to isolate the motor-control center under test.

Insulation tests on 600-volt motor-control centers shall be conducted using a 1,000-volt insulation-resistance test set. Readings shall be recorded every 15 seconds for the first minute and every minute thereafter for 10 minutes. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Insulation tests on motor-control centers 480 volts or less shall be conducted using a 500-volt insulation-resistance test set.Readings shall be recorded every 15 seconds for the first minute and every minute thereafter for 10 minutes. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Prior to final acceptance the motor control center shall be energized and loaded (to the maximum load possible, but not less than 10 percent of expected full load)for a minimum of 10 minutes and the temperature measured, with a non-contact device, to verify connection integrity. The temperature detector shall be accurate within 0.5 degrees C. Each phase temperature of 3 phase circuits and individual connections compared to other similarly loaded connections shall be within 3 degrees C of each other. Temperatures outside these values warrant investigation.

Phase-rotation tests shall be conducted on all three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical connections to motors and other connected equipment shall be clockwise.

Test data shall be recorded and shall include location and identification of motor-control centers and megohm readings versus time.

Final acceptance shall depend upon the satisfactory performance of the motor-control centers under a full functional test. No motor-control center shall be energized until recorded test data have been approved by the Contracting Officer.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16361

MEDIUM VOLTAGE SWITCHGEAR

05/09

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Medium Voltage Switchgear Drawings
1.4.2 Calibration Schedule
1.4.3 Formal Request for Settings
1.4.4 Factory Test Reports
1.4.4.1 Switchgear Production and Design Tests
1.4.4.2 Switchgear Paint Qualification Test
1.4.4.3 Communication Processor Configuration Tests
1.4.5 Final Switchgear Shop Drawings
1.5 DEFINITIONS
1.6 MANUFACTURER QUALIFICATIONS

PART 2 PRODUCTS

2.1 MEDIUM VOLTAGE SWITCHGEAR
2.1.1 Auxiliary Section(s)
2.1.2 Metal-Clad Switchgear
2.1.2.1 Circuit Breaker
2.1.2.2 Space Only Compartments
2.1.2.3 Breaker Lifter
2.1.4.3 Auxiliary Ground and Test Device
2.2.3 Compartment Details
2.1.4 Mimic Bus
2.1.5 Protective Relays
2.1.5.1 Multi-function Relays
2.1.6 Relay Management System and KCCS Requirements
2.1.6.1 Relay Management System
2.1.6.2 Communication Processors and Equipment
2.1.6.3 Communication Integration
2.1.6.4 System GPS Clock
2.1.7 Control Devices
2.1.7.1 Test Switches
2.1.7.2 Control, Transfer and Selector Switches
2.1.7.3 Instrument Transformers
2.1.7.4 Heaters
2.1.7.5 Pilot and Indicating Lights
2.1.8 Insulated Barriers
2.1.9 Corrosion Protection
2.1.9.1 Galvanized Steel
2.1.10 Surge Arresters
2.2 SOURCE QUALITY CONTROL

2.2.1 Integral Assembly Test
2.3 SPARE PARTS AND ANCILLARY EQUIPMENT
2.3.1 Spare Protective Relays
2.3.2 Spare Communication Processor
2.3.3 Desktop Computer

PART 3 EXECUTION

3.1 INSTALLATION
3.2 GROUNDING
3.2.1 Switchgear Grounding
3.2.2 Connections
3.2.3 Grounding and Bonding Equipment
3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES
3.3.1 Medium Voltage Switchgear
3.3.2 Meters and Instrument Transformers
3.3.3 Galvanizing Repair
3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES
3.4.1 Interior Location
3.5 FACTORY TESTING
3.6 FIELD QUALITY CONTROL
3.6.1 Performance of Acceptance Checks and Tests
3.6.1.1 Medium Voltage Circuit Breakers (Vacuum)
3.6.1.2 Switchgear Assemblies
3.6.1.3 Instrument Transformers
3.6.1.4 Protective Relays
3.6.1.5 Grounding System
3.6.2 Follow-Up Verification
3.6.3 Manufacturer's Certification
3.6.4 Training

-- End of Section Table of Contents --

SECTION 16361

MEDIUM VOLTAGE SWITCHGEAR
05/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C57.12.28	(1999) Pad-Mounted Equipment - Enclosure Integrity

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2008) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 653/A 653M	(2008) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 780	(2001) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2007; INT 2008) National Electrical Safety Code
IEEE C37.04	(1999) Rating Structure for AC High-Voltage Circuit Breakers
IEEE C37.20.2	(1999) Metal-Clad Switchgear
IEEE C37.20.7	(2007) Guide for Testing Medium-Voltage Metal-Enclosed Switchgear for Internal Arcing Faults
IEEE C57.13	(2008) Standard Requirements for Instrument Transformers
IEEE C62.11	(2005; Amendment A 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (

IPI - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

IPC-CC-830B	Qualification and Performance of Electrical Insulating Compound for Printed Wiring Assemblies

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.1	(2008) Electric Meters; Code for Electricity Metering
NEMA C37.06	(2000) AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities
NEMA LI 1	(1998) Industrial Laminated Thermosetting Products

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Acceptance Testing Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Standard for Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 16003, "General Electrical Provisions" apply to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Medium Voltage Switchgear Drawings
Final Switchgear Shop Drawings
KCCS intergration design
Communications Interconnection Diagrams

SD-03 Product Data

Medium Voltage Switchgear
Circuit Breaker
Auxiliary Ground and Test Device
Multi-function Relays, SEL 351A
Communication Processors, SEL 2032
System GPS Clock, SEL 2407
DC Power Supply

Ethernet Switch
Control, Transfer and Selector Switches
Instrument Transformers
Heaters
Pilot and Indicating Lights
Surge Arresters
Desktop Computer

Submittal shall include manufacturer's information for each component, device and accessory provided with the equipment.

SD-06 Test Reports

Submit Factory Test Reports for all tets specified by paragrapgh entitled "Factory Test Reports".

Submit report of results of acceptance checks and tests specified by paragraph entitled "Field Quality Control"

SD-07 Certificates

Certification of the CITECT integrator shall be submitted showing the integrator has experience with CITECT use in power systems. Submittal shall include sample CITECT development screens that include power systems related elements.

SD-09 Manufacturer's Field Reports

Integral Assembly Test

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following:

Medium Voltage Switchgear
Communication Processors
Multi-Function Relays

SD-11 Closeout Submittals

Calibration schedule
Formal request for settings

1.4 QUALITY ASSURANCE

1.4.1 Medium Voltage Switchgear Drawings

Drawings shall include, but are not limited to the following:

a. An outline drawing with front, top, and side views

b. Ampere ratings of bus bars

c. Maximum short-circuit bracing

d. Nameplate data

e. Provisions for future extension

f. Circuit breaker and switch type(s), interrupting ratings, and trip devices including available settings

g. Elementary diagrams and wiring diagrams with terminals identified and indicating prewired interconnections between items of equipment and the interconnection between the items

h. One-line diagram, including switch(es), circuit breakers, current transformers, meters, and fuses

i. Manufacturer's instruction manuals and published time-current curves (on full size 11 x 17 inches logarithmic paper) of overcurrent relays to ensure that protection and coordination are achieved.

j. Communications Interconnection Diagrams detailing all the connections between the Communication Processor, Protective Relays, Power Meters, Switches, and Gateways. The diagrams shall include cable types, port assignments, and communication port settings where applicable.

1.4.2 Calibration Schedule

a. Provide a calibration schedule including the anticipated dates when equipment requiring coordination and protection will be installed, the anticipated date when the Contractor will submit a formal request for settings, and the anticipated date when the manufacturer's technical representative will perform settings and calibrate equipment.

1.4.3 Formal Request for Settings

a. Protective relay settings will be provided by the Contracting Officer. Submit a formal request for settings 30 days in advance of the factory acceptance tests.

b. The equipment requiring protection and coordination shall be installed prior to making this request.

c. Communication Processor settings will be provided by the contractor and downloaded prior to the factory acceptance tests. A shop drawing detailing the settings shall be submitted and approved by the Contracting Officer prior to downloading.

1.4.4 Factory Test Reports

a. Switchgear Production and Design Tests
b. Switchgear Paint Qualification Test
c. Communication Processor Configuration Tests
d. Circuit Breaker Power Factor Tests
e. Integral Assembly Test

1.4.4.1 Switchgear Production and Design Tests

Furnish reports which include results of production and design tests performed according to IEEE C37.20.2. Production tests shall be performed

by the manufacturer on each switchgear assembly to ensure that design performance is maintained in production. Impulse withstand tests shall be performed on each switchgear assembly.

1.4.4.2 Switchgear Paint Qualification Test

Furnish reports showing that the paint qualification test has been performed according to IEEE C37.20.2 or ANSI C57.12.28 as applicable, to ensure the adequacy of finishes to inhibit the buildup of rust on ferrous metal materials used for enclosures.

1.4.4.3 Communication Processor Configuration Tests

Furnish reports indicating that the communication processor has been correctly configured to interface with each of the protective relays, KCCS, and the SEL 5040 report server.

1.4.5 Final Switchgear Shop Drawings

After the switchgear has been manufactured and acceptance tests have been completed the switchgear manufacturer shall submit a Final Switchgear Shop Drawings as-built set of switchgear drawings documenting any changes to the contracting officer for approval. Provide two CD contain the complete set of the as-built drawing in AutoCad format.

1.5 DEFINITIONS

The Kennedy Complex Control System (KCCS) is a combination of hardware and software components that are used to monitor and control Power, HVAC, Water & Waste and Pneumatic Utilities across the Kennedy Space Center.

Citect is an Industrial Controls, Supervisor Control And Data Acquisition (SCADA) software application that is used to monitor and control the I/O devices connected to the KCCS network. The Citect application provides the Human Machine Interface (HMI) to display, trend, alarm and control and/or monitor the I/O points connected to or through the I/O devices. Information is transferred to and from the Citect server over a dedicated Ethernet controls network using Modbus TCP/IP as the preferred transportation protocol.

1.6 MANUFACTURER QUALIFICATIONS

Material and equipment to be provided under this specification shall be the standard catalog product of a manufacturer regularly engaged in the manufacture of switchgear assemblies and their component parts and equipment. Equipment shall be of the latest standard design for indoor service and shall have been in repetitive manufacture for at least 50 units.

PART 2 PRODUCTS

2.1 MEDIUM VOLTAGE SWITCHGEAR

2.1.1 Auxiliary Section(s)

Auxiliary sections shall have a hinged front panel, and a ground bus, necessary terminal blocks, wiring and control buses, control power transformer, and cable supports.

2.1.2 Metal-Clad Switchgear

Switchgear shall conform to IEEE C37.20.2 for metal-clad medium voltage vacuum circuit breaker type, insulated for 15 kV for use on 13.8 kV system. The switchgear shall also meet the requirements of IEEE C37.20.7, Accessability Type 2C, for arc resistant switchgear with suitable construction at the front, back and sides and between adjacent cells. Each steel unit forming part of the switchgear structure shall be self-contained and shall house two-high breaker or instrument compartments, and a full height center and rear compartment for the buses and outgoing cable connections. For two-high breaker units, provide a removable metal barrier to separate the two cable circuits. Equip individual circuit-breaker compartments with drawout contacts, rails, disconnecting mechanism, and a cell interlock to prevent moving the removable element into or out of the "connected" position while the circuit breaker is closed. Provide front steel hinged doors with multi-point latching system for each breaker compartment. Design the structure to allow for future additions. Provide laminated plastic nameplates for each relay, switch, meter, device, and cubicle to identify its function. Provide permanent labels for wiring and terminals corresponding to the designations on approved shop drawings. Mount nameplates on each circuit breaker compartment door using stainless steel screws.

a. Phase buses and connections: Mount bus structure on insulated supports of high-impact, non-tracking, high-quality insulating material and brace bus to withstand the mechanical forces exerted during short-circuit conditions when connected directly to a source having maximum of 18,000 amperes rms symmetrical available. Bus bars shall be rated 1200 amperes, shall be insulated and shall be high conductivity copper having silver plated joints. Make bus bar connections from main buses to the incoming circuit breaker studs. Equip outgoing circuit breaker studs with mechanical clamp type cable connectors for the size of cables shown. Provide cable supports for outgoing cables. Wire secondary circuits, including heater circuits, to terminal blocks. Terminal blocks shall be readily accessible for making external connections as required.

b. Ground bus: Provide a copper ground bus sized for full short-circuit capacity. Secure ground bus to each vertical structure and extend ground bus the entire length of switchgear. Include provisions for making the station ground connections.

c. DC bus: Provide an insulated copper bus or wire extending the entire length of switchgear. Bus shall be rated 100 amperes at 125 Vdc. Provide pull-out fuse blockto each circuit breaker open and close circuits.

d. Each breaker compartment shall have provision for mounting up to four sets of ANSI rated current transformers, two on line side and two on load side of each breaker.

e. PTs: Provide 3-phase draw-out PTs with primary and secondary fuses.

Enclosures shall be walk-in enclosure and shall be designed for outdoor location and shall conform to the Category A requirements of Table A1 of Appendix A to IEEE C37.20.2. The walk-in enclosure shall be provided with adequate width and height to allow the removal and insertion of the circuit breaker. The walk-in enclosure shall be provided with lighted front aisle

and NEMA 5-20R recepacles at each end for services. Power for the space heaters, fluorescent lights and receptacles shall be provided from an internal power panel. Provide method for easy connection of internal power panel from external power source.

2.1.2.1 Circuit Breaker

Each vacuum circuit breaker shall be an electrically operated, three-pole, circuit interrupting device rated as indicated at maximum voltage of 15 kV and 95 kV BIL. Breaker shall be sized for 1200A and be designed for service on a 13.8 kV system with a short-circuit capacity of not less than 500 MVA. Rating shall be based on IEEE C37.04 and NEMA C37.06. Breaker frame size shall be as indicated. Circuit breaker shall be drawout-mounted with position indicator, operation counter, auxiliary switches, and primary and secondary disconnect devices. Circuit breaker shall be operated by an electrically charged, mechanically and electrically trip-free, stored-energy operating mechanism. Provide for manual charging of the mechanism and for slow closing of the contacts for inspection or adjustment. Circuit breaker control voltage shall be 125 VDC.

a. Contacts: Silver-plated, multifinger, positive pressure, self-aligning type for main drawout contacts.

b. Each drawout breaker shall be provided with three-position operation. The connected position and the test/disconnect position shall be clearly identified by an indicator on the circuit breaker front panel.

(1) Connected position: Contacts are fully engaged. Breaker shall be tripped before it can be racked into or out of this position.

(2) Test/disconnect position: Position shall allow for complete testing and operation of the breaker without energizing the primary circuit.

(3) Withdrawn (removed) positions: Places breaker completely out of compartment, ready for removal.

2.1.2.2 Space Only Compartments

Provide fully equipped with busing, control switch, indicating lights, and drawout breaker mounting and connecting straps to accommodate future breakers. Provide compartments with doors.

2.1.2.3 Breaker Lifter

Provide a portable lifter rated for lifting and lowering circuit breakers from two-high cubicles. Portable lifter shall have swivel casters in front for ease of movement.

2.1.4.3 Auxiliary Ground and Test Device

Provide electrically operated auxiliary ground and test device which can be installed into any breaker compartment during maintenance. This device shall permit solidly grounding the equipment and provide six test terminals on the front of the device for testing by qualified personnel. These terminals shall provide access to all three phases on both sides of the

selected breaker compartment for phasing and other tests.

2.2.3 Compartment Details

Compartments shall be completely wired with cable terminals, cable clamps, control bus, control power switch, fuse and terminal blocks. Terminal blocks shall be readily accessible for the external connections of metal-clad switchgear.

Low voltage wiring for controls, metering, relaying and accessories shall be run to terminal blocks.

All switchgear components, including but not limited to fuse blocks, pushbuttons, selector switches, indicating lights and terminal blocks, shall have a unique designation by cubicle, (ie: A1, B1, A2, B2, this would be Bus A Device 1, Bus B Device 1 etc.). A label with minimum 1/4" high lettering with the device designation shall identify the device. Wiring between sections/cubicles shall identify the end devices by "section/cubicle number and device designation".

Terminal blocks shall have engraved plastic terminal strips with screw type terminals having letter designations and numbered terminal points. Terminal blocks in each section / cubicle used for the same wiring as the adjacent sections / cubicles shall have the same letter designation preceded by the section /cubicle number. Terminal blocks associated with current transformers shall be short-circuiting type. Terminal blocks with sliding links will not be allowed. Terminal blocks for multi-ratio current transformers shall be wired with all taps and ground, one terminal block per current transformer. CT Tap jumpers shall not be located on the same side as the leads from the CT. Wiring shall be SIS Class insulation, sized #14 AWG for control, #12 AWG for potential leads and #10 AWG for current leads. Terminate all conductors with compression ring terminal lugs. Male/female spade or forked connectors shall not be used. Final conductor leads for terminations on the switchgear heaters shall be a minimum of 150 degrees high temperature wiring.

Wire marking for controls, metering, relaying and accessories conductors shall be at both ends. Wire markers shall be white plastic tubing heat stamped with black block type letters. All wire markers shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached, as well as the terminal number to which the wire is directly attached (near end/far end marking).

An identification plate engraved with circuit and function designations shall identify each compartment of the switchgear assembly.

Removable elements of the same type and rating in the switchgear assembly shall be physically and electrically interchangeable in corresponding compartments.

2.1.4 Mimic Bus

Provide mimic bus using 3/32-inch red plastic laminate. Mimic bus shall show breakers and bus. Fasten to switchgear using stainless steel screws.

2.1.5 Protective Relays

2.1.5.1 Multi-function Relays

Protective relays shall be Schweitzer Engineering Laboratories model number 3516 for main incoming and tie breakers and model number 351-A for feeder breakers. All relay com ports shall be set at 19,200 baud rate, and all relays shall have the following options:

1. Relay shall have corrosion limiting finishes on all surfaces including circuit boards. Circuit board coating shall conform to specification IPC-CC-830B.

2. Relay shall have connectorized terminals. CT connector shall be the shorting type.

3. The relay shall include a front mounted intergral display and have the capability to display custom messages.

4. The relay shall be connected to the communications processor via an IRIG-B connection cable.

2.1.6 Relay Management System and KCCS Requirements

2.1.6.1 Relay Management System

The protective relays will be connected to the existing KSC Relay Management System through a local SEL 2032 communications processor via the SEL 2701 Ethernet interface card.This system provides the user the ability to fully program the relay, including making setting changes, either locally or remotely and has the ability to verify and compare relay settings in the relay with the settings stored in the system database. The system is capable of viewing real-time power system parameters (including kW, kVAR, Voltage, Current, PF), collect relay status information (including relay health), read event reports from the relay (including faults, high or low Voltage, high current levels), and analyze event reports graphically, either locally or remotely. The system shall have a minimum communication baud rate of 19,200.

Integration of the protective relays into the existing RMS shall be performed by Schweitzer Engineering Services. The server for the RMS is located in the KSC Launch Control Center (LCC) and is loaded with SEL-5010, SEL-5040 and SEL-5601 application software programs. All of these programs shall be updated to incorporate the relays installed under this project.

2.1.6.2 Communication Processors and Equipment

The Communication Processors shall be a Schweitzer Engineering Laboratories 2032, part number SEL-2032332344H0XX and have the SEL-2701 Ethernet processor card installed in port 17. Each processor shall be supplied with a Square D EGX-100 gateway to connect to KCCS.

Additionally, an N-TRON 308TX 8 port Ethernet Switch or equivalent, and a 125VDC to 24VDC PS5R 50 watt DC Power Supply shall be supplied to integrate the Communication Processors and the CM4000 power meters with KCCS.

2.1.6.3 Communication Integration

Integration of the relays and communication processors with the existing

KCCS (CITECT) system shall be performed by Schweitzer Engineering Services in coordination with the contractor's specialist and the CITECT integrator. This integration shall include, but not be limited to setting up each port on the 2032 processors and programing each 2032 to efficiently provide SCADA type data and control to KCCS via port 16 on the processor. "Efficiently" implies that data will be transmitted and received such that the response time to the KCCS workstation will be less than 4 seconds. This document will provide the minimum required data point list for the relays.Sample 2032 setting files from previous projects to assist in the integration effort will be provided by the Government.

The relays shall be able to communicate with KCCS via an ethernet connection using MODBUS via TCP/IP (Citect standard Modnet driver). The communication shall occur via port 16 on the SEL-2032 communication processor. Port 16 shall be configured as a Modbus serial port and it shall be connected to an EGX gateway to convert Modbus serial to Modbus TCP/IP. The gateway shall connect to the KCCS network and provide the communication path to allow the KCCS servers to communicate to each protective relay with the Ctect SCADA application software. The manufacturer shall provide, in writing, after communication integration is complete, that the communications system provided under this project will communicate efficiently with the Citect software. If problems are encountered Citect is located at 30,000 Mill Creek Avenue, Alpharette, GA 30022. Phone is 770-521-7511, facsimile is 770-521-7512. Sales email is sales-americas@citect.com, service email is support-americas@citect.com.

Provide Engineering and Technical Support for on-site modifications to the existing user interface screens used by the ISC power coordinators as part of the Kennedy Complex Control System (KCCS). The contractor shall provide technical support to develop additional screens and/or modifications to existing screens required to incorporate the new relays into the KCCS system. The additional screens will allow the ISC power coordinator to monitor and control each circuit breaker via Citect "Genies" and "Super-Genies". The Government will perform the final integration of the new screens, Genies, and Super-Genies into the existing KCCS file server. The existing KCCS system shall be modified to incorporate all the changes associated with the installation of the new relays. The modifications to the project shall include but not be limited to, adding/deleting variable tags, alarm tags and trend tags, modifying/building "genies and super genies" and modifying/creating user interface screens. All modifications to the Citect project shall comply with the KCCS Software Architecture Standard. The following minimum information and control shall be available to the user through the developed genies:

a) Individual phase and ground currents.
b) Phase-to-phase and phase-to-neutral voltage.
c) Alarm on circuit breaker trip, cause of trip and magnitude of the fault current (trip records).
d) Circuit breaker status including open, close, tripped, truck position and connected, test or disconnected if available.
e) Time-stamped trip data including magnitude and cause of trip.
f) Remote circuit breaker open and close commands.

Coordinate all communication network interface equipment and software (if necessary) with the Citect integrator to ensure that the communication solution provided is efficient and compatible with the existing KCCS architecture. Provide manufacturer's cut sheets and interconnection drawings for additional equipment not specified herein but necessary to

insure the relay data communication will be TCP/IP Modbus. Acceptance of additional equipment shall be subject to the approval of the Contracting Officer.

The communication system shall be capable of retrieving breaker status of A Government library of Citect symbols, genies and super genies has already been developed and will be provided to the contractor to assist with the development of the new operator screens. This library includes the Citect interface for the SEL-351A relay.

A minimum of two KCCS intergration design reviews shall be scheduled by the contractor to ensure that all of the parties involved in developing any new Citect interfaces (screens, alarms, trends, and data exchange methods) are properly coordinated. At the first meeting, an existing KCCS Citect sample project will be provided by the Government to assist in the development of new interfaces. At the second meeting the contractor shall provide a 60% developed Citect project that demonstrates the monitor and control functions associated with the new interface. The first meeting shall be scheduled within 75 daysof the contract award.

Final acceptance testing of the developed Citect project shall be performed by the Contractor using their own laptop computer. The tests shall be performed on site on active equipment after the relays have been installed and fully integrated into the SEL-2032 communication processor.

Upon the completion of the contract, the Contractor shall provide to the Government a complete set of Communication Interconnection Diagrams depicting the system as installed.

2.1.6.4 System GPS Clock

Provide a relay system GPS clock source, Schweitzer Engineering Laboratories type SEL 2407, capable of providing an unmodulated IRIG-B timing signal to substation protective relays for analysis of electrical system fault analysis. The GPS controlled clock shall be suitable for 125 VDC operating voltage complete with a GPS antenna, suitable for pipe mounting with coaxial cable and applicable connectors.

2.1.7 Control Devices

2.1.7.1 Test Switches

Provide test switches as indicated on the drawings. Test switches shall be ABB Type FT-1 with clear covers or approved equivalent and shall be mounted on the door of the instrument compartment.

2.1.7.2 Control, Transfer and Selector Switches

Shall be rotary cam operated for remote operation devices with individual stages, a dust-tight cover and contacts with a positive wiping action. Contacts shall be silver-to-silver or an approved substitute which provides equal or superior performance. Contacts shall have a rating adequate for the duty performed, but shall not be less than 600 volts, 20 amperes continuous. Circuit breaker control switches shall have a red and green target. Red, amber and green indicator lamps shall also be provided and wired as shown. Circuit breaker control switches shall have a combination of maintained action and spring return type of operation. Circuit breaker control switches shall have pistol grip handles. All switches shall be equipped with engraved plastic escutcheons identifying its function and

position.

2.1.7.3 Instrument Transformers

Instrument transformers shall conform to IEEE C57.13, as applicable.

a. Current transformers: Transformers shall be multi-ratio relay accuracy,as indicated, 60 Hz, and coordinated to the rating of the associated switchgear, relays, meters, and instruments. CT's for relaying shall have a 10C200 rating as a minimum. CT's shall have a thermal rating factor of 2.0.

b. Potential transformers: Transformers shall be drawout type, 60 Hz, with voltage ratings and ratios coordinated to the ratings of the associated switchgear, relays, meters, and instruments. Potential transformers shall be with two fuses in the primary. Fuses shall be current limiting and sized as recommended by the potential transformer manufacturer. Transformers shall meet ANSI metering accuracy classifications of 0.3 W, X, Y.

2.1.7.4 Heaters

Provide 240-volt heaters in each switchgear section. Heaters shall be of sufficient capacity to control moisture condensation in the compartments, and shall be sized 250 watts minimum. Heaters shall be controlled by a thermostat and humidistat located inside switchgear. Thermostats shall be industrial type, high limit, to maintain compartments within the range of 60 to 90 degrees F. Humidistats shall have a range of 30 percent to 60 percent relative humidity. Energize electric heaters in switchgear assemblies while the equipment is in storage or in place prior to being placed in service.

2.1.7.5 Pilot and Indicating Lights

Provide LED type, rated for 120 volt DC. Lights shall be capable of being relamped from the front. Provide open, close, and trip lights for all circuit breakers.

2.1.8 Insulated Barriers

Where insulated barriers are required by reference standards, provide barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness.

2.1.9 Corrosion Protection

Bases frames, and channels of unit substation shall be corrosion resistant and shall be fabricated of galvanized steel. Base shall include any part of switchgear that is within 3 inches of concrete pad. Paint unit substation, including bases with manufacturer's standard paint.

2.1.9.1 Galvanized Steel

Galvanized steel shall conform to ASTM A 123/A 123M, ASTM A 653/A 653M G90 coating, and ASTM A 153/A 153M, as applicable. Galvanize after fabrication where practicable.

2.1.10 Surge Arresters

Provide one surge arrester for each conductor on circuits where indicated. Surge arresters shall conform to IEEE C62.11 for intermediate class indicated and shall be rated 10 kV.

2.2 SOURCE QUALITY CONTROL

2.2.1 Integral Assembly Test

Switchgear shall have an Integral Assembly test performed at the switchgear manufacturer's test facility. This test verifies connections between switchgear cubicles, including but not limited to control wiring, control power, and the main bus. This test shall conform to IEEE C37.20.2.

2.3 SPARE PARTS AND ANCILLARY EQUIPMENT

2.3.1 Spare Protective Relays

The Contractor shall provide one spare SEL 351A relay for the project.

2.3.2 Spare Communication Processor

The Contractor shall provide one spare communication processor for the project. The communication processor shall be the same as specified in paragraph above entitled "Communication Processors".

2.3.3 Desktop Computer

The Contractor is required to provide to the Government a desktop computer containing at a minimum, the following features:
Intel Core 2 Duo E7400 2.8GHz dual-core processor, 4GB RAM, 640GB 3.0GB/s Serial ATA hard drive, dual-layer DVD burner, six USB ports, two audio ports, one FireWire port, wireless keyboard and mouse, and Windows XP Professional, 19-in LCD monitor a 4:3 aspect ratio.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

Grounding shall conform to NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Switchgear Grounding

Provide bare copper cable as indicated, connecting to building steel. Switchgear neutral connections shall not be smaller than No. 2/0 AWG.

3.2.2 Connections

Make joints in grounding conductors and loops by exothermic weld.

3.2.3 Grounding and Bonding Equipment

Grounding and bonding shall conform to UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect unit substations furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Medium Voltage Switchgear

Medium voltage switchgear installation shall conform to IEEE C37.20.2.

3.3.2 Meters and Instrument Transformers

Meters and Instrument Transformer installation shall conform to NEMA C12.1.

3.3.3 Galvanizing Repair

Repair damage to galvanized coatings caused by handling, transporting, cutting, welding, or bolting. Make repairs in accordance with ASTM A 780, zinc rich paint. Do not heat surfaces that repair paint has been applied to.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.4.1 Interior Location

Mount switchgear on existing concrete floor.

3.5 FACTORY TESTING

Factory tests on the switchgear shall be performed in accordance with IEEE C37.20.2. All tests shall be witnessed by the Contracting Officer or his designee unless waived, in writing, and no equipment shall be shipped until it has been approved for shipment by the Contracting Officer. Factory test results shall be signed off by the Contracting Officer or his designee unless waived in writing.

Factory tests shall also demonstrate switchgear ability to communicate with the existing KCCS. The following minimum functionality shall be demonstrated:

a) Correct graphics for symbols, colors, and animation of the user screens as defined during the software development reviews.

b) Alarms and trends.

c) Display of all the information referenced in the communication section.

d) Open and close commands for the breakers.

e) The communication network provided with the switchgear does not generate any "hardware alarms" within the Citect project.

Provide documentation on successful completion of factory tests for the

above equipment prior to shipping the switchgear to KSC.

3.6 FIELD QUALITY CONTROL

3.6.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and in accordance with NETA ATS, 2003. All acceptance test results shall be neatly cataloged and bound, and shall be submitted to the contracting officer or his designee prior to final acceptance.

3.6.1.1 Medium Voltage Circuit Breakers (Vacuum)

Perform all acceptance tests per section 7.6.3 of NETA ATS 2003 with the following additions/deletions:

1. Perform power factor test across of pole with the breaker open and phase to phase with the circuit breaker closed.

2. Time-travel analysis requirement is waived.

3.6.1.2 Switchgear Assemblies

Perform all acceptance tests per section 7.1 of NETA ATS 2003 with the following deletion:

1. Primary current injection test is waived.

3.6.1.3 Instrument Transformers

Perform all acceptance tests per section 7.10 of NETA ATS 2003 with the following additions:

1. Verify all current transformer ratio taps for each CT.

2. Verify phase, polarity, and all connections from each CT ratio tap to the switchgear termination points.

3.6.1.4 Protective Relays

a. Visual Inspection

(1) Inspect connections on the rear of the relay. Ensure cables/wires are secure and tight.

(2) Ensure relay is properly mounted to panel door.

b. Electrical Tests

(1) Install relay settings obtained from the Contracting Officer. Verify relay operates per installed settings and manufacturer's curves. A minimum of three trip points per element shall be used to verify the selected curves.

(2) Verify that each of the relay contacts performs its intended function in the control scheme including breaker trip tests, close inhibit tests, 86 lockout tests, and alarm functions if required.

3.6.1.5 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

3.6.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device, by simulating a fault and shall be opened and closed by the protective device by using KCCS. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times for checks, settings, and tests.

3.6.3 Manufacturer's Certification

A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations for both the switchgear and relaying system.

3.6.4 Training

Provide the services of manufacturer representatives to train the owner's personnel in operation of the switchgear and programming of the relay systems. The manufacturer representatives shall be factory-trained and shall have a thorough knowledge of the switchgear, all protective devices, metering, hardware and system programming. The training session on the IEDs and all controls shall include:

1. One Day - Switchgear on-site training - Switchgear Manufacturer
   a) Full operation demonstrations of all functions.
   b) Breaker electrical and mechanical operations.
   c) Explanations and instructions for all protective devices.

2. One Day - Relay on-site training - Relay Manufacturer
   a) Classroom on-site training for programming the relays and relay management system.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16410

AUTOMATIC/MANUAL TRANSFER AND BYPASS/ISOLATION SWITCHES

09/99

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 Acceptance checks and tests
1.4 SERVICE CONDITIONS

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH (ATS)
2.1.1 Accessories
2.2 MANUAL TRANSFER SWITCH (MTS)
2.2.1 Accessories
2.3 ENCLOSURE
2.3.1 Construction
2.3.2 Cleaning and Painting
2.4 SOURCE QUALITY CONTROL
2.4.1 ATS, MTS and Closing Tests
2.4.2 Dielectric Withstand Tests
2.4.3 Operational Tests
2.4.4 Non-welding of Contacts
2.4.5 Temperature Rise Test

PART 3 EXECUTION

3.1 INSTALLATION
3.2 FIELD QUALITY CONTROL
3.2.1 Performance of Acceptance Checks and Tests
3.2.1.1 Automatic Transfer
3.2.1.2 Manual Transfer
3.2.2 Follow-Up Verification

-- End of Section Table of Contents --

SECTION 16410

AUTOMATIC/MANUAL TRANSFER AND BYPASS/ISOLATION SWITCHES
09/99

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Acceptance Testing Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2000; R 2005) Industrial Control and Systems: General Requirements
NEMA ICS 2	(1996; R 2004) Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 4	(2000) Industrial Control and Systems: Terminal Blocks
NEMA ICS 6	(1993; R 2001) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code
NFPA 70B	(2002) Electrical Equipment Maintenance

UNDERWRITERS LABORATORIES (UL)

UL 1008	(2003) Automatic Transfer Switches

1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Automatic transfer switch

Manual transfer switch

Include a one-line diagram of each ATS, MTS assembly, an

elementary or schematic diagram, a wiring diagram of the unit, and an interface equipment connection diagram that shall show all conduit and wiring between ATS, MTS and other related equipment. Device and nameplate numbers and item numbers shown on the list of equipment and materials shall appear on drawings wherever the item of equipment or material appears. One-line diagram shall show interlocking provisions and cautionary notes, and elementary or schematic diagram shall appear on the same drawing.

SD-03 Product Data

Automatic transfer switch (ATS)

Manual transfer switch (MTS)

Accessories

Submit a description of each separate item of equipment or materials recommended for approval.

SD-06 Test Reports

Acceptance checks and tests

SD-07 Certificates

Certificates shall be submitted to ensure compliance with existing network communications

SD-09 Manufacturer's Field Reports

ATS, MTS and closing tests

Dielectric withstand tests

Operational tests, including communications

Non-welding of contacts

Temperature rise test

Perform tests on each assembled switch unit. Test reports shall be certified and dated, shall demonstrate that the tests were conducted as specified, and that tests were successfully completed prior to the shipment of the equipment. Submit reports within 14 days following completion of the tests.

SD-10 Operation and Maintenance Data

Automatic transfer switch

Manual transfer switch

1.3 QUALITY ASSURANCE

1.3.1 Acceptance checks and tests

Submit report of test results specified in paragraph entitled "Field Quality Control"

1.4 SERVICE CONDITIONS

ATS and MTS shall be suitable for performance under the following service conditions:

a. Relative humidity: 100 percent maximum, continuous.

b. Temperature: Minus 20 degrees F to 120 degrees F.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH (ATS)

Provide each automatic transfer switch with the number of poles, amperage, voltage, and withstand ratings as indicated. Transfer switch shall conform to UL 1008 as a recognized component for emergency systems, NEMA ICS 1, NEMA ICS 2, and be rated for all classes of loads when installed in an unventilated enclosure. Electrical operation shall be accomplished by a nonfused momentarily energized solenoid direct operating or electric motor operated mechanism or stored energy operator. Provide mechanical locking in each direction. Operation shall be double throw switching where normal and alternative contacts operate with no intentional delay in mid position.

ATS shall be rated for continuous duty at the continuous current rated specified. ATS constructed with either automatic or non-automatic circuit breakers are unacceptable. ATS equipped with protective devices to interrupt fault currents are also unacceptable.

Where indicated, Automatic Transfer Switches shall be equipped with network communications capable of communicating all stored information to KCCS (SCADA) via an ethernet connection using MODBUS via TCP/IP (Citect Modnet Driver). The manufacturer shall provide all drivers required for communications and shall certify equipment will communicate with the Citect software, in writing to the Contracting Officer.

2.1.1 Accessories

A separately mounted control unit shall include:

a. Nonadjustable, one-second time delay to override momentary dips in normal power source.

b. Phase voltage relay supervision of three phases of the normal source. Relay shall dropout at 65 to 70 percent and pickup at 92 to 95 percent of nominal voltage to detect "brown-out" conditions Phase relays using dropping resistors to develop correct voltage for monitoring are unacceptable.

c. Voltage/frequency lockout relay with 90 percent pick-up nominal, to prevent premature transfer.

d. System test switch, momentary type.

e. Auxiliary pilot contacts rated 10 amperes at 480 volts a.c., one closed on normal and one closed on alternative.

f. Retransfer time delay to normal power source: adjustable from 0 to 30 minutes. ATS Only.

g. Pilot lights to indicate source to which the load is connected.

2.2 MANUAL TRANSFER SWITCH (MTS)

Provide each manual transfer switch with the number of poles, amperage, voltage, and withstand ratings as indicated. Transfer switch shall conform to UL 1008, rated for all classes of loads when installed in an unventilated enclosure. Electrical operation shall be accomplished by a nonfused momentarily energized solenoid direct operating or electric motor operated mechanism or stored energy operator. Provide mechanical locking in each direction. Operation shall be double throw switching where normal and alternative contacts operate with no intentional delay in mid position.

2.2.1 Accessories

A separately mounted control unit shall include:

a. Auxiliary pilot contacts rated 10 amperes at 480 volts a.c., one closed on normal and one closed on alternative.

b. Pilot lights to indicate source to which the load is connected.

2.3 ENCLOSURE

Each switch and its accessories shall be in a free-standing, floor-mounted, and ventilated NEMA ICS 6, Type 1, smooth sheet metal enclosure constructed in accordance with UL 1008. Metal shall be not less than US Standard Gauge No. 14. The enclosure shall be equipped with grounding lugs grounding the enclosure using No. 4 AWG copper conductors. Contractor's field wiring terminating within the enclosure shall comply with NFPA 70. If wiring is not color coded, wires shall be permanently tagged near the terminal at each end with the wire number shown on approved shop drawings. Terminal blocks shall conform to NEMA ICS 4. Terminal facilities shall be arranged for entrance of external conductors from the top of the enclosure. Main switch terminals, including the neutral terminal, shall be of the pressure type and suitable for the termination of copper conductors shown.

2.3.1 Construction

Enclosure shall be constructed for convenient removal and replacement of contacts, coils, springs and control devices from the front without the removal of main power conductors or removal of major components.

2.3.2 Cleaning and Painting

Ferrous surfaces shall be cleaned and painted. Surfaces to be painted shall be free of all oil, grease, welding slag and spatter, mill scale, deleterious corrosion, dirt, and other foreign substances. Painting shall include at least one coat of rust-inhibiting primer and one coat of finish enamel. Rust-inhibiting primer shall be applied to a clean, dry surface as soon as practicable after cleaning. Painting shall be manufacturer's standard material and process, except the total dry film thickness shall be

not less than 2.5 mils. Color of the finish coat shall be the manufacturer's standard color. Finish shall be free from runs, sags, peeling or other defects.

2.4 SOURCE QUALITY CONTROL

2.4.1 ATS, MTS and Closing Tests

ATS and MTS shall be tested and rated to withstand and close in on an available fault or short-circuit current of 50,000 amperes, RMS symmetrical, at a power factor between 0.0 and approximately 0.20 for a duration of 10 cycles at a maximum voltage of 480 volts ac.

2.4.2 Dielectric Withstand Tests

UL 1008 Dielectric tests at 1960 volts, rms, minimum after the withstand current test.

2.4.3 Operational Tests

Perform test to demonstrate that the operational sequence of each ATS, MTS and BP/IS unit conforms to the requirements of the specifications with regard to operating transfer time, voltage, frequency, and timing intervals.

2.4.4 Non-welding of Contacts

UL 1008, Transfer switch shall be electrically operable to alternate source after the withstand current test.

2.4.5 Temperature Rise Test

UL 1008. Temperature rise tests after the overload and endurance tests to confirm the ability of the transfer switches to carry their rated current within the allowable temperature limits.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall conform to the requirements of NFPA 70 and manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

3.2.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations NFPA 70B, NETA ATS, and referenced ANSI standards. Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.2.1.1 Automatic Transfer

a. Visual and Mechanical Inspection

(1) Inspect for physical damage

(2) Compare nameplate information and connections to drawings and specifications.

(3) Check for proper anchorage and required area clearances

(4) Check tightness of all control and power connections

(5) Perform manual transfer operation

(6) Check blade alignment

(7) Confirm proper lubrication

(8) Check switch to ensure positive mechanical interlock between normal and alternate sources

(9) Ensure manual transfer warnings are attached and visible

(10) Check that all covers, barriers, and doors are secure

(11) Clean entire assembly using approved methods and materials

b. Electrical Tests

(1) Perform insulation-resistance tests phase-to-phase and phase-to-ground with switch in both source positions

(2) Perform a contact-resistance test across all main contacts and switch blades

(3) Verify settings and operation of control devices in accordance with the specifications

(4) Calibrate and test all relays and timers including voltage and frequency-sensing relays, in-phase monitor (synchronism check), engine start and cooldown timers, and transfer and retransfer timers

(5) Perform automatic transfer tests:

(a) Simulate loss of normal power

(b) Return to normal power

(c) Simulate loss of emergency power

(d) Simulate all forms of single-phase conditions

(6) Monitor and verify correct operation and timing of the following simulations:

(a) Normal voltage-sensing relays

(b) Time delay upon transfer

(c) Alternate voltage-sensing relays

(d) Automatic transfer operation

(e) Interlocks and limit switch function

(f) Time delay and retransfer upon normal power restoration

3.2.1.2 Manual Transfer

a. Visual and Mechanical Inspection

(1) Inspect for physical damage

(2) Compare nameplate information and connections to drawings and specifications.

(3) Check for proper anchorage and required area clearances

(4) Check tightness of all control and power connections

(5) Perform manual transfer operation

(6) Check blade alignment

(7) Confirm proper lubrication

(8) Check switch to ensure positive mechanical interlock between normal and alternate sources

(9) Ensure manual transfer warnings are attached and visible

(10) Check that all covers, barriers, and doors are secure

(11) Clean entire assembly using approved methods and materials

b. Electrical Tests

(1) Perform insulation-resistance tests phase-to-phase and phase-to-ground with switch in both source positions

(2) Perform a contact-resistance test across all main contacts and switch blades

(3) Verify settings and operation of control devices in accordance with the specifications

3.2.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times of checking and timing.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16445

SWITCHGEAR ASSEMBLIES

05/09

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM REQUIREMENTS
1.3 SUBMITTALS
1.4 OPERATION AND MAINTENANCE DATA REQUIREMENTS
1.5 DEFINITIONS
1.6 FACTORY TESTING
1.7 MANUFACTURER QUALIFICATIONS

PART 2 PRODUCTS

2.1 EQUIPMENT STANDARDS
2.2 CONSTRUCTION
2.2.1 Switchgear and Auxiliary Compartments
2.2.2 Compartment Details
2.2.3 Mimic Bus
2.2.4 Buses
2.2.5 Switchgear Assemblies
2.3 SWITCHGEAR COMPONENTS
2.3.1 Power Circuit Breakers
2.3.2 Molded-Case Circuit Breakers
2.3.3 Instruments and Instrument Transformers
2.3.4 Control-Power Circuit Overcurrent Protection
2.3.5 Control-Power Circuit Transfer Contactor
2.3.6 Service and Maintenance Devices
2.3.8 Protective Relays and Devices
2.3.8 Indicator Lights
2.4 CONTROL SYSTEMS
2.4.1 Sequence of Operation
2.4.1.1 Normal Configuration
2.4.1.2 Automatic Mode
2.4.1.3 Manual Mode
2.5 PROGRAMMABLE LOGIC CONTROLLER
2.6 SWITCHGEAR MONITORING AND CONTROL SYSTEMS
2.6.1 Switchgear Communications
2.7 EQUIPMENT FINISH
2.7.1 Equipment Finish (Protective Coatings)
2.7.2 Surface Preparation
2.7.3 Powder Coat
2.7.4 Final Coating
2.8 SPACE HEATERS
2.9 UNINTERRUPTIBLE POWER SUPPLY (UPS)
2.10 EXTERNAL VOLTAGE SOURCE

PART 3 EXECUTION

3.1 INSTALLATION
3.2 FACTORY TESTING
3.3 FIELD TESTING
3.4 RELAY SETTINGS AND TESTS
3.4.1 FIELD TESTING FOR COMMUNICATIONS (SMCS)
3.4.1.1 Field Quality Control
3.4.1.2 Field Testing
3.4.1.3 Manufacturer's Certification
3.4.1.4 Training
3.4.1.5 After Start-Up Support
3.5 ENERGIZING SWITCHGEAR ASSEMBLIES

-- End of Section Table of Contents --

SECTION 16445

SWITCHGEAR ASSEMBLIES
05/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C37.121	(1989) Unit Substation Requirements
ANSI C57.12.28	(1999) Pad-Mounted Equipment - Enclosure Integrity
ANSI C57.12.29	(1999) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

ASTM INTERNATIONAL (ASTM)

ASTM A 366/A 366M	(1999) Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev B; Am 1) Colors Used in Government Procurement

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61131-1	(1993) Programmable Controllers - part 3: Programming Languages

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3	(2000) Local Area Networks: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Same as ISO/IEC 8802-3
IEEE C2	(2007; Errata 2007; INT 2008) National Electrical Safety Code
IEEE C37.20.1	(2002; Addenda A 2005; Addenda B 2006; R 2007) Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE C37.90.1	(2002; Errata 2003; Errata 2004) Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

IEEE C57.12.90	(2006) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE Std 4	(1995) Standard Techniques for High Voltage Testing

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 3	(2005) Standard for Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Acceptance Testing Specifications

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Standard for Grounding and Bonding Equipment
UL 1558	(1999; Rev thru Mar 2006) Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

1.2 SYSTEM REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Certificate of Compliance shall be submitted showing communication system will communicate with existing Citect Software.

Equipment Foundation Data for switchgear assemblies shall include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

For the existing ECS switchgear #1 and ECS switchgear #2 in the ECS room the Contractor shall identify all control circuits leaving switchears and shall be responsible for re-connecting all active circuits to the new switchgears.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification. Submit these items together with the Section 16286, "Overcurrent Protective Devices" submittals which are referenced in this section.

SD-02 Shop Drawings

Connection diagrams shall be submitted indicating the relations

and connections of the following items by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Switchgear Assemblies
Buses
Switchgear Components including all control switches and auxiliary relays
Control-Power Circuit Transfer Contactor
Local/Remote Switch
Space Heaters
Programmable Logic Controller (PLC)
Sequence of Operation for all switchgear operational modes including Local Only, Remote-Automatic, and Remote-Manual functions.
Switchgear Monitoring and Control System hardware, software and interconnections

Fabrication drawings shall be submitted for the following items consisting of fabrication and assembly details to be performed in the factory.

Switchgear Assemblies
Enclosures
Buses
Switchgear Components including all control switches and auxiliary relays
Weatherproof Enclosures
Local/Remote Switch
Space Heaters

Installation Drawings shall be submitted for the switchgear assemblies in accordance with the paragraph entitled, "Installation," of this section. Drawings shall include complete details of equipment layout and design.

SD-03 Product Data

Equipment Foundation Data for switchgear assemblies shall be submitted in accordance with paragraph entitled, "System Requirements," of this section.

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

Switchgear Assemblies
Enclosures
Buses
Switchgear Components including all control switches and auxiliary relays
Weatherproof Enclosures
Local/Remote Switch
Control-Power Circuit Transfer Contactor
Equipment Finish
Space Heaters
Programmable Logic Controller (PLC)
Switchgear Monitoring and Control System (SMCS)hardware, software and interconnections

Touch Screen

SD-06 Test Reports

Test Reports shall be submitted for the following tests on switchgear assemblies in accordance with the paragraphs entitled, " Factory Testing" of this section. Switchgear assemblies shall not be energized until all recorded test data have been approved by the Contracting Officer.

Production Tests for switchgear:

Dielectric Tests
Relaying and metering circuit performance tests
Mechanical Operation Tests
Complete functional testing of the entire system
Grounding of Instrument Transformer Case Test
Electrical Operation and Control-Wiring Tests
Control Wiring Continuity Tests
Polarity Verification

Production Tests on transformers shall include:

Resistance measurements of windings
Ratio tests
Polarity and phase-rotation tests
No-load loss tests
Mechanical Operation Tests
Dielectric tests

Field test reports shall be submitted for the following tests on switchgear assemblies in accordance with the paragraphs entitled, " Field Testing" and "Relay Settings and Tests," of this section.

Electrical Acceptance Tests

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for the Switchgear Assemblies including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards, safety precautions, and installation instructions.

SD-10 Operation and Maintenance Data

Provide seven bound Operating and Maintenance Manuals for each switchgear assembly. The manual shall include the following data:

Relays
Breakers
Trip units
Contactors
Control switches
Metering
Spare parts list
As-built schematics
As-built wiring diagrams
As-built one-line diagram

Switchgear Operation Procedures
Programmable Logic Controller (PLC)
Touch Screen

Provide six (6) bound copies of the Switchgear Monitoring and Control System (SMCS) for the switchgear assembly as follows:

Complete system description
Maintenance section including all instruction leaflets and technical data
Two Original Licensed Copies of all software manuals
All software programs
Device address listing
Software data files
Function block program listing
All application software screens
Detailed startup report, including a list of customer trained individuals
List of Programming and monitoring software and hardware

1.4 OPERATION AND MAINTENANCE DATA REQUIREMENTS

Operation and maintenance manuals for for each switchgear assembly shall include the following:

a. Instruction manuals for each device, including but not limited to, relays, breakers, trip units, contactors, control switches metering, touch screen, spare parts list, and Programmable Logic Controller (PLC), furnished in the switchgear.

b. Maintenance manuals for each device, including but not limited to, relays, breakers, trip units, contactors, control switches metering, touch screen, and Programmable Logic Controller (PLC), furnished in the switchgear.

c. Final as-built schematics, as-built one-line diagram and as-built wiring diagrams (full point to point including wiring tags)for the switchgear.

d. Integral Switchgear operation procedures detailing all switching modes including, but not limited to, loss of power source, loss of PLC, loss of touch pad.

Operation and maintenance manuals for switchgear Monitoring and Control System (SMCS) shall include the following:

a. Instruction manuals for each device, including but not limited to, Complete system description, all instruction leaflets and technical data, Two Original Licensed Copies of all software manuals, All software programs, function block program listing, Device address listing, Software data files, all application software screens, detailed startup report including a list of customer trained individuals, and List of Programming and monitoring software and hardware

1.5 DEFINITIONS

KSC Complex Control System (KCCS) is the KSC SCADA system that is currently in operation.

1.6 FACTORY TESTING

Factory tests on transformers and switchgear assemblies shall be made in accordance with the applicable provisions of the referenced standards.

Tests on transformers shall include resistance measurements of windings, ratio tests, polarity and phase-rotation tests, no-load loss tests at rated voltage, excitation current at rated voltage, impedance voltage and load-loss at rated current, Mechanical Operation Tests, and dielectric tests. Tests shall be conducted in accordance with IEEE C57.12.90.

Tests on switchgear assemblies shall include polarity verification, grounding of instrument transformer case test, mechanical operation tests, electrical operation and control-wiring tests, complete functional testing of the entire system, control wiring insulation tests, relaying and metering circuit performance tests, control wiring continuity tests, and dielectric tests. Tests shall be conducted in accordance with IEEE Std 4.

1.7 MANUFACTURER QUALIFICATIONS

Material and equipment to be provided under this specification shall be the standard catalog product of a manufacturer regularly engaged in the manufacture of switchgear assemblies and their component parts and equipment as specified herein. Equipment shall be of the latest standard design for indoor or outdoor service as indicated, and shall have been in repetitive manufacture for at least 150 units.

PART 2 PRODUCTS

2.1 EQUIPMENT STANDARDS

Switchgear assemblies shall conform to IEEE C37.20.1 and UL 1558.

2.2 CONSTRUCTION

2.2.1 Switchgear and Auxiliary Compartments

Switchgear assemblies and auxiliary equipment shall be stationary mounted in self-supporting, self-contained, sheet metal enclosures with front-hinged doors and hinged rear covers, lockable with Owner-furnished padlocks. Sheet metal compartments shall be joined together to form a continuous structure. Sheet metal barriers, enclosures, and external covers and doors shall be constructed from cold-rolled carbon-steel sheets of commercial quality not less than 14-gage, with stretcher-level flatness in accordance with ASTM A 366/A 366M.

Unit sheet metal shall enclose one or more vertically mounted power circuit breakers or auxiliary equipment in individual sheet metal compartments and a full height rear compartment. Housing shall be approximately 90 inches high with individual ventilated front- and rear-hinged panels and bolted top covers. Rear compartment shall contain the main bus, main bus-tap connections, cable connections, and instrument transformers.

2.2.2 Compartment Details

Compartments shall be completely wired with cable terminals, cable clamps, control bus, control power switch, and terminal blocks. Terminal blocks shall be readily accessible for the external connections of metal-enclosed

switchgear.

Low voltage wiring for controls, metering, relaying and accessories shall be run to terminal blocks.

All switchgear components, including but not limited to fuse blocks, pushbuttons, selector switches , indicating lights and terminal blocks, shall have a unique designation by cell, (ie: 1A, 1B, 2A, 2B, this would be cell 1 device A, cell 1 device B etc.). A label with minimum 1/4" high lettering with the device designation shall identify the device. Wiring between sections/cubicles shall identify the end devices by "section/cubicle number and device designation.

Terminal blocks shall have engraved plastic terminal strips with screw type terminals having letter designations and numbered terminal points. Terminal blocks in each section / cubicle used for the same wiring as the adjacent sections / cubicles shall have the same letter designation preceded by the section /cubicle number. Terminal blocks associated with current transformers shall be short-circuiting type. Terminal blocks with sliding links will not be allowed. Terminal blocks for multi-ratio current transformers shall be wired with all taps and ground, one terminal block per current transformer. Wiring shall be SIS Class insulation, sized #12 AWG at the 120/240V panel with 20 amp breakers; #14 AWG for control, #12 AWG for potential leads, and #10 AWG for current leads. Terminate all current conductors with compression ring terminal lugs and control and potential conductors with compression forked (with tabs) terminal lugs. Male/female spade connectors shall not be used. Final conductor leads for terminations on the switchgear heaters shall be a minimum of 150 degrees high temperature wiring.

Wire marking for controls, metering, relaying and accessories conductors shall be at each end. Wire markers shall be white plastic tubing heat stamped with black block type letters. All wire markers shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached, as well as the terminal number to which the wire is directly attached (near end/far end marking).

An identification plate engraved with circuit and function designations shall identify each compartment of the switchgear assembly.

Removable elements of the same type and rating in the switchgear assembly shall be physically and electrically interchangeable in corresponding compartments. Front-hinged panel shall be suitable for mounting instruments, relays, control switches, and indicating lamps.

Barriers between a sectionalized bus with bus sectionalizing breakers in a compartment shall be sheet steel not less than 11 gage. Other covers, barriers, panels, and doors shall be not less than 14 gage.

Each compartment shall be reinforced with structural members and welded or bolted together. Welds shall be ground to a smooth flat surface before painting.

2.2.3 Mimic Bus

Provide mimic bus using 3/32-inch red plastic laminate. Mimic bus shall show breakers and bus. Fasten to switchgear using stainless steel screws.

2.2.4 Buses

Switchgear assemblies shall be completely bussed utilizing electrical grade, high conductivity, solid copper bus bar having a rectangular cross section. Main, riser and bus tap connections shall be uniformly positioned and phase sequenced in accordance with IEEE C37.20.1. Busses shall be supported and braced to withstand both electrically and mechanically the required short circuit current ratings, but shall not be less than 65,000 amperes symmetrical.

Termination and connection points of all bus bar used in the switchgear shall be silver plated by an electroplating process. Silver coating methods that do not use the flow of electrical current as part of the process shall not be acceptable. After plating, the contact surface shall not be sanded or otherwise abraded, but shall be cleaned immediately prior to final assembly.

All bus bar connections shall be made using silicon bronze or Grade 5 steel bolts with wide flat silicon bronze or Grade 5 steel washers under the bolt head and nut. These connections shall be tightened and checked by use of a calibrated torque wrench. Other connection designs may be used with the written approval of the Contracting Officer.

Main bus shall be readily accessible for connection of future switchgear assemblies at either end. Main and auxiliary control drawout type connections shall be silver-to-silver contact, positive pressure, self-aligning, with enclosure-to-enclosure stationary mechanism when breaker is in drawout position.

Voltage rating and insulation level of switchgear assemblies shall conform to IEEE C37.20.1.

Temperature limits for buses and bus-tap connections in switchgear assemblies shall be in accordance with IEEE C37.20.1.

A continuous rigid copper ground bus shall extend throughout the entire assembly and shall ground the stationary structure and equipment. Ground bus shall be capable of carrying the rated short circuit current of the protective devices in the switchgear assembly for a minimum period of 30 cycles.

Enclosures shall be completely bused with an insulated solid rigid copper bus bar of rectangular cross section. Bus bar and connections shall be uniformly positioned and phase sequenced within the enclosure for adaptation to metal-enclosed switchgear assemblies in accordance with IEEE C37.20.1.

Bus bar shall be supported and braced to withstand short-circuit stresses with momentary current ratings, in accordance with IEEE C37.20.1. Contact surfaces of all bus connections shall be silverplated and bolted together to ensure maximum conductivity. Voltage and current ratings shall conform to IEEE C37.20.1.

Insulating supports shall consist of track-resistant, flame-retardant IEEE Class 130 electrical insulating materials. Voltage rating and insulation level shall conform to IEEE C37.20.1.

Sheet metal weatherproof enclosures shall be constructed from carbon steel sheets of commercial quality, not less than 14 gage. Each section shall be

reinforced with structural members and bolted together. Complete assembly shall be structurally supported as indicated.

2.2.5 Switchgear Assemblies

General arrangement of the number of compartments and each compartment's components shall be as shown.

Bus sectionalizing switchgear compartments shall include a metal-enclosed low-voltage power circuit breaker.

Switchgear compartments shall include the following equipment:

Metal-enclosed low-voltage power circuit breaker
Provisions for terminating cables of the metal-enclosed bus

Auxiliary station power compartments shall include the following:

Control-power transformer and primary fuses
Circuit overload protection

Auxiliary metering compartments shall include the following:

Current transformers
Potential transformers
Multi-function meters

Auxiliary bus sectionalizing compartments shall include the following:

A contact for automatic transfer of control power
Auxiliary control devices
Programmable Logic Controller

Switchgear compartments for future use shall be fully equipped to receive the removable element with complete bus connections, disconnecting devices, rails, and cell interlocks.

Filler compartments incidental to the switchgear assembly shall be empty compartments with bolted cover plates.

Main and feeder power circuit breakers shall be suitable for fully rated nonselective trip systems in accordance with ANSI C37.121.

2.3 SWITCHGEAR COMPONENTS

2.3.1 Power Circuit Breakers

All switchgear, main, and feeder breakers shall be power circuit breakers. Circuit breakers shall conform to Section 16286, "Overcurrent Protective Devices."

2.3.2 Molded-Case Circuit Breakers

Molded-case circuit breakers shall conform to Section 16286, "Overcurrent Protective Devices."

2.3.3 Instruments and Instrument Transformers

Indicating instruments, protective relays, current and potential

transformers, instrument transfer switches, and control-power transformers shall conform to the applicable requirements of Section 16286, "Overcurrent Protective Devices."

2.3.4 Control-Power Circuit Overcurrent Protection

Branch-circuit breakers shall provide circuit overload protection to compartment heater, lights, convenience outlets, transformer fans, and other devices.

2.3.5 Control-Power Circuit Transfer Contactor

Contactor for automatic transfer of control-power shall be designed for 120/240-volt, single-phase, 60-Hz service with current rating. Contactor shall be the open type, two-pole, double-throw with solid neutral connections and shall automatically transfer its load circuits to the alternate power supply upon loss of power in the normal supply. Device shall be electrically operated and electrically held and shall obtain its operating current from the source to which the load is transferred. Contactors for automatic transfer of control power shall be suitable for installation in metal-enclosed switchgear. Provide two extra normally-open and two extra normally-closed contacts. One contact shall be wired to the PLC for control power indication and one contact shall be wired for the local control power light.

2.3.6 Service and Maintenance Devices

Following service and maintenance devices shall be included as a part of the switchgear:

A manual handle for operating the air and power circuit breaker isolating mechanism

Removable manual maintenance closing devices for air and power circuit breakers

Facilities for operating air and power circuit breakers in the test or removed position

Facilities for withdrawing air and power circuit breakers for inspection or maintenance

Test plugs and cable for meters and relays

2.3.8 Protective Relays and Devices

Protective relays and devices shall comply with Section 16286, "Overcurrent Protective Devices."

2.3.8 Indicator Lights

Indicator lights shall comply with Section 16286, "Overcurrent Protective Devices". The light colors shall be as follows:

Function	Color
Breaker Open	Green
Breaker Closed	Red
Power On	white - (Control Power)
Auto Mode	Blue

Function	Color
Manual Mode	White
Auto Lockout	Amber

2.4 CONTROL SYSTEMS

All breakers shall be electrically operated.

Main secondary breaker section shall include undervoltage and phase-sequence relays with adjustable time-delay.

A Control-Power Circuit Transfer Contactor shall be provided for the automatic transfer of control power. Each of the control power transformers shall be capable of furnishing power through the selective contactor for the main breakers, feeder breakers, compartment heaters, interior lighting, utility outlets, battery chargers, power meters, PLC, and other miscellaneous equipment. An external UPS power will supply power to the power meters, trip units, PLC, Touch Screen, and a receptacle in the controls compartment for the communications equipment such as the Ethernet hub and media converter. The receptacle on UPS power shall be clearly marked "UPS POWER" using a laminated plastic nameplate having 3/16-inch high black letters on a white background.

All automatic control functions shall be accomplished using a Programmable Logic Controller (PLC). During maintenance or operations that require the PLC to be taken off-line, breakers shall remain in the last state.

All timing and control shall be performed using the Programmable Logic Controller (PLC). Auxiliary relays shall only be used where breaker circuit loads exceed the rating of the PLC outputs. Auxiliary relays shall only be used to directly connect only one breaker circuit and shall provide no relay logic or timing functions. Auxiliary relays shall be plug-in type relay with tubular terminals rated for 120 volt AC operation with vibration-resistant 10 ampere output contacts. Relay shall have pilot light and retainer clips. Bases shall be octal, single tier with screw terminals.

The switchgear control shall be designed to open the main breaker on loss of power and provide automatic re-transfer on source return after an adjustable time period. The re-transfer operation shall be open transition, selectable from a video control/touch screen.

The touch screen controls shall allow the user to select operating modes and initiate the appropriate changes to the PLC logic to allow the selection. The touch screen controls shall also allow the user to change the time delays for the transfer scheme. These changes shall not require the use of other equipment such as a laptop computer or additional PLC programming software. Touch screen controls for operating breakers shall require two step command, the first to initiate command and the second to confirm command.

The Touch Screen shall be as follows:

1- Touch screen display shall be impact and scratch resistant.
2- Color CRT with greater than or equal to 9 inch screen size.
3- Screen lockout for cleaning.
4- Field replaceable display that is capabile of being replaced while in service.
5- One spare display shall be provided with each install.

6- Touch screen communication functions shall have integrated PLC drivers for direct serial connection to PLC controller.
7- Simultaneous communication to multiple PLC's.
8- Dual serial ports.
9- Windows based configuration software.
10- Support for third party graphics.
11- Dynamic object based graphics
12- Bitmap graphics.
13- Software manuals
14- Users manuals
15- Interface cables

2.4.1 Sequence of Operation

Sequence of operation for the transfer scheme of the switchgear shall be as follows. Each switchgear shall have two operating modes: Automatic and Manual. The Local/Remote switch and command from KCCS to the PLC program shall determine the mode. Breakers shall remain in last state when mode is changed except when going to the automatic mode. Only controls under the current mode shall have any control capability over the breakers. Overcurrent and undervoltage feature will not be defeated in any mode.

2.4.1.1 Normal Configuration

The normal configuration for each switchgear is with the main breaker in the closed position and the PLC program in automatic mode.

2.4.1.2 Automatic Mode

This mode is designed as the normal configuration for the switchgear and gives the PLC at the switchgear complete and autonomous control of the switchgear. The PLC program shall be controlled by KCCS to allow KCCS to take control of the switchgear remotely through an Ethernet connection to the PLC by enabling or disabling the automatic mode control feature. An indicator light visually seen on the front of the switchgear shall illuminate while in the automatic mode.

If KCCS has enabled the automatic mode control feature the breakers will remain in their current positions unless the following situation occurs:

1) Loss of source feeder:

a) If the multifunction relay (relays 27, 47, 59, 81) for main A detects phase voltage imbalance, loss of voltage, undervoltage, overvoltage or frequency, for a period adjustable from 5 to 120 seconds initially set at 10 seconds, the corresponding main breaker shall open.

b) If the voltage returns to the main of the switchgear for a period adjustable from 1 to 120 seconds initially set at 60 seconds,then the substation will automatically re-close the main breaker.

2.4.1.3 Manual Mode

This mode is designed to bypass the automatic features provided in the automatic mode. The KCCS operator shall have the ability to toggle the substation in and out of manual mode. An indicator light visually seen on the front of the switchgear shall illuminate while in the manual mode.

In manual mode the substation does not shunt trip the main if an under voltage is detected by the UV relay. Normal mode of operation is automatic mode.

A discrete indication shall be sent to KCCS via a set of contacts.

2.5 PROGRAMMABLE LOGIC CONTROLLER

The Programmable Logic Controller (PLC) shall be a Modicon Quantum PLC. It shall be programmed in accordance with IEC 61131-1 in function block format and shall provide timer, counter and relay logic functions for automatic transfer control. The PLC shall be programmed using an IBM compatible Personal Computer and Windows-based graphic software (Concept version 2.5). The PLC shall be powered from the 120-volt UPS power via the control power. The PLC memory shall be maintained by battery such that the memory shall not be lost on loss of power.

The control function of this system will be considered a critical system. KCCS shall be used as a redundant control system. The PLC shall be UL 508 listed. Provide a documented copy of the function block program in both paper and electronic media format.

The PLC system shall be complete and fully functional. All devices, components, programming, materials, and other work necessary to form a complete, maintainable, and operable system shall be supplied at no additional cost to Government.

After the program is loaded the processor shall have a minimum of 20 percent spare memory installed.

A means to prevent unauthorized or unintended alteration of read-write memory shall be provided. This may be DIP switches, jumpers, or selector switches. There shall be nothing to prevent authorized Space Center or third party Government personnel from changing any part of the program at any time after acceptance of the system.

The processor shall contain a battery for the purpose of retaining program memory in the event of a loss of AC power. This battery shall have the capability of retaining memory for a minimum of 1000 hours and shall be capable of being replaced without interruption or degradation of the memory. Visual indication of backup battery status shall be provided. Visual indication and alarm in the event of low battery voltage shall be provided before battery failure. The low battery alarm shall trigger a general alarm condition to the diagnostic system.

PLC shall have discrete multiple program and data file structures. The processor shall have not less than thirty two (32) bit math functions to include addition, subtraction, multiplication, division, equality, greater than, and less than using signed, double precision, and floating point numbers.

The status of latch relays and one-shots, and all data from timers, counters, and math functions, shall be retained during any power outage.

The processor shall have LED indicators to indicate:

1) that the processor is scanning memory, reading inputs, and controlling outputs,

2) that a processor fault exists, and 3) that the battery is charged and capable of supporting processor memory.

The processor shall be capable of the following modes of operation:

a) Run (outputs enabled, programming protected)
b) Halt or Program (outputs disabled, programming allowed)
c) Run/Program (on-line programming allowed while running)
d) Disable Outputs or Test (outputs disabled, inputs enabled)

The processor shall have an RS-232C or RS-422 port for communication with computers, message displays, and other serial devices.

The controller, including output devices, shall provide for an orderly shut down and alarm in the event of disruption of program execution or scan, loss of logic power, loss of communication between controller and essential devices, or memory error. All output devices shall have an option to disable all outputs or hold all outputs in the last state in the event of a shut down alarm.

Fault checking shall include, as a minimum, the following:

User memory check sum
Loss of logic power
Executive memory check
I/O fault check
Watchdog timer

The processor shall have a battery-backed real-time clock/calendar so that events may be logged and operations changed by the time of day and the day of the week. The clock/calendar shall keep track of seconds, minutes, hours, day of the week, day of the month, month, and year. The clock shall compensate for leap years and shall be accurate to less than one second per day at 25 degrees C.

The processor power supply shall have an LED to indicate that the power supply voltages are within tolerances. The processor power supply shall provide all DC power necessary to operate the processor and the I/O modules. The power supply shall be designed for 115 VAC plus/minus 10 percent or 230 VAC plus/minus 10 percent, at 57-63 Hertz. Transient and harmonic electromagnetic interference shall not damage or cause malfunctions of the semiconductor memory or other electronic components. All electronic equipment shall function properly when subjected to typical industrial plant ambient electrical noise.

The outputs of the PLC controlling circuit breakers shall be located on separate modules (each main breaker shall be controlled from a separate output module). Chassis or racks for mounting all types of input and output modules shall be provided. A simple means shall be provided for removing and inserting the modules into the rack. Racks shall provide a means of assuring that all modules stay firmly in place.

Light emitting diodes shall provide a visual indication of the status of all-digital inputs and outputs.

Field voltages and currents shall be electrically isolated from processor voltages and currents. I/O modules shall be designed to operate in harsh industrial environments and shall meet the Surge Withstand Capability of

IEEE C37.90.1.

The available I/O modules shall include, as a minimum, the following:

Digital AC/DC input modules, 230/120/24-48/12/5 VAC/DC
Digital AC output modules, 230/120 VAC
Digital DC output modules, 48/24/12/5 --DC sink or source
Digital DC output modules, 120 VDC
Analog input modules, 12-bit resolution
Analog output modules, 12-bit resolution'
ASCII Communication Module
High Speed Local Area Network Module (if not integral to the processor)

Provide a minimum of ten user defined inputs, wired to an accessible terminal strip. Provide fused terminals from control power source to be used as source for inputs.

The I/O modules shall plug into a rack and shall be designed for removal/replacement without removal of field wiring connections.

Racks or modules shall have a terminal marking area that allows wiring references to be written next to each terminal screw.

Racks or modules shall have 300 volt field wiring terminals, with captive hardware that is able to accept two 14 AWG wires, for field wiring connections.

Sink type input modules shall be used. Sourced output modules shall be used.

Spare I/O slots shall be provided for expansion of a minimum of 20% inputs and 20% outputs above the system's initial requirements.

The PLC system shall be an industrial-hardened hardware platform that is designed to withstand the vibrations, thermal extremes, and electrical noise associated with harsh industrial environments.

The programmable controller system shall be capable of operating in ambient temperature of 0 to 60 degrees C (32 to 140 degrees F.)

The programmable controller system shall be capable of operating in a relative humidity of 5 to 95 percent, without condensing.

The programmable controller system shall be capable of operating with the following vibrations: 1 g @ 57-2000 Hz with shock of +/-15g peak, 11 ms half-sine wave.

The processor shall be designed to operate in harsh industrial environments and shall meet the Surge Withstand Capability of IEEE C37.90.1. Unit shall also meet NEMA ICS 3.

The programmable controller shall be physically shielded from all devices with rectifiers including uninterruptible power supplies (UPS).

The programmable controller shall be capable of communicating all registers to KCCS via an Ethernet connection using MODBUS via TCP/IP (Citect standard Modnet Driver). The Manufacturer shall provide, in writing that the communications system provided under this project will communicate efficiently with the Citect software. The local representative to contact

for questions about communications is Scott Mack of CI-Technologies, Phone: (704) 329-3838, FAX (704) 329-3839

Provide two licensed copies of all software and all hardware necessary to modify and download the program for the programmable controller.

2.6 SWITCHGEAR MONITORING AND CONTROL SYSTEMS

Provide a complete switchgear Monitoring and Control System (SMCS) as described in this specification. This system is defined to include, but not to be limited to, a programmable logic controller (PLC) that monitors and controls remote devices, the trip units, power meters, touch screen, device communication interface hardware, intercommunication wiring, software, startup and training services, and ongoing technical support. This system shall comply with the applicable portions of IEEE 802.3. Provide two licensed copies of all software and all hardware necessary to modify and dowload the program fo the touch screen.

The following KCCS points for indication and control shall be inputs and outputs from the PLC:

KCCS Inputs for Indication
- Secondary voltage monitors (discrete)
- Main circuit breakers status open/close (discrete)
- Automatic/Manual status (discrete)
- Trip lockout indications on all electrically operated breakers (discrete)
- All feeder breakers status open/close (discrete)
- Normal Configuration (discrete)
- Internal Status registers of the PLC (Communication via Ethernet connection TCP\IP or connection with Modicon Quantum PLC)
- Breaker connected status (discrete)

KCCS Outputs for Control
- Main circuit breakers open/close (discrete)
- All electrically operated feeder breakers open/close (discrete)
- Automatic/Manual transfer control function

2.6.1 Switchgear Communications

The switchgear shall be wired with Cat 5E cable and capable of supporting the following communications. Provide a minimum six port Ethernet hub at the switchgear for communication to the following:

1. TCP/IP Modbus connection to switchgear PLC

2. TCP/IP Modbus connection to each Square D Power Logic CM-4000 meter via ECC module.

3. TCP/IP Modbus connection to a media converter.

4. TCP/IP Modbus connection to the trip unit interface.

2.7 EQUIPMENT FINISH

2.7.1 Equipment Finish (Protective Coatings)

Adequate consideration shall be given to the intended location of equipment and materials and to continuous exposure to the KSC corrosive environment.

The equipment finish shall meet the requirement of ANSI C57.12.28 and ANSI C57.12.29. There will not exist any holidays, sags, pinholes, blistering, solvent popping or rust as part of the finish. The finish will be smooth and even, resistant to corrosion, sunlight and abrasion resistant with a high impact strength.

2.7.2 Surface Preparation

Steel parts shall be free of weld slag and mill scale. The switchgear enclosure shall be chemically cleaned, rinsed, phosphate coated, rinsed, and deionized in preparation for the powder coat.

2.7.3 Powder Coat

The switchgear enclosure shall be coated with a corrosion resistant thermosetting polyester coating applied by electrostatic powder spray. The applied coating shall be uniform and pinhole free with a minimum of 2.5 mils.

2.7.4 Final Coating

Following the application and cure of the powder coat and the manufacturing assembly of the switchgear enclosure, the switchgear enclosure shall be coated with a silicone enamel as a final coating. This coating shall be free from surface defects with a 1.5 mil minimum dry film thickness. The color of the final coating shall be No. 70 light gray in accordance with FED-STD-595.

In addition for NEMA 3R weatherproof enclosures, after the final coating, on the bottom and the bottom 6-inches of the switchgear enclosure, a rubberized or coal tar protective coating at least 1/32-inch thick shall be applied on top of the final coating.

2.8 SPACE HEATERS

Each section of the switchgear assembly shall be equipped with externally energized space heaters to provide approximately 4 watts per square foot of outer surface area. Heaters shall be such that the power density does not exceed 4 watts per square inch of heater element surface. Heaters shall be rated at 240 volts for connection to 120 volts. Heaters shall be located at the lowest portion of each space to be heated. Terminals shall be covered. Thermostats shall be used to regulate the temperature.

All heaters shall be installed and operable at the time of shipment so that the heaters can be operated immediately upon arrival at the site, during storage, or before installation. Connection locations shall be marked prominently on drawings and shipping covers and shall have temporary leads for storage operation. Leads shall be easily accessible without having to remove shipping protection. Wiring shall by type TFE.

The Government shall label and secure all control wiring connecting to the Switchgear. The Contractor shall provide new terminal strips, if required, inside the top of the switchgear. The Government shall connect the existing external control wiring to the terminal strips. If new terminal strips are required, Contractor shall connect wiring internal to switchgear to terminal strips.

2.9 UNINTERRUPTIBLE POWER SUPPLY (UPS)

An existing external Uninterruptible Power Supply (UPS) system will be available to power the PLC, digital trip units, meters, Ethernet hub, media converter, touch screen display, and any other loads required on the UPS. The substation needs to be wired to accept the external UPS source.

2.10 EXTERNAL VOLTAGE SOURCE

All externally powered wiring shall be grouped together as much as possible and connected to a terminal block which shall be marked with a laminated plastic nameplate having 3/16-inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

Externally powered wiring will include 120-volt unit space heaters.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall conform to IEEE C2 and NFPA 70.

Complete assembly shall be electrically and mechanically connected together at the site from coordinated subassemblies shipped in complete sections from the manufacturer. Installation shall be carefully aligned, leveled, and secured to the foundation and shall conform to the manufacturer's recommendations.

Noncurrent carrying parts and enclosures of the switchgear shall be bonded together and grounded to the ground grid with a maximum resistance to ground of 20 ohms. Ground connections shall be exothermically welded in accordance with UL 467. Minimum size of ground conductor shall be 4/0 AWG.

Switchgear assemblies separated for shipping shall be carefully joined to present a neat appearance, and main and ground bus joints shall be tight. Assemblies shall be handled with lifting devices.

Installation Drawings shall be submitted for the switchgear assemblies. Drawings shall include complete details of equipment layout and design.

3.2 FACTORY TESTING

Factory witness testing (source inspection) at Government's option, shall take place at vendor's facility for switchgears, automatic transfer switches, circuit breakers and transformers.

3.3 FIELD TESTING

The switchgear manufacturer shall provide the test equipment, labor and technical expertise for testing and checkout of the switchgear assembly as a connected system. The manufacturer shall provide written test results for all tests performed. Submit test reports to the Contracting Officer prior to energizing equipment. Any material, equipment or devices found to be defective shall be replaced at no cost to the Government. All electrical acceptance tests of transformers, switchgear, breakers, relaying, metering and all related material shall be done in accordance with NETA ATS to include secondary current injection tests and

manufacturers recommendations. The Contractor shall submit a testing procedure 30 days prior to field testing. The testing procedure shall evaluate the functionality and performance of all control and automatic sequencing and operation of the switchgear.

Testing in addition to those described in NETA ATS shall be as follows:

1. Demonstrate switchgear automatic mode, timing functions, and interlocks for main as specified.

2. Remove all controls and UPS power form PLC/PC and verify when power is restored, programming automatically recovers with no anomalies. This test shall ensure fully functional programming is restored and ready to operation on restoration of power to PLC/PC. Perform this test three separate times.

3. Demonstrate UPS voltage automatic transfer relay and components function properly.

4. Demonstrate control voltage automatic transfer relay and components function properly.

5. Functionally verify SMCS system through the Ethernet connection is fully operational and all I/O functions are as specified.

Final acceptance shall depend upon the satisfactory performance of the equipment under test.

3.4 RELAY SETTINGS AND TESTS

All circuit-interrupting devices shall be properly coordinated before the switchgear assemblies are energized. Protective relays shall be thoroughly inspected and adjusted at the site in the presence of and at the discretion of the Contracting Officer.

3.4.1 FIELD TESTING FOR COMMUNICATIONS (SMCS)

3.4.1.1 Field Quality Control

Furnish the services of a manufacturer's representative to assist in starting-up and programming the system. The manufacturer's representative shall be factory-trained and shall have a thorough knowledge of the software, hardware, and system programming. The manufacturer's representative shall provide the following services:

1. Perform full functionality tests on the communications network from all IED's to the Ethernet gateway.
2. Setting all the addresses of all devices in the equipment
3. Verifying and troubleshooting the integrity of the data line.
4. Assisting the owner in correcting any data line problems
5. Configure the SMCS software to match the field devices.

3.4.1.2 Field Testing

Verify complete system operation including all hardware, software and communication devices. Verify networking performance with all interfacing systems by other manufacturers.

3.4.1.3 Manufacturer's Certification

A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

3.4.1.4 Training

Furnish the services of manufacturer representatives to train the owner's personnel in operation and programming of the system. The manufacturer representatives shall be factory-trained and shall have a thorough knowledge of the switchgear, PLC and touchscreen software, hardware and system programming. The training session on the PLC and all controls shall include:

1. Switchgear on-site training
   a) Full operation demonstrations of all functions.
   b) Breaker electrical and mechanical operations.
   c) Explanations and instructions for all protective devices.

2. Classroom on-site training for programming the touch screen.

3.4.1.5 After Start-Up Support

The manufacturer shall provide a 24-hour 800 telephone number manned with Engineers/Technicians expert in SMCS devices, software and communication system troubleshooting or capable of providing technical information. This support shall be provided at no cost to the Owner for a period of five years.

3.5 ENERGIZING SWITCHGEAR ASSEMBLIES

Switchgear assembly shall not be energized until it is completely installed, tested, approved by the Contracting Officer, and ready for operation. Site testing shall have been approved by the Contracting Officer.

Using ammeter, voltmeter, and wattmeter or phase-angle meter, the values and polarities of voltage and current shall be measured and compared with those expected in the various relay circuits. Contact positions of directional elements and the voltage relays shall be inspected and noted.

After inspection and satisfactory tests have been completed on all active relay circuits under a no-load condition, each relay shall be given an operational test with diverted load currents or simulated ground faults.

A report shall be prepared with records of connections, electrical constants, settings, test values (expected versus actual), operating performance, and failures or weaknesses found on test.

Tests and procedures for testing shall be in accordance with paragraph entitled "Field Testing" in this section and the manufacturer's recommendations. Upon completion of all testing and approval of the Contracting Officer, the switchgear shall be energized, as approved by the Contracting Officer.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16446

PANELBOARDS

04/09

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL REQUIREMENTS
1.3 SUBMITTALS

PART 2 PRODUCTS

2.1 PANELBOARDS
2.2 CIRCUIT BREAKERS
2.3 DIRECTORY CARD AND HOLDER
2.4 FACTORY TESTING
2.5 PRECAUTIONARY LABEL

PART 3 EXECUTION

3.1 INSTALLATION
3.2 SITE TESTING

-- End of Section Table of Contents --

SECTION 16446

PANELBOARDS
04/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD 595	(Rev B) Colors Used in Government Procurement

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA PB 1	(2006; Errata 2008) Standard for Panelboards

UNDERWRITERS LABORATORIES (UL)

UL 67	(1993; 11th Ed) Panelboards

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Detail Drawings shall be submitted for the panelboards consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents. Drawings shall include details of bus layout.

Outline Drawings for panelboards shall indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Detail Drawings and Outline Drawings shall be submitted for panelboards in accordance with paragraph entitled, "General Requirements," of this section.

SD-03 Product Data

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

Panelboards
Directory Card and Holder

SD-04 Samples

Keys shall then be properly tagged and delivered to the Contracting Officer.

SD-06 Test Reports

Test reports shall be submitted for the following tests in accordance with the paragraph entitled, "Site Testing," of this section. Panelboards shall not be energized until the recorded test data have been submitted to and approved by the Contracting Officer.

Continuity Tests
Insulation Tests

SD-07 Certificates

Statements shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for Panelboards 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 PANELBOARDS

Power-distribution panelboards and lighting and appliance branch-circuit panelboards shall be totally enclosed in a steel cabinet, dead-front circuit breaker type with copper buses, surface- or flush-mounted as indicated. Panelboards shall conform to NEMA PB 1 and NEMA AB 1. Branch circuit panels shall have buses fabricated for bolt-on type circuit breakers.

An outer door or cover, hinged on one side, shall be provided on surface-mounted panelboards to provide gutter space access. A center door shall be provided for circuit breaker/switch access only.

Voltage and current rating, number of phases, and number of wires shall be as indicated. Four-wire distribution panelboards and lighting and

appliance branch-circuit panelboards shall be provided with an isolated full-capacity neutral bus. Panelboards shall be rated for 240-volt (maximum), single-phase, 120/208-volt, three-phase, and 277/480-volt, three-phase, 60-hertz current as indicated.

Three-phase, 4-wire and single-phase, 3-wire distribution lighting and branch circuit panelboards shall be provided with an isolated full-capacity bus providing spaces for single-pole circuit breakers/switches and spaces indicated as spare.

Panelboards shall be provided with a separate grounding bus bonded to the enclosure. Grounding bus shall be a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.

Each panelboard, as a complete unit, shall have a short-circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or as indicated. Series rating is not allowed.

Panelboards and main lugs or main breaker shall have current ratings as shown on the panelboard schedule.

Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Single-phase, three-wire panelboard busing shall be such that when any two adjacent single-pole breakers are connected to opposite phases, two-pole breakers can be installed in any location. Three-phase, four-wire busing shall be such that when any three adjacent single-pole breakers are individually connected to each of the three different phases, two- or three-pole breakers can be installed at any location. Current-carrying parts of the bus assembly shall be plated. Mains ratings shall be as shown.

Mechanical lugs furnished with panelboards shall be cast copper or copper alloys of sizes suitable for the conductors indicated to be connected thereto.

Panelboard box shall be galvanized rust-resistant code-gage sheet steel without knockouts. Entire panelboard front shall be hinged on one side with a piano hinge for the full height and shall also have captive screws opposite the hinged side. Where panelboards are installed flush with the walls, the installation details shall be such that the hinged front can be opened without damage to the adjacent wall surfaces. Provide 6-inch by 1-1/2 inch steel locking hasp on the opposite side from the hinge for padlocking by Owner. Color of the finished coat of trim and front shall match the adjacent walls except that when the box is installed in electrical closets or equipment rooms, the gray finish as specified will be acceptable.

Panelboard enclosures shall be NEMA 250, Type 1. Enclosures shall be provided with hinged fronts and corrosion-resistant steel pin-tumbler cylinder locks. Locks shall be keyed alike, and two keys shall be provided for each enclosure.

Panelboards shall be finished with manufacturer's standard finish. Finish color shall be No. 70 gray conforming to FED-STD 595.

2.2 CIRCUIT BREAKERS

Circuit breakers shall be the molded-case type as specified in Section 16286,

"Overcurrent Protective Devices." Frame and trip ratings shall be as indicated.

Interrupting rating of circuit breakers shall be as indicated. If not shown, the interrupting rating for circuit breakers in 120/208-volt panelboards shall be not less than 10,000 amperes rms symmetrical, and that for breakers in 277/480-volt panelboards shall be not less than 18,000 amperes rms symmetrical.

Circuit breakers shall be bolt-on type. Plug-in type shall not be acceptable.

Connections to the bus shall be bolt-on type.

When multiple wires per phase are specified, the circuit breakers shall be furnished with connectors made to accommodate multiple wires.

Circuit breaker spaces called out on the drawings shall be complete with mounting hardware to permit ready installation of the circuit breakers.

2.3 DIRECTORY CARD AND HOLDER

A directory card shall be mounted on the inside of hinged fronts and doors 0.030-inch thick minimum plastic in a metal frame, with spaces for circuit numbers, outlets controlled, and room numbers. Where hinged fronts or doors are not required, the directory card shall be provided 0.030-inch thick minimum plastic in a metal frame mounted on the left-hand side of the front trim. Directory card shall identify each branch circuit with its respective and numbered circuit breaker.

2.4 FACTORY TESTING

Complete panelboards shall be tested in accordance with UL 67.

2.5 PRECAUTIONARY LABEL

To ensure persons are aware of immediate or potential hazard in the application, installation, use, or maintenance of panelboards, each panelboard shall be conspicuously marked on the trim or dead front shield with the text (or equivalent) **DANGER** symbol. If the panel is supplied with a door, the label shall be visible when the door is in the open position.

PART 3 EXECUTION

3.1 INSTALLATION

Panelboards shall be installed as indicated and in accordance with the manufacturer's instructions. Panels shall be fully aligned and mounted so that the height of the top operating handle will not exceed 72-inches above the finished floor.

Directory-card information shall be typewritten in capital letters to indicate outlets controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering.

3.2 SITE TESTING

Each panelboard enclosure key shall be shown to operate the enclosure locks in the presence of the Contracting Officer.

Panelboards shall be given continuity and insulation tests after the installation has been completed and before the panelboard is energized.

Test equipment, labor, and personnel shall be provided by the Contractor as required to perform the tests as specified. Continuity tests shall be conducted using a dc device with buzzer.

Insulation tests on 480-volt panelboards shall be conducted using a 1,000-volt insulation-resistance test set. Readings shall be recorded every minute until three equal and consecutive readings have been obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Insulation tests on panelboards rated 300 volts or less shall be conducted using a 500-volt minimum insulation-resistance test set. Readings shall be recorded after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Test data shall be recorded and shall include the location and identification of panelboards and megohm readings versus time.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16960

APPARATUS COORDINATION, INSPECTION AND TESTING

05/09

PART 1 GENERAL

1.1 REFERENCES
1.2 INTENT
1.3 SUBMITTALS

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS FOR ALL APPARATUS COORDINATION, INSPECTION AND TESTING
3.1.1 Definitions
3.1.1.1 Contractor
3.1.1.2 Specialist
3.1.1.3 Independent Testing Firm
3.1.2 Contractor General Responsibilities
3.1.2.1 Qualified Independent Specialist and Qualified Testing Company
3.1.2.2 Contractor's Responsibility
3.1.3 Specialist
3.1.3.1 Qualifications and Responsibilities
3.1.4 Testing Firm Requirements
3.1.4.1 Testing Firm Compliance
3.2 COORDINATION REQUIREMENTS
3.2.1 General
3.2.2 Preparation of Procedures and Schedules
3.2.3 Scheduling Tests
3.2.4 Contractor Support of the Testing Firm
3.2.5 Interface Design and Record Drawings
3.3 SITE VISITS
3.4 FIELD TESTS AND INSPECTIONS
3.4.1 General
3.4.2 Inspection of Purchased Equipment
3.4.3 Report of Damage
3.4.4 Identification of Equipment and Wiring and Miscellaneous Checks
3.4.5 Faulty Equipment
3.4.6 Remote Control/Indication Interface Wiring

-- End of Section Table of Contents --

SECTION 16960

APPARATUS COORDINATION, INSPECTION AND TESTING
05/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2009) Acceptance Testing Specifications

1.2 INTENT

The intent of this Section is to insure that all electrical workmanship and equipment, whether Government -furnished or Contractor-furnished, is installed and performs in accordance with the design specifications, drawings, manufacturer's instructions and all applicable codes and requirements. It is also intended to provide, insure, or determine the following:

a. If the equipment has been subjected to damage during shipment or installation;

b. If the equipment being provided by the Contractor is in accordance with specifications;

c. Provide initial acceptance tests and recorded data that can be used as a bench mark for future routine maintenance and trouble shooting by Government operating forces.

d. Determine whether the equipment and systems are suitable for energization and placing into normal operating service.

e. Provide assurance that each system component is not only installed satisfactorily, but that it performs and will continue to perform its function in the system with reasonable reliability, and that all new and modified portions of the system are coordinated with each other and with existing system.

f. Provide for the development of necessary equipment and system detail drawings which will become the final system Record drawings. The system drawings shall include all equipment electrical interconnections, equipment AC and DC schematics, and system AC and DC control wiring and associated schematics required to cover all electrical aspects of the electrical installation.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Submit the following documents to the Contracting Officer.

Specialist's name (company and individuals)
Specialist's experience similar work
Florida Registered PE
Experience with the development of electrical system drawings
List of projects completed in last 3 years
Experience with development of electrical system Drawings
Testing Firm's Florida Registered PE, Experience and Background
Testing experience record
Instrument calibration program
List of test equipment

SD-02 Shop Drawings

Submit the following documents to the Contracting Officer.

System Drawings
Record drawings

SD-06 Test Reports

Submit the following documents to the Contracting Officer.

System Checkout Procedures
Site Visits
Report of Damage
Faulty Equipment
Certified copies of all inspection reports

SD-07 Certificates

Submit the following documents to the Contracting Officer.

Certified copies of all inspection reports
Test results
Specialist's Certification Statement of document review and approval
NETA ATS Certification certificates for all Technicians

System Checkout Procedures

SD-11 Closeout Submittals

Record Drawings

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS FOR ALL APPARATUS COORDINATION, INSPECTION AND TESTING

3.1.1 Definitions

3.1.1.1 Contractor

For the purposes of this Section, the term "Contractor"is defined as the Prime Electrical Contractor responsible, overall, for all aspects related to the completion of construction contract.

3.1.1.2 Specialist

Specialist: An independent firm or individual, whose services have been secured by the Contractor , to prepare required system installation drawings, required for the specific implementation of system modifications and/or new equipment installations.

3.1.1.3 Independent Testing Firm

Independent Testing Firm: An independent firm, or individual, whose services have been secured by the Contractor to provide for apparatus testing, relay and equipment calibration tests, development of "system" functional testing procedures, and for certifying that all electrical systems are suitable for operation as designed.

Note: The Independent Testing Firm and the Specialist may be the same firm as long as the firm meets all of the experience requirements of both.

3.1.2 Contractor General Responsibilities

3.1.2.1 Qualified Independent Specialist and Qualified Testing Company

Throughout the construction project, and particularly during the installation and energization of new electrical systems, the Contractor shall provide the services of a qualified independent Specialist and a qualified Testing company for the purposes of insuring that the completed and documented equipment or systems are suitable for operation. The Contractor shall primarily be responsible for coordinating with the Specialist and/or the Testing firms, as required, in gathering any required field information, for the procurement of all required equipment, and in the development of required system drawings for systems installations.

3.1.2.2 Contractor's Responsibility

The Contractor's engagement of the testing firm to perform inspections and tests of the facilities in no way relieves the Contractor of the responsibility for the performance of the many and varied tests, checkouts, and inspections required during the various stages of construction, nor does it relieve the Contractor of any of his obligations set forth in this contract.

3.1.3 Specialist

3.1.3.1 Qualifications and Responsibilities

The specialist shall be an individual or a firm of established reputation (or, if newly organized, whose personnel have previously established a reputation in the field), which is regularly engaged in, and which maintains a regular force of engineers and technicians skilled in the development of electrical system control drawings, interconnection drawings, AC and DC schematics, and control panel point-to-point wiring diagrams. The Specialist shall not be a subsidiary Division nor Department of either the installing Contractor or the manufacturer of the equipment, materials or systems being inspected and tested.

The following information shall be submitted to the Contracting Officer:

Specialist's name (company and individuals)
Specialist's experience similar work
Florida Registered PE
Experience with the development of electrical system drawings
List of projects completed in last 3 years
Experience with development of electrical system Drawings
Specialist's Certification Statement of document review and approval

The Specialist shall employ at least one Florida Registered PE, with a minimum of 10 years experience in the area of protective relaying and electrical power system protection and control system design.

The Specialist shall be available throughout the contract period and shall not be changed throughout the work unless approved by the Contracting Officer.

The Specialist shall be responsible for working with the Contractor in obtaining all required apparatus drawings, from approved shop drawings, and field information required for preparation of all of the various types of drawings listed below. Each drawing type shall be provided on one or more individual sheets as required to describe the electrical system. Drawing types shall not be combined. Completed System drawings shall be submitted to the Contracting Officer for approval prior to any equipment installation.

Required system drawing types are as follows:

1. Power system One Line Diagrams
2. 3-Line AC Schematics of the power system
3. AC and DC Schematics for all power circuit breakers, transformers and associated controls and protection schemes being installed
4. Equipment Interconnection Drawings
5. Control Panel point-to-point Wiring Drawings

Upon final approval of the System drawings for construction from the Government, the Specialist and the Contractor shall work together to install the electrical systems accordingly.

The Specialist shall be responsible for updating the system drawings to reflect any approved field changes that are made during construction. A complete set of Record Drawings shall be submitted at the completion of the project.

3.1.4 Testing Firm Requirements

The testing firm shall not be a subsidiary Division or Department of either the installing Contractor or the manufacturer of the equipment, materials or systems being inspected and tested. The Testing Firm and the Specialist Firm may be the same company. The above does not preclude the Contractor from engaging the services of manufacturer's field engineers for checking, commissioning, etc., of equipment of specialized nature. The testing firm proposed for use by the Contractor must be approved by the Contracting Officer within a forty-five day period after contract award.

The following information shall be submitted to the Contracting Officer :

Testing Firm's Florida Registered PE, Experience and Background
Testing experience record
Instrument calibration program
Copies of the NETA ATS Certification certificates for all Technicians to be used on the project.
Test Results of all system tests

3.1.4.1 Testing Firm Compliance

The testing firm shall comply with the following:

1. The testing firm shall have at least one full time Professional Electrical Engineer, registered in the State of Florida. Additional staffing must include two or more technicians with a minimum of 4000 hours experience in electrical testing.

2. The testing firm shall have an instrument calibration program which maintains all applicable test instrumentation within rated accuracy. The test equipment shall have accuracy traceable to the National Bureau of Standards. The frequency of the calibration program shall not exceed six months.

3. The testing firm shall provide a list of test equipment that is planned to be used on the project, including manufacturer, model, serial number and year.

The Testing firm shall be responsible for coordinating with the Contractor and the Specialist for the review of the system drawings and in the joint development of the required equipment checkout procedures prior to equipment energization.

System Checkout Procedures shall be developed for each major phase of construction completion prior to the energization of any new equipment or busses where new work has been performed.

3.2 COORDINATION REQUIREMENTS

3.2.1 General

The Contractor shall provide complete, coordinated and operational packages of electrical equipment to the Government for approval. Recognizing that different manufacturers require differing installation requirements, relaying, and auxiliary accessories in order to provide an operating system, the Contractor shall provide the services of the Specialist to coordinate the interfaces required between and among the various items of equipment, such that a complete, coordinated, and operational system is

provided. Any additional items required to provide a complete, coordinated, and operational system shall be provided by the Contractor at no additional cost to the Government.

3.2.2 Preparation of Procedures and Schedules

The Contractor, Testing Firm and Specialist shall work together to prepare proposed system checkout procedures and schedules for all inspections, tests, settings and calibrations specified or otherwise required. This work shall be coordinated and shall be compatible with both the work of other crafts, the electric system outage constraints and the project schedule. The above shall be organized and submitted with all proposed testing and checkout forms for the review and approval of the Contracting Officer . The procedures must provide specific instructions, in accordance with equipment manufacturer's recommendations, for the checking and testing of each component in addition to the system functional checks. Tests and inspections shall also be scheduled as the job progresses and may require repetition in greater detail at a later stage of construction. Prior approval of the Contracting Officer is required before any tests are conducted.

3.2.3 Scheduling Tests

Tests shall be scheduled so that the time period between the test completion and equipment energization will be held to a minimum. In switchgear compartments where tests have been completed, adequate heating shall be provided to keep all components dry until circuit energization.

3.2.4 Contractor Support of the Testing Firm

The Contractor shall assist the independent testing firm in performing its work. The Contractor shall obtain required settings of all protective devices, drawings, wiring diagrams and any other information required by the testing firm to do their work.

3.2.5 Interface Design and Record Drawings

As described in paragraph above entitled "Specialist Qualifications and Responsibilities" , the Specialist shall complete all apparatus engineering interface design work and review the various manufacturer's shop drawings to verify that all necessary auxiliary items required for the performance of the functions specified are provided. The Specialist shall ensure that proper coordination among the shop drawings from the various manufacturers is accomplished. During development of the system drawings, the Specialist shall provide submittal drawing packages to the Contractor for submittal to the Government for approval. The Contractor's submittals shall include the Specialist's certification statement of document review and approval. Interface design drawings shall be submitted as a complete set of drawings, for each portion of the work, prior to construction. The interface design drawings shall incorporate all of the types of drawings as listed under the Specialist Qualifications and Responsibilities portion of this Section. Drawings shall incorporate all equipment shop drawings after they have been approved.

Record drawings shall be prepared based on manufacturer's shop drawings for the actual equipment being provided, the system drawings prepared by the Specialist, including existing system drawings and field verified control wiring. These drawings shall also incorporate any approved field changes made subsequent to the Government 's previous approval. Final record

drawings shall be furnished in Bently MicroStation, AutoCAD, or .DXF electronic file format and in accordance with the requirements of Section 01780, "Project Record Documents".

3.3 SITE VISITS

Contractor shall engage the Specialist to make periodic site inspections (not less than three separate visits and no less than one week apart) to verify that the equipment is being installed in accordance with the system drawings. The Specialist, and the Testing firm representative as required, shall be present prior, during and after major portions of the power system are commissioned for temporary of permanent service. Certified copies of all inspection reports shall be submitted to the Contracting Officer no less than ten days after each inspection. The report shall contain the date of inspection, the equipment inspected, deficiencies noted, and recommended corrective action. The Electrical Design Engineer may be present during the periodic site inspections and final testing. Notify the Contracting Officer in writing at least ten working days prior to date of Specialist site inspections and checkout.

3.4 FIELD TESTS AND INSPECTIONS

3.4.1 General

The Contractor shall provide all labor, equipment, and incidentals required for testing, except that the Government will provide electric power as required. All acceptance checks, settings, and tests shall be performed in accordance with the manufacturer's recommendations, in accordance with the latest IEEE recognized standards and under the supervision of the Testing Firm representative and the Specialist. All work shall be performed in a careful and safe manner so as not to endanger personnel or equipment. Testing shall be performed in such a way as to obtain information about the performance of the breakers, relays, meters, wiring, and instrument transformers together and as a unit, as well as separately. The Testing Firm shall review and approve the results of all tests and recommend corrective action when test results are not acceptable.

3.4.2 Inspection of Purchased Equipment

Equipment purchased by the Contractor or furnished by the Government for Contractor installation shall be inspected and tested to determine its condition. See other applicable sections of the specifications and contract documents for required Contractor checks and responsibilities.

3.4.3 Report of Damage

At any stage of construction and when observed, any electrical equipment or system determined to be damaged, faulty or requiring repairs shall be reported to the Contracting Officer.

3.4.4 Identification of Equipment and Wiring and Miscellaneous Checks

Prior to checkout and testing, the Contractor shall insure that all equipment and wiring is properly and permanently identified with nameplates and other identification. The Contractor shall also check and tighten all terminals and connection points, repair all damaged or scratched finishes, inspect for broken and missing parts and review and collect manufacturer's drawings and instructions for delivery to the Contracting Officer. The Contractor shall also make routine checks and tests as the job progresses

and as necessary to insure that all wiring and equipment is properly installed and wired.

3.4.5 Faulty Equipment

Any system component or workmanship which is found defective on the basis of acceptance tests, whether the test is witnessed by the Government Inspector or not, shall be reported in writing on the day of the occurrence. Using an appropriate form, the testing firm shall report the nature of the problem and recommend corrective action if applicable. Original and duplicate shall be submitted to the Contractor and Government representative. The testing firm shall retain a copy. All copies shall be signed by persons witnessing the test. Corrective action shall be performed by the Contractor, at no additional cost to the Government. Contractor shall also bear the costs of additional tests until satisfactory results are obtained.

3.4.6 Remote Control/Indication Interface Wiring

Prior to closeout of the contract, the Contractor shall demonstrate that all of the KCCS interface status points are operating correctly from their origination points to the KCCS system.

-- End of Section --