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ESR		REV/DATE	
DIR	DRA NO. E-AC000000 -1108	SIGNATURE	
EFF	TITLE 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	
EQ. LOC. UK-0020, K6-1141, M6-0996		CONTRACT	
SDL 79K11107			

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, 183-232, 177-182, 287-335, 287-335, 287-335, 287-335	NEW	A	327	*	*	*	*
10	SW	79K38608	NEW	B	10	*	*	*	*
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
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<i>Ernesto T. Camacho</i> Ernesto Camacho, 867-4002	TA-B3-B	9/30/09	OTHER N/A
N/A		JOINT RELEASE N/A	
PROCUREMENT PKG		RELEASE <i>Dung Trang</i> Dung Trang, 861-2266	
		TA-B3-B	9/30/09

9/30/09

**DOCUMENT RELEASE AUTHORIZATION CONTINUATION
KENNEDY SPACE CENTER, NASA**

2.

1. DRA No.

E-AC000000 -1108

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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	***	***	***	***

QUANTITY	MAIL CODE	NAME	QUANTITY	MAIL CODE	NAME
DRA	TA-B3B	E. CAMACHO	DRA+1C+1S	NE-M8	J. RYMKOS
DRA	TA-B3D	R. BOYLES	DRA+1C+1S	NE-M8	S. LUCIANO
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	
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C = Half size Drawings (79K38608, 79K38612, 79K38551, 79K36517 Rev. A, and 79K38550)
 B = B- Size (11X17) Drawings (79K38608, 79K38612, 79K38551, 79K36517 Rev. A, and 79K38550)
 P = F-Size Drawings (79K38608, 79K38612, 79K38551, 79K36517 Rev. A, and 79K38550)
 S = A-Size Specification (79K38609, 79K38612, and 79K38549)
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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	Replace 15kV Feeders and Ducts, VAB Area North PCN 98778 September 25, 2009 FW&A No. 0601-25.1	JOHN F. KENNEDY SPACE CENTER, NASA KENNEDY SPACE CENTER, FLORIDA	
	DRAFTSMAN KELEMEN			CHECKER W WILSON
MATERIAL	TRACER			CHECKER
HEAT TREATMENT	ENGINEER D. TRANG			ENGINEER
FINAL PROTECTIVE FINISH	SUBMITTED <i>[Signature]</i> 9/29/09	SCALE	DWG SIZE A	
	APPROVAL <i>Ernesto T. Camacho</i> 9/29/09	UNIT WT	79K38609 SHEET 1 OF 93	

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SECTION 01 11 00

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01/08

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-- End of Section Table of Contents --

SECTION 01 11 00

SUMMARY OF WORK
01/08

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1.2 WORK COVERED BY CONTRACT DOCUMENTS

1.2.1 Project Description

The work to be performed under this project consists of providing the labor, equipment, and materials to revitalize the cable and duct system in the LC39 area by replacing old 15kV XLP and PILC cables with EPR to improve the reliability and safety of the system. The project will also add conduit by way of microtunneling where required to install the new cables or to maintain spare ducts where none are available. Potential hazards include aged asbestos fireproofing on cables in manholes that may be present as well as on going construction in the areas of this project.

1.2.2 Location

The work shall be located at the Kennedy Space Center, approximately as indicated. The exact location will be shown by the Contracting Officer.

1.3 CONTRACT DRAWINGS

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

Drawing No. 79K38608
Sheets 1 through 21

1.4 SALVAGE MATERIAL AND EQUIPMENT

Items designated by the Contracting Officer to be salvaged shall remain the property of the Government.

The salvaged property shall be segregated, itemized, delivered, and off-loaded at the Government designated storage area.

Contractor shall maintain property control records for material or equipment designated as salvage. Contractor's system of property control may be used if approved by the Contracting Officer. Contractor shall be responsible for storage and protection of salvaged materials and equipment until disposition by the Contracting Officer.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

SPECIFICATION COVER SHEET

-- End of Section --

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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 33 00

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02/09

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-- End of Section Table of Contents --

SECTION 01 33 00

SUBMITTAL PROCEDURES

02/09

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 Submittal Descriptions (SD)

Submittals requirements are specified in the technical sections. Submittals are identified by Submittal Description (SD) numbers and titles as follows:

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-05 Design Data

Design calculations, mix designs, analyses or other data pertaining to a part of work.

SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. (Testing must have been within three years of date of contract award for the project.)

Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and Material Safety Data sheets concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative 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, to confirm compliance with manufacturer's standards or instructions. The documentation 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.

Factory test reports.

SD-10 Operation and Maintenance Data

Data that is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel, including manufacturer's help and product line documentation necessary to maintain and install equipment. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

This data is intended to be incorporated in an operations and maintenance manual or control system.

SD-11 Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

Special requirements necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.1.2 Work

As used in this section, on- and off-site construction required by contract documents, including labor necessary to produce submittals, construction, materials, products, equipment, and systems incorporated or to be

incorporated in such construction.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with this section.

1.3 PREPARATION

1.3.1 Format for SD-02 Shop Drawings

- a. Shop drawings are not to be less than 210 by 297 mm nor more than 1189 by 841 mm, except for full size patterns or templates. Prepare drawings to accurate size, with scale indicated, unless other form is required. Drawings are to be suitable for reproduction and be of a quality to produce clear, distinct lines and letters with dark lines on a white background.
- b. Present A4 297 by 210 mm sized shop drawings as part of the bound volume for submittals required by section. Present larger drawings in sets.
- c. Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to information required in paragraph entitled "Identifying Submittals."
- d. Number drawings in a logical sequence. Contractors may use their own number system. Each drawing is to bear the number of the submittal in a uniform location adjacent to the title block. Place the Government contract number in the margin, immediately below the title block, for each drawing.
- e. Reserve a blank space on the right hand side of each sheet for the Government disposition stamp.
- f. Dimension drawings, except diagrams and schematic drawings; prepare drawings demonstrating interface with other trades to scale. Use the same unit of measure for shop drawings as indicated on the contract drawings. Identify materials and products for work shown.
- g. Include the nameplate data, size and capacity on drawings. Also include applicable federal, military, industry and technical society publication references.

1.3.2 Format of SD-03 Product Data and SD-08 Manufacturer's Instructions

- a. Present product data submittals for each section as a complete, bound volume. Include table of contents, listing page and catalog item numbers for product data.
- b. Indicate, by prominent notation, each product which is being submitted; indicate specification section number and paragraph number to which it pertains.
- c. Supplement product data with material prepared for project to satisfy submittal requirements for which product data does not exist. Identify this material as developed specifically for

project, with information and format as required for submission of SD-07 Certificates.

- d. Provide product data in metric dimensions. Where product data are included in preprinted catalogs with English units only, submit metric dimensions on separate sheet.
- d. Provide product data in metric dimensions. Where product data are included in preprinted catalogs with English units only, submit metric dimensions on separate sheet.
- e. Include the manufacturer's name, trade name, place of manufacture, and catalog model or number on product data. Also include applicable federal, military, industry and technical society publication references. Should manufacturer's data require supplemental information for clarification, submit as specified for SD-07 Certificates.
- f. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. State on the certificate that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.
- g. Collect required data submittals for each specific material, product, unit of work, or system into a single submittal and marked for choices, options, and portions applicable to the submittal. Mark each copy of the product data identically. Partial submittals will not be accepted for expedition of construction effort.
- h. Submit manufacturer's instructions prior to installation.

1.3.3 Format of SD-05 Design Data and SD-07 Certificates

Provide design data and certificates on 297 by 210 mm paper.
Provide a bound volume for submittals containing numerous pages.

1.3.4 Format of SD-06 Test Reports and SD-09 Manufacturer's Field Reports

- a. Provide reports on 297 by 210 mm paper in a complete bound volume.
- b. Indicate by prominent notation, each report in the submittal. Indicate specification number and paragraph number to which it pertains.

1.3.5 Format of SD-10 Operation and Maintenance Data (O&M)

Comply with the requirements specified in Section 01 78 00
CLOSEOUT SUBMITTALS for O&M Data format.

1.3.6 Format of SD-11 Closeout Submittals

- a. When submittal includes a document which is to be used in project or become part of project record, other than as a submittal, do not apply Contractor's approval stamp to document, but to a separate sheet accompanying document.
- b. Provide all dimensions in administrative submittals in metric. Where data are included in preprinted material with English units only, submit metric dimensions on separate sheet.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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SECTION 01 42 00
SOURCES FOR REFERENCE PUBLICATIONS
11/08

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 ORDERING INFORMATION

-- End of Section Table of Contents --

SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS

11/08

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization, (e.g. ASTM B 564 Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the standards producing organization should be ordered from the source by title rather than by number.

ACI INTERNATIONAL (ACI)
38800 Country Club Drive
Farmington Hills, MI 48331
Ph: 248-848-3700
Fax: 248-848-3701
E-mail: bkstore@concrete.org
Internet: <http://www.concrete.org>

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1819 L Street, NW, 6th Floor
Washington, DC 20036
Ph: 202-293-8020
Fax: 202-293-9287
E-mail: info@ansi.org
Internet: <http://www.ansi.org/>

AMERICAN PETROLEUM INSTITUTE (API)
1220 L Street, NW
Washington, DC 20005-4070
Ph: 202-682-8000
Fax: 202-682-8223
Internet: <http://www.api.org>

AMERICAN WATER WORKS ASSOCIATION (AWWA)
6666 West Quincy Avenue
Denver, CO 80235
Ph: 800-926-7337
Fax: 303-347-0804
Internet: <http://www.awwa.org>

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)
600 North 18th Street
P.O. Box 2641
Birmingham, AL 35291
Ph: 205-257-2530
Fax: 205-257-2540
Internet: <http://www.aeic.org>

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9500
Fax: 610-832-9555
E-mail: service@astm.org
Internet: <http://www.astm.org>

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
445 Hoes Lane
Piscataway, NJ 08855-1331
Ph: 732-981-0060
Fax: 732-981-1712
E-mail: customer-services@ieee.org
Internet: <http://www.ieee.org>

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
P.O. Box 1568
Carrollton, GA 30112
Ph: 770-830-0369
Fax: 770-830-8501
Internet: <http://www.icea.net>

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)
P.O. Box 687
106 Stone Street
Morrison, CO 80465
Ph: 303-697-8441
Fax: 303-697-8431
E-mail: neta@netaworld.org
Internet: <http://www.netaworld.org>

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)
3, rue de Varembe, P.O. Box 131
CH-1211 Geneva 20, Switzerland
Ph: 41-22-919-0211
Fax: 41-22-919-0300
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Internet: <http://www.usace.army.mil/publications>
or <http://www.hnd.usace.army.mil/techinfo/engpubs.htm>

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CLOSEOUT SUBMITTALS

01/08

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Warranty Management Plan

One set of the warranty management plan containing information relevant to the warranty of materials and equipment incorporated into the construction project, including the starting date of warranty of construction. Furnish with each warranty the name, address, and telephone number of each of the guarantor's representatives nearest to the project location.

Spare Parts Data

Two copies of list that indicates manufacturer's name, part number, nomenclature, and stock level recommended for maintenance and repair. List those items that may be standard to the normal maintenance of the system.

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with paragraph entitled, "Operation and Maintenance," of this section.

SD-11 Closeout Submittals

Record Drawings

Drawings showing final as-built conditions of the project. The manually prepared drawings must consist of 1 set of completed final as-built original transparency drawings, 2 sets of blue-line prints of the transparencies, and the approved marked working as-built prints.

1.2 PROJECT RECORD DOCUMENTS

1.2.1 Record Drawings

This paragraph covers record drawings complete, as a requirement of the contract. The terms "drawings," "contract drawings," "drawing files," "working record drawings" and "final record drawings" refer to contract drawings which are revised to be used for final record drawings showing

as-built conditions.

1.2.1.1 Working Record and Final Record Drawings

Revise 2 sets of paper drawings by red-line process to show the as-built conditions during the prosecution of the project. Keep these working as-built marked drawings current on a weekly basis and at least one set available on the jobsite at all times. Changes from the contract plans which are made in the work or additional information which might be uncovered in the course of construction must be accurately and neatly recorded as they occur by means of details and notes. Prepare final record (as-built) drawings after the completion of each definable feature of work as listed in the Contractor Quality Control Plan (Foundations, Utilities, Structural Steel, etc., as appropriate for the project). Show on the working and final record drawings, but not limited to, the following information:

a. The actual location, kinds and sizes of all sub-surface utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, show by offset dimensions to two permanently fixed surface features the end of each run including each change in direction on the record drawings. Locate valves, splice boxes and similar appurtenances by dimensioning along the utility run from a reference point. Also record the average depth below the surface of each run.

c. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from contract plans.

d. Changes in details of design or additional information obtained from working drawings specified to be prepared and/or furnished by the Contractor; including but not limited to fabrication, erection, installation plans and placing details, pipe sizes, insulation material, dimensions of equipment foundations, etc.

e. The topography, invert elevations and grades of drainage installed or affected as part of the project construction.

f. Changes or modifications which result from the final inspection.

g. Where contract drawings or specifications present options, show only the option selected for construction on the final as-built prints.

i. Systems designed or enhanced by the Contractor, such as HVAC controls, fire alarm, fire sprinkler, and irrigation systems.

1.2.1.2 Drawing Preparation

Modify the record drawings as may be necessary to correctly show the features of the project as it has been constructed by bringing the contract set into agreement with approved working as-built prints, and adding such additional drawings as may be necessary. These working as-built marked prints must be neat, legible and accurate. These drawings are part of the permanent records of this project and must be returned to the Contracting Officer after approval by the Government. Any drawings damaged or lost by the Contractor must be satisfactorily replaced by the Contractor at no expense to the Government.

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. Text for all changes shall be printed block lettering.
- c. Lines drawn to indicate changes shall be made 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.

1.2.1.3 Manually Prepared Drawings

Redline additions and corrections to the contract drawings must be neat, clean and legible, shall be done to the same level of detail, and match the adjacent existing line work and lettering. The Contracting Officer will review record drawings for accuracy and conformance to the above specified drafting standards. Corrections, changes, additions, and deletions required must meet these standards. The title block to be used for any new record drawings must be similar to that used on the original drawings.

a. When final revisions have been completed, Letter or stamp each drawing with the words "RECORD DRAWINGS / AS-BUILT CONDITIONS" followed by the name of the Contractor in letters at least 5 mm high. Mark original contract drawings either "Record" drawings denoting no revisions on the sheet or "Revised Record" denoting one or more revisions. Date all original contract drawings in the revision block.

b. The Government will promptly return one set of prints annotated with any necessary corrections. Within 7 days for contracts less than \$5 million, revise the drawings accordingly at no additional cost and submit one set of final prints for the completed phase of work to the Government. Within 10 days of substantial completion of all phases of work, submit the final record drawing package for the entire project. Submit two blue-line prints of these drawings and the return of the approved marked record prints, complete in all details. Paper prints and reproducible drawings will become the property of the Government upon final approval. Failure to submit final record drawings and marked prints, as required herein, will be cause for withholding any payment due the Contractor under this contract. Approval and acceptance of final record drawings must be accomplished before final payment is made to the Contractor.

1.2.2 Final Approved Shop Drawings

Furnish final approved project shop drawings 30 days after transfer of the completed facility.

1.3 SPARE PARTS DATA

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.

1.4 WARRANTY MANAGEMENT

1.4.1 Warranty Management Plan

b. Listing and status of delivery of all Certificates of Warranty for extended warranty items, to include load break switches, vacuum fault interrupting switches, cable, etc.

c. A list for each warranted equipment, item, feature of construction or system indicating:

1. Name of item.
2. Model and serial numbers.
3. Location where installed.
4. Name and phone numbers of manufacturers or suppliers.
5. Names, addresses and telephone numbers of sources of spare parts.
6. Warranties and terms of warranty. Include one-year overall warranty of construction. Items which have extended warranties must be indicated with separate warranty expiration dates.
7. Cross-reference to warranty certificates as applicable.
8. Starting point and duration of warranty period.
9. Summary of maintenance procedures required to continue the warranty in force.
10. Cross-reference to specific pertinent Operation and Maintenance manuals.
11. Organization, names and phone numbers of persons to call for warranty service.

1.5 OPERATION AND MAINTENANCE MANUALS

Operation and Maintenance Manuals must be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Bind information in manual format and grouped by technical sections. Test data must 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 must have 10 millimeter holes and be bound in 3-ring, loose-leaf binders. Organize data by separate index and tabbed sheets, in a loose-leaf binder. Binder must lie flat with printed sheets that are easy to read. Caution and warning indications must be clearly labeled.

Submit classroom and field instructions in the operation and maintenance of systems equipment where required by the technical provisions. These services must be directed by the Contractor, using the manufacturer's

factory-trained personnel or qualified representatives. Contracting Officer will be given 7 calendar days written notice of scheduled instructional services. Instructional materials belonging to the manufacturer or vendor, such as lists, static exhibits, and visual aids, must be made available to the Contracting Officer.

Submit 6 copies of the project operation and maintenance manuals 30 calendar days prior to testing the system involved. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

1.6 CLEANUP

The following applies to areas affected by the work of this project. Leave premises "broom clean." Clean debris from drainage systems. Sweep paved areas and rake clean landscaped areas. Remove waste and surplus materials, rubbish and construction facilities from the site.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

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SECTION 03 30 53

MISCELLANEOUS CAST-IN-PLACE CONCRETE
04/08

PART 1 GENERAL

1.1 SUMMARY

Perform all work in accordance with ACI MCP SET Parts 2 and 3.

1.2 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.

ACI INTERNATIONAL (ACI)

ACI MCP SET (2008) Manual of Concrete Practice

ASTM INTERNATIONAL (ASTM)

ASTM A 185/A 185M (2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

ASTM A 615/A 615M (2008b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM C 1064/C 1064M (2008) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

ASTM C 143/C 143M (2008) Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C 150 (2007) Standard Specification for Portland Cement

ASTM C 171 (2007) Standard Specification for Sheet Materials for Curing Concrete

ASTM C 172 (2008) Standard Practice for Sampling Freshly Mixed Concrete

ASTM C 173/C 173M (2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C 231 (2008c) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

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 31/C 31M	(2008a) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(2007) Standard Specification for Concrete Aggregates
ASTM C 39/C 39M	(2005e1e2) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 494/C 494M	(2008a) Standard Specification for 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 685/C 685M	(2007) Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C 94/C 94M	(2007) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2006) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 75	(2003) Standard Practice for Sampling Aggregates

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
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1.3 SYSTEM DESCRIPTION

The Government retains the option to sample and test joint sealer, joint filler material, waterstop, aggregates and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary to assist the Government in procurement of representative test samples. Obtain samples of aggregates at the point of batching in accordance with ASTM D 75. Sample concrete in accordance with ASTM C 172. Determine slump and air content in accordance with ASTM C 143/C 143M and ASTM C 231, respectively, when cylinders are molded. Prepare, cure, and transport compression test specimens in accordance with ASTM C 31/C 31M. Test compression test specimens in accordance with ASTM C 39/C 39M. Take samples for strength tests not less than once each shift in which concrete is produced. Provide a minimum of three specimens from each sample; two to be tested at 28 days (90 days if pozzolan is used) for acceptance, and one will be tested at 7 days for information.

1.3.1 Strength

Acceptance test results are the average strengths of two specimens tested at 28 days (90 days if pozzolan is used). The strength of the concrete is considered satisfactory so long as the average of three consecutive acceptance test results equal or exceed the specified compressive strength, f'c, and no individual acceptance test result falls below f'c by more than 3.4 MPa.

1.3.2 Construction Tolerances

Apply a Class "C" finish to all surfaces except those specified to receive a Class "D" finish. Apply a Class "D" finish to all post-construction surfaces which will be permanently concealed. Surface requirements for the classes of finish required are as specified in Part 4 of ACI MCP SET.

1.3.3 Concrete Mixture Proportions

Concrete mixture proportions are the responsibility of the Contractor. Mixture proportions shall include the dry weights of cementitious material(s); the nominal maximum size of the coarse aggregate; the specific gravities, absorptions, and saturated surface-dry weights of fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per cubic meter of concrete. Provide materials included in the mixture proportions of the same type and from the same source as will be used on the project. Specified compressive strength f'c shall be 20.7 MPa at 28 days (90 days if pozzolan is used). The maximum nominal size coarse aggregate is 19 mm, in accordance with ACI MCP SET Part 3. The air content shall be between 4.5 and 7.5 percent with a slump between 50 and 125 mm. The maximum water cement ratio is 0.50.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Air-Entraining Admixture; G
Water-Reducing or Retarding Admixture; G
Curing Materials; G
Reinforcing Steel

Manufacturer's literature from suppliers which demonstrates compliance with applicable specifications for the above materials.

Conveying and Placing Concrete

Methods and equipment for transporting, handling, depositing, and consolidating the concrete prior to the first concrete placement.

Formwork

Formwork design prior to the first concrete placement.

Forms
Installation Drawings
Ready-Mix Concrete
Mix Design Data
Air-Entraining Admixtures
Fly Ash
Steel Reinforcement
Accessories
Curing Compound
Concrete

SD-06 Test Reports

Aggregates

Test reports for aggregates showing the material(s) meets the quality and grading requirements of the specifications.

Concrete Mixture Proportions

The mixture proportions that will produce concrete of the quality required, ten days prior to placement of concrete. Applicable test reports to verify that the concrete mixture proportions selected will produce concrete of the quality specified.

Compressive Strength Testing
Slump

SD-07 Certificates

Cementitious Materials

Aggregates

Certificates of compliance stating that the material(s) meet the quality and grading requirements of the specifications under which it is furnished.

Bill of Lading

1.5 QUALITY ASSURANCE

Indicate specific locations of Steel Reinforcement Construction Joints Contraction Joints on installation drawings and include, but not be limited to, square meters of concrete placements, thicknesses and widths, plan dimensions, and arrangement of cast-in-place concrete section.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Provide cementitious materials that conform to the appropriate specifications listed:

2.1.1.1 Portland Cement

ASTM C 150, Type I, IA, II, IIA, III, IIIA or V, except that the tricalcium aluminate of the Type III or IIIA cement shall be limited to 5 percent.

2.1.1.2 Pozzolan

Provide pozzolan that conforms to ASTM C 618, Class C or F, including requirements of Tables 1A and 2A.

2.1.2 Aggregates

Fine and coarse aggregates shall meet the quality and grading requirements of ASTM C 33 Class Designations 4M or better.

2.1.3 Admixtures

Admixtures to be used, when required or approved, shall comply with the appropriate specification listed. Retest chemical admixtures that have been in storage at the project site, for longer than 6 months or that have been subjected to freezing, at the expense of the Contractor at the request of the Contracting Officer and will be rejected if test results are not satisfactory.

2.1.3.1 Air-Entraining Admixture

Provide air-entraining admixture that meets the requirements of ASTM C 260.

2.1.3.2 Water-Reducing or Retarding Admixture

Provide water-reducing or retarding admixture meeting the requirements of ASTM C 494/C 494M, Type A, B, or D.

2.1.4 Water

Use fresh, clean, potable water for mixing and curing, free from injurious amounts of oil, acid, salt, or alkali, except that unpotable water may be used if it meets the requirements of COE CRD-C 400.

2.1.5 Reinforcing Steel

Provide reinforcing bars conforming to the requirements of ASTM A 615/A 615M, Grade 60. Welded steel wire fabric shall conform to the requirements of ASTM A 185/A 185M. Details of reinforcement not shown shall be in accordance with ACI MCP SET Part 3, Chapters 7 and 12.

2.1.6 Formwork

The design and engineering of the formwork as well as its construction, will be the responsibility of the Contractor.

2.1.7 Form Coatings

Coat forms, for exposed surfaces, with a nonstaining form oil to be applied shortly before concrete is placed.

2.1.8 Curing Materials

Provide curing materials conforming to the following requirements.

2.1.8.1 Impervious Sheet Materials

Impervious sheet materials, ASTM C 171, type optional, except polyethylene film, if used, shall be white opaque.

2.1.8.2 Membrane-Forming Curing Compound

ASTM C 309, Type 1-D or 2, Class A or B.

2.2 READY-MIX CONCRETE

a. Concrete shall be ready-mix concrete with mix design data conforming to ACI MCP SET Part 2

d. Slump: 25 to 100 mm according to ASTM C 143/C 143M and ACI MCP SET Part 1.

e. Portland Cement conforming to ASTM C 150, Type I.

g. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

h. Air-Entraining Admixtures conforming to ASTM C 260.

i. Water-reducing admixtures, retarding admixtures, accelerating admixtures, water-reducing and accelerating admixtures, and water-reducing and retarding admixtures shall conform to ASTM C 494/C 494M.

j. Fly Ash used as an admixture shall conform to ASTM C 618, Class C or F with 4 percent maximum loss on ignition and 35 percent maximum cement replacement by weight.

k. Ground granulated blast furnace slag used as an admixture shall conform to ASTM C 989, Grade 120 with between 25 to 50 percent maximum cement replacement by weight.

2.3 STEEL REINFORCEMENT

2.3.1 Deformed Steel Bars

Provide steel bars conforming to ASTM A 615/A 615M, Grade 408 MPa ACI MCP SET Parts 2 and 3.

2.3.2 Welded Wire Fabric

Provide welded wire fabric conforming to ASTM A 185/A 185M.

2.4 FORMS

Forms shall be of wood, steel, or other approved material and conform to ACI MCP SET, Parts 2 and 3.

Provide form release conforming to ACI MCP SET, Part 4.

2.5 ACCESSORIES

2.5.1 Curing Compound

Provide curing compound conforming to ASTM C 309.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 General

Prepare construction joints to expose coarse aggregate. The surface shall be clean, damp, and free of laitance. Construct ramps and walkways, as necessary, to allow safe and expeditious access for concrete and workmen. Remove snow, ice, standing or flowing water, loose particles, debris, and foreign matter. Earth foundations shall be satisfactorily compacted. Ensure spare vibrators are available. The entire preparation shall be accepted by the Government prior to placing.

3.1.2 Embedded Items

Secure reinforcement in place after joints, anchors, and other embedded items have been positioned. Arrange internal ties so that when the forms are removed the metal part of the tie is not less than 50 mm from concrete surfaces permanently exposed to view or exposed to water on the finished structures. Embedded items shall be free of oil and other foreign matters such as loose coatings or rust, paint, and scale. The embedding of wood in concrete is permitted only when specifically authorized or directed. All equipment needed to place, consolidate, protect, and cure the concrete shall be at the placement site and in good operating condition.

3.1.3 Formwork Installation

Forms shall be properly aligned, adequately supported, and mortar-tight. Provide smooth form surfaces, free from irregularities, dents, sags, or holes when used for permanently exposed faces. Chamfer all exposed joints and edges, unless otherwise indicated.

3.1.4 Production of Concrete

3.1.4.1 Ready-Mixed Concrete

Provide ready-mixed concrete conforming to ASTM C 94/C 94M except as otherwise specified.

3.1.4.2 Concrete Made by Volumetric Batching and Continuous Mixing

Concrete made by volumetric batching and continuous mixing shall conform to ASTM C 685/C 685M.

3.2 CONVEYING AND PLACING CONCRETE

Perform conveying and placing concrete in conformance with the following requirements.

3.2.1 General

Concrete placement is not permitted when weather conditions prevent proper

placement and consolidation without approval. When concrete is mixed and/or transported by a truck mixer, deliver the concrete to the site of the work completing the discharge within 1-1/2 hours or 45 minutes when the placing temperature is 30 degrees C or greater unless a retarding admixture is used. Convey concrete from the mixer to the forms as rapidly as practicable by methods which prevent segregation or loss of ingredients. Concrete shall be in place and consolidated within 15 minutes after discharge from the mixer. Deposit concrete as close as possible to its final position in the forms and regulate it so that it may be effectively consolidated in horizontal layers 450 mm or less in thickness with a minimum of lateral movement. Carry on the placement at such a rate that the formation of cold joints will be prevented.

3.2.2 Consolidation

Consolidate each layer of concrete by internal vibrating equipment. Systematically accomplish internal vibration by inserting the vibrator through the fresh concrete in the layer below at a uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1.5 times the radius of action of the vibrator and overlay the adjacent, just-vibrated area by approximately 100 mm. Ensure that the vibrator penetrates rapidly to the bottom of the layer and at least 150 mm into the layer below, if such a layer exists. Hold vibrator stationary until the concrete is consolidated and then withdraw it slowly at the rate of about 75 mm per second.

3.2.3 Cold-Weather Requirements

No concrete is to be mixed or placed when the ambient temperature is below 2 degrees C or if the ambient temperature is below 5 degrees C and falling. Provide suitable covering and other means as approved for maintaining the concrete at a temperature of at least 10 degrees C for not less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. Do not mix salt, chemicals, or other foreign materials with the concrete to prevent freezing. Remove and replace concrete damaged by freezing at the expense of the Contractor.

3.2.4 Hot-Weather Requirements

When the rate of evaporation of surface moisture, as determined by use of Figure 1 of ACI MCP SET Part 2, is expected to exceed 1 kg/square meter per hour, provisions for windbreaks, shading, fog spraying, or covering with a light-colored material shall be made in advance of placement, and such protective measures taken as quickly as finishing operations will allow.

3.2.5 Lifts in Concrete

Deposit concrete in horizontal layers not to exceed 600 mm in thickness. Carry on placement at a rate that prevents the formation of cold joints. Place slabs in one lift.

3.3 FORM REMOVAL

Do not remove forms before 24 hours after concrete placement, except as otherwise specifically authorized. Do not remove supporting forms and shoring until the concrete has cured for at least 5 days. When conditions require longer curing periods, forms shall remain in place.

3.4 FINISHING

3.4.1 General

Do not finish or repair concrete when either the concrete or the ambient temperature is below 10 degrees C.

3.4.2 Finishing Formed Surfaces

Remove all fins and loose materials , and surface defects including filling of tie holes. Repair all honeycomb areas and other defects. Remove all unsound concrete from areas to be repaired. Surface defects greater than 13 mm in diameter and holes left by removal of tie rods in all surfaces not to receive additional concrete shall be reamed or chipped and filled with dry-pack mortar. Brush-coat the prepared area with an approved epoxy resin or latex bonding compound or with a neat cement grout after dampening and filling with mortar or concrete. The cement used in mortar or concrete for repairs to all surfaces permanently exposed to view shall be a blend of portland cement and white cement so that the final color when cured is the same as adjacent concrete.

3.4.3 Finishing Unformed Surfaces

Float finish all unformed surfaces, that are not to be covered by additional concrete or backfill, to elevations shown, unless otherwise specified. Surfaces to receive additional concrete or backfill shall be brought to the elevations shown and left as a true and regular surface. Slope exterior surfaces for drainage unless otherwise shown. Carefully make joints with a jointing tool. Finish unformed surfaces to a tolerance of 10 mm for a float finish and 8 mm for a trowel finish as determined by a 3 m straightedge placed on surfaces shown on the drawings to be level or having a constant slope. Do not perform finishing while there is excess moisture or bleeding water on the surface. No water or cement is to be added to the surface during finishing.

3.4.3.1 Float Finish

Provide float finished surfaces, screeded and darbied or bullfloated to eliminate the ridges and to fill in the voids left by the screed. In addition, the darby or bullfloat shall fill all surface voids and only slightly embed the coarse aggregate below the surface of the fresh concrete. When the water sheen disappears and the concrete supports a person's weight without deep imprint, complete floating. Floating shall embed large aggregates just beneath the surface, remove slight imperfections, humps, and voids to produce a plane surface, compact the concrete, and consolidate mortar at the surface.

3.5 CURING AND PROTECTION

Beginning immediately after placement, and continuing for at least 7 days, except for concrete made with Type III cement, at least 3 days, cure and protect all concrete from premature drying, extremes in temperature, rapid temperature change, freezing, mechanical damage, and exposure to rain or flowing water. Provide all materials and equipment needed for adequate curing and protection at the site of the placement prior to the start of concrete placement. Accomplish moisture preservation of moisture for concrete surfaces not in contact with forms by one of the following methods:

- a. Continuous sprinkling or ponding.

- b. Application of absorptive mats or fabrics kept continuously wet.
- c. Application of sand kept continuously wet.
- d. Application of impervious sheet material conforming to ASTM C 171.
- e. Application of membrane-forming curing compound conforming to ASTM C 309, Type 1-D, on surfaces permanently exposed to view. Accomplish Type 2 on other surfaces in accordance with manufacturer's instructions.

Accomplish the preservation of moisture for concrete surfaces placed against wooden forms by keeping the forms continuously wet for 7 days , except for concrete made with Type III cement, for 3 days. If forms are removed prior to end of the required curing period, use other curing methods for the balance of the curing period. Do not perform protection removal if the temperature of the air in contact with the concrete may drop more than 15 degrees C within a 24 hour period.

3.6 TESTS AND INSPECTIONS

3.6.1 General

The individuals who sample and test concrete, as required in this specification, must have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I.

3.6.2 Inspection Details and Frequency of Testing

3.6.2.1 Preparations for Placing

Inspect foundation or construction joints, forms, and embedded items in sufficient time prior to each concrete placement by the Contractor to certify that it is ready to receive concrete.

3.6.2.2 Air Content

Check air content at least once during each shift that concrete is placed. Obtain samples in accordance with ASTM C 172 and tested in accordance with ASTM C 231.

3.6.2.3 Slump

Check slump once during each shift that concrete is produced. Obtain samples in accordance with ASTM C 172 and tested in accordance with ASTM C 143/C 143M.

3.6.2.4 Consolidation and Protection

Ensure that the concrete is properly consolidated, finished, protected, and cured.

3.6.3 Action Required

3.6.3.1 Placing

Do not permit placing to begin until the availability of an adequate number

of acceptable vibrators, which are in working order and have competent operators, has been verified. Do not continue placing if any pile is inadequately consolidated.

3.6.3.2 Air Content

Whenever an air content test result is outside the specification limits, adjust the dosage of the air-entrainment admixture prior to delivery of concrete to forms.

3.6.3.3 Slump

Whenever a slump test result is outside the specification limits, adjust the batch weights of water and fine aggregate prior to delivery of concrete to the forms. The adjustments are to be made so that the water-cement ratio does not exceed that specified in the submitted concrete mixture proportion.

3.6.4 Reports

Report the results of all tests and inspections conducted at the project site informally at the end of each shift. Submit written reports weekly. Deliver within 3 days after the end of each weekly reporting period.

3.7 FORM WORK

Form work shall conform to ACI MCP SET Parts 2 through 5.

3.7.1 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. Chamfer exposed joints and exposed edges. Arrange internal ties so that when the forms are removed, the form ties are not less than 50 mm from concrete surfaces permanently exposed to view or exposed to water on the finished structure.

3.7.2 Form Coating

Coat forms, for exposed surfaces, with a nonstaining form release coating applied shortly before concrete is placed. 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.

3.7.3 Removal of Forms

Remove forms carefully to prevent damage to the concrete. Do not remove forms before the expiration of the minimum time indicated below:

3.8 STEEL REINFORCING

3.8.1 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.

3.8.2 Fabrication

Shop fabricate steel reinforcement in accordance with ACI MCP SET Parts 2 and 3. Shop details and bending shall be in accordance with ACI MCP SET Parts 2 and 3.

3.8.3 Splicing

Perform splices in accordance with ACI MCP SET Parts 2 and 3.

3.8.4 Supports

Secure reinforcement in place by the use of metal or concrete supports, spacers, or ties.

3.9 EMBEDDED ITEMS

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

3.10 BILL OF LADING

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

3.11 FIELD TESTING

- a. Provide samples and test concrete for quality control during placement. Sampling of fresh concrete for testing shall be in accordance with ASTM C 172.
- b. Test concrete for compressive strength at 7 and 28 days for each design mix. Concrete test specimens shall conform to ASTM C 31/C 31M. Perform Compressive strength testing conforming to ASTM C 39/C 39M.
- c. Test Slump at the site of discharge for each design mix in accordance with ASTM C 143/C 143M.
- d. Test air content for air-entrained concrete in accordance with ASTM C 231. Test concrete using lightweight or test extremely porous aggregates in accordance with ASTM C 173/C 173M.
- e. Determine temperature of concrete at time of placement in accordance with ASTM C 1064/C 1064M.

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COMMON WORK RESULTS FOR ELECTRICAL

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COMMON WORK RESULTS FOR ELECTRICAL
11/08

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.

ASTM INTERNATIONAL (ASTM)

ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.28 (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity

IEEE C57.12.29 (2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

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

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2003) Acceptance Testing Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA RN 1 (2005) Standard for Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

NEMA TC 2 (2003) Standard for Electrical Polyvinyl Chloride (PVC) Tubing and Conduit

NEMA TC 3 (2004) Standard for Polyvinyl Chloride PVC Fittings for Use With Rigid PVC Conduit and Tubing

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2007; AMD 1 2008) National Electrical Code - 2008 Edition

UNDERWRITERS LABORATORIES (UL)

UL 6 (2007) Standard for Electrical Rigid Metal Conduit-Steel

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Conduits, Raceways and Fittings; G
Spare Parts

SD-06 Test Reports

Continuity Test; G
Phase-Rotation Tests; G
Insulation Resistance Test; G

SD-08 Manufacturer's Instructions

Submit Manufacturer's Instructions.

1.3 PREVENTION OF CORROSION

Protect metallic materials against corrosion. Provide equipment enclosures with the standard finish by the manufacturer when used for most indoor installations. Do not use aluminum when in contact with earth or concrete and, where connected to dissimilar metal, protect by approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

1.4 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.
- b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

1.5 GENERAL REQUIREMENTS

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

1.6 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

- a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
- b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
- c. Safety precautions.
- d. The procedure in the event of equipment failure.
- e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and be secured to prevent easy removal or peeling.

1.7 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.8 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm. Lettering shall be a minimum of 6.35 mm high normal block style. Nameplates shall have beveled edges and shall be fastened to equipment with stainless steel screws.

1.9 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

- a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers and pad-mounted SF6 switches, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and have nominal dimensions of 178 by 255 mm with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 50 mm high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPS0710D72 or approved equal.

PART 2 PRODUCTS

2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products, and meet the requirements of NFPA 70 and UL when UL standards are established for those items.

2.1.1 Rigid Steel Conduit

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

Fittings for rigid steel conduit shall be threaded. Split couplings are not permitted.

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

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

2.1.2 Rigid Nonmetallic Conduit

Rigid nonmetallic conduit shall comply with NEMA TC 2 and NEMA TC 3 with wall thickness not less than Schedule 40.

PART 3 EXECUTION

3.1 CONDUITS, RACEWAYS AND FITTINGS

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

Do not install crushed or deformed conduit. Avoid trapped conduit runs where possible. Take care to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clear any clogged conduit of obstructions or be replaced.

3.1.1 Rigid Steel Conduit

Make field-made bends and offsets with approved hickey or conduit bending machine. Conduit elbows larger than 65 millimeter shall be long radius.

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

3.1.2 Rigid Nonmetallic Conduit

Rigid PVC conduit shall be direct buried.

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

3.2 IDENTIFICATION PLATES AND WARNINGS

Furnish identification plates for all pad mounted and vault style switches, identifying the equipment served, voltage, phase(s) and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

3.3 FIELD TESTING

Submit Test Reports in accordance with referenced standards in this section.

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

Contractor shall provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

Isolate completely all wire and cable 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.

Perform Insulation-Resistance Test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Take readings after 1 minute and until the reading is constant for 15 seconds. Minimum insulation-resistance values shall not be less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes 8AWG and smaller insulation resistance testing is not required.

Perform Continuity Test to insure correct cable connection (i.e correct phase conductor, grounded conductor, and grounding conductor wiring) end-to-end. Any damages to existing or new electrical equipment resulting from contractor mis-wiring will be repaired and re-verified at contractor's expense. All repairs shall be approved by the CO prior to acceptance of the repair.

Conduct Phase-Rotation Tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. Do not energize any conductor until the final test reports are reviewed and approved by the CO.

3.4 FIELD TEST EQUIPMENT

Provide evidence of calibration to Contracting Officer prior to initial

tests.

Date of last calibration and certification shall conform to NETA ATS and consist of:

1. The testing organization shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.
2. The firm providing calibration service shall maintain up to date instrument calibration instructions and procedures for each test instrument calibrated.
3. The accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).
4. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a) Field instruments: Analog and Digital, 12 months maximum. .
 - b) Laboratory instruments: 12 months maximum.
 - c) Leased specialty equipment: 12 months maximum.
5. Dated calibration labels shall be visible on all test equipment.
6. Records, which show date and results of instruments calibrated or tested, must be kept up to date.
7. Calibrating standard shall be of better accuracy than that of the instrument tested.

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MEDIUM VOLTAGE CABLE

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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

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

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

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8 (2000) 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

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 400.2 (2004) Guide for Field Testing of Shielded
Power Cable Systems Using Very Low
Frequency (VLF)

IEEE Std 404 (2006) Extruded and Laminated Dielectric
Shielded Cable Joints Rated 2500 V Through
500 000 V

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(2007; AMD 1 2008) National Electrical
Code - 2008 Edition

1.2 DEFINITIONS

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

1.3 GENERAL REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL apply to work specified in this section.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

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

Pulling Plan; G

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

Splicer / Terminator Certifications; G

SD-03 Product Data

Provide manufacturer's catalog data for the following items:

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

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; G
Accelerated Water Absorption Test; G
Water Immersion Test; G
Ionization; G
High-Voltage; G
Qualification Test Reports; G
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; G
Terminations; G
Splice Kits; G (including splice grounding)

1.5 QUALIFICATIONS

Personnel performing Medium Voltage (MV) splicing must have 5 years 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 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 terminations shall be required to perform a minimum of one splice or termination of each type in the presence of a manufacturer's 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 termination or splice has been started by a splicer, the same splicer must 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:

Use 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 4.5 meters.

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 Reports 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 1524 millimeter in diameter must have arbor holes sized for 65 millimeter spindles; those greater than 1524 millimeter in diameter must have arbor holes sized for 76 millimeter 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 1.8 meters 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 or non-conducting shield over the conductors, 5.59 millimeter 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 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 2 millimeter.

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, must be provided with a factory applied coating of polyvinylchloride of at least 0.51 millimeter thick. Polyvinylchloride (PVC) coated items must have a uniform thickness and be free of blisters, breaks, and holidays. PVC compound must conform to ASTM D 746.

Cable racks, rack arms and related fittings must 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.

2.8.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 31 MPa; and that are 0.9 millimeter thick, non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 150 degrees C. Provide a one-piece nylon, self-locking tie at

each end of the cable tag. Ties must have a minimum loop tensile strength of 780 newtons. The cable tags must have block letters, numbers, and symbols 25 millimeter high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags orientation.

2.9 FIREPROOF TAPE

Fireproof tape must be approximately 0.8 millimeter thick by 76 millimeters 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

The Contractor shall 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. The Contractor shall notify the Contracting Officer 48 hours in advance of this mandatory inspection point.

As part of the mandatory inspection point, the Contractor shall positively identify and label the medium voltage cable to be worked utilizing electronic cable identifier. The process of identifying and labeling the cable to be worked shall be witnessed by the Government. Cable cutting and demolition of any medium voltage cable shall only occur 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 150 millimeters 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 300 millimeters long and must have a diameter 13 millimeters 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. Pull a series of four-50 millimeter wire brushes back and forth through the duct. Progressively increase the size of the four wire brushes until four-100 millimeter wire brushes can be pulled back and forth, and all of the debris has been removed. Next pull a flexible mandrel with two-100 millimeter heavy duty wire brushes on each side through the duct. The mandrel must not be less than 300 millimeters long, and must have a diameter that is 13 millimeters to 25 millimeters less than the inside diameter of the duct. Next, pull a 1.5 meter 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

Submit a pulling plan.

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 (760 millimeter minimum) quadrant block cable pulling sheaves and necessary jamb skid support must be used at the pulling end to ensure that sidewall pressures during pulling are not excessive. Use a dynamometer in the pulling line to ensure that the pulling force is not exceeded. The pulling force must 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 28,900 newtons for pulling eyes. The allowable tension on cable must not exceed the value computed from the following equation:

$$TM = 0.036 \times N \times CM$$

Where: TM = maximum allowable pulling tension in newtons

N = number of conductors in the cable

CM = cross-sectional area of each conductor in square millimeter

The allowable sidewall pressure is the smaller of 7300 newtons per meter of bend radius or the cable manufacturer's recommended maximum value. The pulling plan submittal must 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 must be unreeled from the top of the reel. Payout must be carefully controlled. Cable to be pulled must 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 760 millimeter. 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 760 millimeter minimum bending radius of the cable during the pulling operations.

Cables shall be pulled into ducts at a speed not to exceed 15 meters 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 600 millimeters.

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 300 millimeter and a maximum 750 millimeter 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 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 25 millimeter into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure-sensitive glass cloth tape.

3.2.6 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.

3.3 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 must 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 must be 5000 megohms at an ambient temperature of 20 degrees C. Readings taken at other than 20 degrees C ambient temperatures 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 Cable Test Form.
- 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) (New cable)	Acceptance (phase to ground test values) (Existing cable spliced to new cable)
(rms voltage, KV)	(peak voltage, KV)	(peak voltage, KV)
15	28	22; (EPR TO EPR)
15	15	15; (EPR TO NON-EPR)

- 4) The sinusoidal test frequency shall be 0.1 Hertz.

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 must be clean and dry and must 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 --

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SF6 INSULATED PAD-MOUNTED SWITCHGEAR
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 NATIONAL STANDARDS INSTITUTE (ANSI)

- | | |
|----------------|---|
| ANSI C37.60 | (1986; R 1992) Requirements for Overhead, Pad-mounted Dry-Vault and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems |
| ANSI C37.72 | (1987) Standard for Manually-Operated Dead-Front Pad Mounted Switchgear with Load Interrupting Switches and Separable Connections for Alternating-Current Systems |
| ANSI C57.12.29 | (1999) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |

ASTM INTERNATIONAL (ASTM)

- | | |
|-------------|--|
| ASTM A 167 | (1999; R 2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM D 2472 | (2000; R 2006) Standard Specification for Sulphur Hexafluoride |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

- | | |
|----------------|---|
| IEEE C2 | (2007; Errata 2007; INT 2008) National Electrical Safety Code |
| IEEE C57.12.29 | (2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |
| IEEE C62.11 | (2005; Amendment A 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV) |
| IEEE Std 386 | (2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

- | | |
|----------|--|
| NETA ATS | (2003) Acceptance Testing Specifications |
|----------|--|

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62271-111 (2005) High Voltage Switchgear And Controlgear Part 111: Overhead, Pad-Mounted, Dry Vault, And Submersible Automatic Circuit Reclosers And Fault Interrupters For Alternating Current Systems Up To 38 Kv

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C37.72 (1987) Manually-Operated, Dead-Front Padmounted Switchgear with Load Interrupting Switches and Separable Connectors for Alternating-Current Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2007; AMD 1 2008) National Electrical Code - 2008 Edition

NFPA 70B (2006; Errata 2007) Electrical Equipment Maintenance

UNDERWRITERS LABORATORIES (UL)

UL 467 (2007) Standard for Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL apply to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

1.3.1 Switched Way

A switched way is considered a three-phase circuit entrance to the bus through a switch. For single-phase switches, it is a single-phase entrance to the bus through a switch.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Provide shop drawings for Switchgear Drawings; G including the following:

Nameplate Diagram
Single-Line Diagram for switch
Connection Diagram for overcurrent protection including CT/PT

wiring, auxiliary power supplies, if any
Outline Drawing, showing plan and elevation views, with complete dimensions
Time-current coordination curves for all available trip settings, plotted on standard log-log coordination paper

SD-03 Product Data

Electronic Overcurrent Control Curves; G
SF6 Insulated Pad-mounted Switchgear; G
Insulated High-Voltage Connectors; G
Surge Arresters; G
Accessories; G
Vacuum Interrupters; G
Electronic Trip Units; G
Switch Enclosures; G, including material composition
Equipment Finish; G Paint Coating System - material and application description
Remote Operators

Each submittal shall include data on switches and associated accessories. Each submittal shall include manufacturer's information for each component, device and accessory provided with the equipment.

SD-06 Test Reports

Acceptance Checks and Tests; G
Design and production test reports for switches shall be submitted and shall be in accordance with ANSI C37.60 and ANSI C37.72.
Basic Impulse Level (BIL)
One Minute Withstand Rating
Momentary and Fault Closing Rating, Asymmetrical and Symmetrical
Mechanical Operational Check
Leak Tests

SD-07 Certificates

Paint Coating System; G

SD-09 Manufacturer's Field Reports

Switchgear design and production tests; G

SD-10 Operation and Maintenance Data

O&M Data shall include
Wiring Diagrams

Maintenance and testing schedules
Recommended Spare Parts List

SF6 Insulated Pad-mounted Switchgear Operation and Maintenance,
Data Package 5; G

SF6 Insulated Pad-mounted Switchgear; G

Accessories; G

Vacuum Interrupters; G

Electronic Trip Units; G

Once equipment is approved and at least 30 days prior to field testing, request trip unit settings from the Government.

1.5 QUALITY ASSURANCE

1.5.1 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

- a. Overall dimensions, weights, plan view, and front view
- b. Ratings
- c. Single-line diagram.

1.5.2 Paint Coating System

Submit IEEE C57.12.29 paint coating system performance requirement tests.

1.5.3 Electronic Overcurrent Control Curves

Provide time-current characteristic curves (on full size logarithmic paper) and instruction manuals for the electronic overcurrent control.

1.6 MAINTENANCE

1.6.1 SF6 Insulated Pad-mounted Switchgear Operation and Maintenance Data

PART 2 PRODUCTS

2.1 SF6 INSULATED PAD-MOUNTED SWITCHGEAR

NEMA C37.72

2.1.1 Ratings and Test Requirements

The voltage rating of the switchgear shall be 15.5 kV. The corresponding ratings associated with the required switchgear voltage rating shall be as follows:

Rated Maximum Voltage, kV	15.5
Rated Withstand Impulse Voltage, kV BIL	95
Continuous and Load Interrupting Current, A	600
Short-Time Current, kA rms Sym	12
Short-Circuit interrupting Current,	

kA rms Sym

12

Switched ways shall be rated for the required continuous and load interrupting current. Short-circuit interrupting current rating applies to fault interrupting switched ways only.

2.1.1.2 Switchgear Construction

Switch contacts and cable entrance terminations shall be contained in an SF6 filled stainless steel tank. Switchgear shall be shipped factory filled with SF6 gas conforming to ASTM D 2472. Switchgear shall be configured with load interrupting and fault interrupting switched ways as indicated. Switchgear shall have front accessible terminations suitable for cables entering from below with the manual operating provisions mounted on the rear. Switch contact positions for switched ways shall be visible through viewing windows in the SF6 tank located adjacent to the manual operating provisions. Provide gas pressure gage in viewable location from switch operating handle. Each switched way shall have three position switch; Open, Closed, Ground.

2.1.2.1 Pad-mounting Provisions

Provide enclosed switchgear suitable for installation on a concrete pad. Switchgear support frame enclosure base and enclosure shall be fabricated of ASTM A 167 type 304 or 304L stainless steel. Enclosure base shall include any part of the switchgear enclosure that is within 75 mm of concrete pad. Paint switchgear tank and support frame enclosure including base No. 70 light gray. Paint coating system shall have the manufacturer's standard Equipment Finish for highly corrosive areas and shall comply with IEEE C57.12.29.

2.1.3 Load Interrupting Switched Ways

Load interrupter switched ways shall provide three-pole group operated switching.

2.1.4 Fault Interrupting Switched Ways

IEC 62271-111. Provide non-fused, non-reclosing, manual reset, Vacuum Interrupters consisting of vacuum bottles and a spring assisted operating mechanism. Each fault interrupting switched way shall utilize internally mounted current transformers and an electronic overcurrent control to provide three-pole ganged tripping and three-phase faults. The electronic overcurrent control shall have provisions for a wide variety of field selectable time-current characteristic curves with ten field selectable trip levels through a current range of 600 amperes. Fault interrupting switched ways shall have provisions for remote tripping via an external dry contact device.

2.1.5 Dead-Front High-Voltage Bushings

IEEE Std 386. 15 kV, 95 kV BIL. Provide 600 ampere one-piece deadbreak apparatus bushings for switched ways and 200 ampere bushing wells with bushing well inserts for fault interrupting switched ways as indicated.

- a. Parking stands: Provide a parking stand near each dead-front bushing. Provide insulated standoff bushings for parking of energized load-break connectors on each parking stands.

2.2 Insulated High-Voltage Connectors

IEEE Std 386. Provide corresponding connector for each switched way. Connectors shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

- a. 200 Ampere loadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 10,000 rms symmetrical amperes.
- b. 600 Ampere deadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 40,000 rms symmetrical amperes. Connectors shall have 200 ampere bushing interface for surge arresters as indicated.

2.3 Surge Arresters

IEEE C62.11, rated 10 kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Provide arresters on switched ways as indicated.

2.4 SF6 Refill Cylinders

Provide two SF6 refill cylinders, minimum size of 6 pounds of SF6; include regulator, valves, and hose for connection to the fill valve of the switch.

2.5 SOURCE QUALITY CONTROL

2.5.1 Switchgear Design and Production Tests

Furnish reports which include results of design and production tests performed according to NEMA C37.72. Production tests shall be performed by the manufacturer on each switchgear assembly to ensure that design performance is maintained in production.

2.5.2 Electronic Trip Units

Electronic trip units shall be solid-state, powered from the current transformers used for sensing or by means of internal potential transformers (PTs). Use of cable fault indicators in lieu of electronic trip units is not acceptable.

Trip units shall be capable of being set for true RMS single-phase or three-phase with neutral sensing capabilities. Trip units shall be capable of being set to provide protection curves including, but not limited to, standard "CO" type overcurrent relay curves and/or mimic the following fuse types: "E", "K", "KS", "QA", "EF", "T".

Trip settings shall be adjustable locally at the switch without requiring removal of the trip unit or the use of a computer or other external programming device. The trip settings shall be clearly visible from the front panel of the trip unit. The units shall not rely on volatile electronic memory to retain their trip settings.

The following trip functions shall be provided:

- Time overcurrent
- Instantaneous
- Ground Fault

Trip units shall provide visible trip indication by phase, which shall remain after a trip event, until the unit is manually reset.

Trip units shall be capable of operating satisfactorily in a coastal, humid climate with temperatures from minus 10 degrees C to 65 degrees C.

If trip unit is not a typical industry standard device (having standard bench testing capabilities), then one test kit shall be provided to provide for in-service functional testing of each trip function. The test kits shall be products of the trip unit manufacturer.

2.5.3 Switch Tank

The switch tank shall be a single tank, factory welded using a minimum 304L stainless steel. The switch tank shall be braced to withstand momentary and full load current duty. The following standard components shall be included:

- Filling valve with gauge.
- Lifting eyes.

- Viewing windows to permit inspection of the switch contacts and means of seeing visible status indication of the vacuum interrupters.

- Gas pressure gauge in viewable location from switch operating handle.

- One line diagram and stainless steel nameplate fastened with stainless steel mechanical fasteners.

- Provide a welded flange ready to accept a future gas pressure switch.
- Provide parking stands for each switched and interrupter way.

2.5.4 Accessories

Provide the following accessories for each switch.

2.5.5 Insulated Medium-Voltage Connectors

Insulated Medium-voltage connectors shall conform to IEEE Std 386. Connector shall 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, 95 kV BIL. Short time rating: 10,000 amperes rms, symmetrical for a time duration of 0.17 seconds.
- b. 600 Ampere deadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 27,000 amperes rms, symmetrical for a time duration of 4.0 seconds. Provide 200 Ampere interface connector (loadbreak reducing plug) for the indicated surge arrester.

2.5.6 Remote Operators

Each switch shall have provisions and equipment necessary to enable operating any way of the switch from a distance of no less than 25 feet, not necessarily in a straight line from the switch. This remote operation feature may be achieved by either manual operation or remote electrical

operation.

2.5.7 Other Operational Features

Fittings, lifting eyes, insulators, and other required operational features or tools, shall be provided with the switch as necessary.

2.5.8 Auxiliary Contacts

Auxiliary contacts to indicate switch/interrupter position status (for future SCADA connection) shall be provided and wired to terminal blocks external to the SF6 enclosure, but enclosed within the overall enclosure.

2.6 SWITCH ENCLOSURES

2.6.1 Pad-Mounted Switch Enclosures

Enclosures shall be in accordance with ANSI C57.12.29 and shall be equipped with a ground bus capable of carrying the rated fault current for one second for each way. Enclosures shall be sized such that the centerline of the apparatus bushing shall be a minimum of 36 inches above the base of the enclosure. Further, there shall be a minimum depth of 24 inches for the interior of the cabinet housing cable terminations.

The overall switch enclosure shall be made of a minimum grade of 304L stainless steel with suitable stiffeners. All flanges shall overlap and interlock. Access to the switch and cable compartments shall be through hinged doors and a hood (if required). The door shall have stiffeners to prevent warping and miss alignment. The doors shall fit to the enclosure to provide a watertight seal. The roof of the enclosure shall be sloped from the center to the edge to prevent standing water.

Switch enclosures shall include:

- Recessed or removable lifting provisions.
- Padlocking provisions
- Mounting provisions internal to the enclosure for anchoring to the pad.
- Minimum 300 series stainless steel hardware.
- Door stops and stays to prevent accidental closing.

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 be as specified in Section 28 05 26.00 40, "GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY" and NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms. When work, in addition to that indicated or specified, is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 28 05 26.00 40,

"GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY" as indicated.

3.2.2 Switchgear Grounding

Connect #4/0 bare copper conductor ground loop, not less than 610 mm below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide #4/0 bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

3.2.3 Connections

Make joints in grounding conductors and ground loop by exothermic weld. Exothermic welds shall be installed as specified in Section 28 05 26.00 40, "GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY".

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount switch on concrete slab. Slab shall be at least 300 mm thick, reinforced with a 152 x 152 - MW19 x MW19 mesh, placed uniformly 100 mm from the top of the slab. Slab shall be placed on a 150 mm thick, well-compacted gravel base. Top of concrete slab shall be approximately 100 mm above finished grade. Edges above grade shall have 15 mm chamfer. Slab shall be of adequate size to project at least 200 mm beyond equipment.

Stub up conduits, with bushings, 150 mm into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training areas. Concrete work shall be as specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

3.4 FIELD QUALITY CONTROL

3.4.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards.

At least 30 days prior to field testing, request trip unit settings from the Government.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.4.1.1 Switchgear

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate information with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Check for proper anchorage, physical damage, alignment, required area clearances, and grounding.
- (4) Inspect doors, panels, and sections for paint, dents,

- (5) Verify that insulating SF6 gas pressure is correct.
- (6) Inspect all indicating devices for proper operation.
- (7) Inspect connections for tightness of bolted joints.
- (8) Lubricate as required.

b. Electrical Tests

- (1) Perform contact-resistance tests.
- (2) Trip fault interrupters by operation of overcurrent.
- (3) Perform insulation-resistance tests.
- (4) Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.
- (5) Set fault interrupter overcurrent control in accordance with government provided settings. Request settings from government, in writing, a minimum of 30 days prior to scheduling electrical tests.
- (4) Perform resistance measurements through accessible bolted electrical connections with a resistance ohmmeter, if applicable.
- (5) Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute. Test voltage shall be in accordance with manufacturer's published data or NETA ATS, Table 10.1.
- (5) Verify open and close operation from control devices, if applicable.

3.4.1.2 Grounding System

a. Visual and Mechanical Inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

Submit the measured ground resistance of each ground rod and

grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.4.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that devices are in good operating condition and properly performing the intended function. 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 and tests.

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GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

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SECTION 28 05 26.00 40

GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY
11/08

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.

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 (Part 1) Normal Measurements

JOHN F. KENNEDY SPACE CENTER (KSC)

KSC-STD-E-0012 (Rev E, 2001) Standard for Facility Grounding and Lightning Protection

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2007; AMD 1 2008) National Electrical Code - 2008 Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-889 (Rev B, Notice 3) Dissimilar Metals

UNDERWRITERS LABORATORIES (UL)

UL 467 (2007) Standard for Grounding and Bonding Equipment

1.2 GENERAL REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL applies to work specified in this section.

Grounding shall comply with KSC-STD-E-0012.

1.3 SUBMITTALS

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

accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit Record Drawings in accordance with paragraph entitled, "Drawings," of this section.

SD-03 Product Data

Submit equipment and performance data for the following items including life, test, system functional flows, safety features, and mechanical automated details.

Submit Manufacturer's catalog data for the following items:

Ground Rods; G
Ground Wires; G
Connectors and Fasteners; G
Bonding; G

SD-06 Test Reports

Submit Test Reports for the following tests on grounding systems in accordance with the paragraph entitled, "Field Tests," of this section. Within the report include certified record of ground-resistance tests grounding electrodes.

Bond Resistance Test; G
Ground Resistance Tests; G

SD-08 Manufacturer's Instructions

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

1.4 DRAWINGS

Identify the location of each ground rod and ground-rod assembly and other grounding electrodes by letter in alphabetical order and keyed to the record of ground-resistance tests.

PART 2 PRODUCTS

2.1 GROUND RODS

Ground rods must conform to the requirements of NFPA 70 and UL 467.

Ground rods must be copper-clad steel rods not less than 20 millimeter in diameter and not less than 3000 millimeter long per section. Ground rods must be clean and smooth and have a cone-shaped point on the first section and be die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in millimeter.

2.2 GROUND WIRES

Ground wires must be in accordance with Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

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

2.3 CONNECTORS AND FASTENERS

Grounding and bonding fasteners and connectors must conform to the requirements of UL 467, and Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

Grounding and bonding fasteners must be copper.

Bonding straps and jumpers must be copper and have a cross-sectional area of not less than 4.12 millimeter diameter (No. 6 AWG).

PART 3 EXECUTION

3.1 BONDING AND GROUNDING

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

3.2 GROUNDING ELECTRODES

Grounding electrodes must include ground rods installed expressly for grounding systems. Install ground rods using a water jetting procedure.

Minimum ground rod section must be 3000 millimeter. Thread sections together and exothermically fusion weld.

Install ground rods for equipment so that the top of the rod is 100 millimeter above grade.

Install ground rods for ductbank so that the top of the rod is not less than 450 millimeter below finished grade.

3.3 GROUND GRIDS

Ground grids must consist of a series of ground rods installed with interconnecting grounding conductors between ground rods. Space ground rods as noted.

Do not bury ground grid less than 450 millimeter below the finish grade. Grounding conductors must not be less than 11.7 millimeter diameter (No. 4/0 AWG) and must be exothermically fusion welded together at crossover points and to ground rods.

3.4 EQUIPMENT GROUNDING

Noncurrent carrying metallic parts of electrical equipment, including metallic cable sheaths, conduit, raceways, and electrical structural members, must be bonded together and connected to the ground grid or ground connection rods.

3.5 GROUNDING CONNECTIONS

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

Exothermic weld ground connections that are buried or in inaccessible locations.

Clean, grease, and remove foreign matter from ground connection surfaces. Do not penetrate clad material in the cleaning process. Make connection between like metals where possible. Where dissimilar metals are welded, brazed, or clamped, follow the weld kit manufacturer's instructions. Connections between dissimilar metals must not produce galvanic action in accordance with MIL-STD-889.

3.6 BONDING

3.6.1 Type of Bonds

Accomplish bonding of metal surfaces by welding. 3.6.1.1 Welding

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

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

3.6.1.2 Clamping

In external locations, use clamping only where a disconnect type of connection is required. Connection device may utilize threaded fasteners. Construct device such that positive contact pressure is maintained at all times. Use machine bolts with tooth-type lockwashers.

3.6.2 Cleaning of Bonding Surfaces

Thoroughly clean surfaces that comprise the bond before joining. Apply an appropriate abrasive with gentle and uniform pressure to ensure a smooth and uniform surface. Do not remove excessive metal from the surface. Clean clad metals in such a manner that the cladding material is not penetrated by the cleaning process. Then clean bare metal with an appropriate solvent to remove any grease, oil, dirt, corrosion preventives, and other contaminants. Bond to the cleaned area must be made within one hour after cleaning. Seal joint and refinish the exposed surfaces within two hours of exposure to prevent oxidation. When additional time is required, apply a corrosion preventive compound until the area can be refinished.

3.6.3 Bonding Straps and Jumpers

Install jumpers such that the vibration by the shock-mounted device will not change its electrical characteristics.

Braze bonds for outdoor locations unless a disconnect type of connection is required. When a disconnect is required, use clamping with bolts. Insert a tooth-type lockwasher between the strap and metallic member for each bolt.

Bond straps directly to the basic structure and do not penetrate any adjacent parts. Install straps in an area that is accessible for

maintenance.

Use single straps for the bonds and install such that they will not restrict movement of structural members. Do not connect two or more straps in series.

Install straps such that they will not weaken structural members to which they are attached.

3.6.4 Equipment and Enclosure Bonding

Each metallic enclosure and all electrical equipment must be bonded to ground. At least one copper connection must be made from the system ground point to one or more enclosures in the area such that all enclosures and equipment provide a low-impedance path to ground when properly bonded together.

3.6.5 Bonding of Conduit and Raceway Systems

Bond all metal conduit, fittings, junction boxes, outlet boxes, armored and metal sheathed cable, and other raceways. Take care 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 must be no exposed threads. Ream all ends of the conduit to remove burrs and rough edges. Conduits entering boxes and enclosures must 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 must be bonded separately on either side of the link. Dielectric link must not be jumpered.

3.6.6 Protection of Finished Bonds

Protect finished bonds by painting to match the original finish after the bond is made.

3.7 FIELD TESTS

Perform the following tests in the presence of the Contracting Officer.

3.7.1 Bond Resistance Test

Resistance of any bond connection must not exceed 0.5 milliohm. Rework bonds that exceed this resistance at no additional cost to the Government.

3.7.2 Ground Resistance Tests

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

Ground resistance and counterpoise tests must be made during dry weather, and no sooner than 48 hours after rainfall. Conduct tests 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. Perform measurements in accordance with IEEE Std 81.

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

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SECTION 33 05 23.19

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 (2007; AMD 1 2008) National Electrical Code - 2008 Edition

1.2 RELATED REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

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

1.4 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.

1.4.1 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.

2.2 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 33 71 02.00 20 UNDERGROUND ELECTRICAL 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 33 71 02.00 20, "UNDERGROUND ELECTRICAL DISTRIBUTION". Clean and dress all areas disturbed by Contractor operations and provide for re-establishing grass as described in Section 33 71 02.00 20, "UNDERGROUND ELECTRICAL 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 01 78 00, "Closeout Submittals".

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 produce evidence, when required, that any item of work has been constructed in accordance with drawings and specifications.

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SECTION 33 71 02.00 20

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SECTION 33 71 02.00 20

UNDERGROUND ELECTRICAL DISTRIBUTION
08/08

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.

ASTM INTERNATIONAL (ASTM)

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

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

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2007; AMD 1 2008) National Electrical Code - 2008 Edition

UNDERWRITERS LABORATORIES (UL)

UL 514B (2004; Rev thru Aug 2007) Standard for Conduit, Tubing and Cable Fittings

UL 651 (2005; Rev thru May 2007) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings

1.2 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.
- b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.
- c. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Pulling-In Irons; G
Conduit, ducts, and Fittings; G
Separators; G
Counterpoise Ground Conductor; G
Buried Warning and Identification Tape; G
Electronic Locating System Equipment; G

1.4 QUALITY ASSURANCE

1.4.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.2.1 Material and Equipment Manufacturing Date

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

PART 2 PRODUCTS

2.1 Conduit, ducts, and Fittings

2.1.1 Plastic Conduit for Direct Burial

UL 651, Schedule 40.

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.

2.1.2 SEPARATORS

51 millimeter plastic duct spacer assembly that will provide a complete enclosed and locked-in conduit assembly is required for all duct banks.

2.1.3 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 5 kV 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".

2.1.4 ELECTRONIC LOCATING SYSTEM EQUIPMENT

The Contractor shall provide electronic ball markers at all direct-buried cable splices. Ball markers shall be made of red polyethylene and 4-inches in diameter. The Contractor shall also provide two electronic marker locators of the appropriate frequency to work with the ball markers.

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. Ground rods shall be installed at 30 meter intervals with two 3000x20mm rods at each location.

2.1.5 MARKERS

Markers shall be made of 20 megapascal concrete. Markers shall be 305mm square and 150mm deep. The top of the markers shall be engraved with the words "ELECTRICAL CABLE BELOW" and an arrow showing the direction of the cable. The letters and arrows shall be V-shaped and shall have a width of stroke of at least 6mm at the top and a depth of 6mm. Markers shall be installed with the engraved face 50mm above the surface, except at roadways, sidewalks or parking lots where it shall be installed flush with the surface.

2.1.6 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 2 degrees C (35 degrees

F), shall neither slump at a temperature of 150 degrees C (300 degrees F), nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials. Inflatable bladders may be used as an option.

2.1.7 Fittings

2.1.7.1 PVC Conduit Fittings

UL 514B, UL 651.

2.As specified in Section 26 05 13.00 98, MEDIUM VOLTAGE CABLE. 2.4 TAPEE 2.5 PULL ROPE

Shall be plastic or flat pull line (bull line) having a minimum tensile strength of 890 N.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 and IEEE C2.

3.2 CABLE INSPECTION

Prior to installation, each cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable prior to installation in accordance with the cable manufacturer's recommendations.

3.3 CABLE INSTALLATION PLAN AND PROCEDURE

As specified in Section 26 05 13.00 98, MEDIUM VOLTAGE CABLE.

3.4 UNDERGROUND STRUCTURE CONSTRUCTION3.4.1 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices shall be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor the irons shall be a minimum of 150 mm from the edge of the sump, and in the walls the irons shall be located within 150 mm of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron shall not be located within 150 mm of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the 150 mm clearance previously

stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 915 mm length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner shall be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of 75 mm from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons shall have a clear projection into the structure of approximately 100 mm and shall be designed to withstand a minimum pulling-in load of 26,700 N. Irons shall be hot-dipped galvanized after fabrication.

3.5 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.5.1 Requirements

Depths to top of the conduit shall be in accordance with NFPA 70. Run conduit in straight lines except where a change of direction is necessary. Numbers and sizes of ducts shall be as indicated. Ducts shall have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of 80 mm per 30 m. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 450 mm (18 inches) for ducts of less than 80 mm (3 inch) diameter, and 900 mm (36 inches) for ducts 80 mm (3 inches) or greater in diameter. Otherwise, long sweep bends having a minimum radius of 7.6 m shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in structures.

3.5.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3.5.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes 75 mm and larger, draw a flexible testing mandrel approximately 305 mm long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes less than 75 mm, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.5.4 Conduit Plugs and Pull Rope

New conduit indicated as being unused or empty shall be provided with plugs on each end. Plugs shall contain a weep hole or screen to allow water drainage. Provide a plastic pull rope having 915 mm of slack at each end of unused or empty conduits.

3.5.5 Conduit and Duct Without Concrete Encasement

Provide not less than 75 mm clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 75 mm, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 6.25 mm sieve. The first 150 mm layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 75 to 150 mm layers. Provide yellow plastic warning tape to read "CAUTION, BURIED ELECTRIC LINE BELOW". Install as indicated.

3.6 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70.

3.6.1 Reconditioning of Surfaces

3.6.1.1 Unpaved Surfaces

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

3.6.1.2 Paving Repairs

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists, restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.

-- End of Section --