PCN	DOCUMENT RELEASE AUTHORIZATION KENNEDY SPACE CENTER, NASA	PAGE 1 OF 2
98860		REV/DATE
ESR N/A		
DIR N/A	DRA NO. A-DRA01 -1462	SIGNATURE
EFF NFLT	TITLE Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Area at KSC	
EQ. LOC. (1)		VEN CODE
SDL N/A		CONTRACT NNK11CA25B/NNK11CA24T

DOCUMENTS

#	PREF	DOCUMENT NUMBER	ISSUE	SIZE	SHTS	B/L NO.	SS	MODEL NUMBER	WUC
1	EO	EO1-79K39135 EDDR, 1	NEW	A	2	353.01	OC	K61-0553	OCFACC0000
		2-22	"	F	21		S1	K61-3416	S1FAC6H000
							K8	K61-3426	K8FAC60000
							MS	K61-0546	MSFAC60000
							K-	K60-0419	K-FAC90000
						353.04	OC	K61-0553-01	OCFACCL000
						353.05	K8	K61-3427	K8FAC6L000
							LO	K61-0506-01	LOFAC9L000
						353.85	S1	K61-3098	S1FACAB000
2	SP	79K39136	A	A	630	"	"	"	"
3	SW	EO1-79K39135**	NEW	M	1	"	"	"	"
4	SW	79K39136**	A	M	1	"	"	"	"
5	STDY	KSC-TA-12383 Cover,1-126,235-238	NEW	A	131				
		127-234	"	B	108	"	"	"	"
6	SW	KSC-TA-12383**	NEW	M	1	"	"	"	"

TECHNICAL REMARKS

** Magenetic Media Release

(1) M7-0355, M7-0360, M7-0407, M7-0996, M7-0355, M6-0399, UK-0020

APPROVALS

TECHNICAL CONTACT	MAIL CODE	DATE	R&QA	MAIL CODE	DATE
Sudhir Mehta	TA-B3B	1-17-2013	Barry Braden	SA-E3	1-18-13
TECHNICAL			OTHER		
Jim Miller	TA-B3B	1/17/2013			
SPACE AND WEIGHT			JOINT RELEASE		
PROCUREMENT PKG.			RELEASE Phil Bennardo	TA-B3B	1/17/13

1-23-13

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DRA	SA-E3	BARRY BRADEN			
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DRA	ISC-4010	JIM PRATTEN			
DRA	ISC-4300	GURKAMAL AUJLA			
DRA	ISC-2100	SON HO			
DRA	TA-B4A	RENE PEREZ			
DRA	SA-E3	GARY HENDRICKS			
DRA	IHA-200	NICK ALEMAN			
DRA	IHA-200	KRISTINA HERPICH			
DRA	IHA-200	TIM TYNDALL			
DRA	ISC-4210	DON HAINSEY			
1P	ISC-4220	AMY MARONI			
DRA	ISC-2510	VICTOR ALLPISTE			
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DRA	OP-CS	RICHARD JOHANBOEKE			
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APPLICATION		REVISION HISTORY					
NEXT ASSY	USED ON	PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL
				A	Added ZSI and Misc. Corrections	1/24/13	SSM

TECHNICAL SPECIFICATIONS FOR DRAWING 79K39135

DOCUMENT INFORMATION: (TITLE, NUMBER, REV, DATE)

79K39136 REV A
Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Processing Areas
PCN 98860

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INSTRUCTIONS: This item must be reviewed under the requirements for "Sensitive But Unclassified Information" as described in NPR 1600.1, Chapter 5.

http://nodis-dms.gsfc.nasa.gov

	Yes	No	SBU Reviewer's Signature	Date	Company / Org
Document contains SBU?	☐	☒	C P Bennardo	01/24/13	NASA/ TA-33B

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Contractor EC Reviewer's Name and Organization	Contractor EC Reviewer's Signature	Date

NASA ECO Reviewer's Name and Organization	NASA ECO Reviewer's Signature	Date
C. P. BENNARDO TA-33B	C. P. Bennardo	01/24/13

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CAD MAINTAINED. CHANGES SHALL BE INCORPORATED ONLY BY THE DESIGN ACTIVITY.

SOFTWARE		
FILENAME		
MATERIAL		
HEAT TREATMENT		
FINAL PROTECTIVE FINISH		

ORIGINAL DATE OF DRAWING (YY/MM/DD)

DRAFTSMAN	CHECKER	
ENGINEER G. Davis	CHECKER	
ENGINEER G. Kerly	STRESS	
ENGINEER S. Mehta		9/25/12
SUBMITTED J. Miller		9/25/12
APPROVED P. Bennardo		9/25/12

JOHN F. KENNEDY SPACE CENTER, NASA
KENNEDY SPACE CENTER, FLORIDA

Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Processing Areas
PCN 98860
January 15, 2013

SIZE	CAGE CODE	DWG NO	REV
A		79K39136	A
SCALE		UNIT WEIGHT	SHEET 1 OF 630

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Technical Specifications
Revitalize Medium Voltage Electrical Distribution Systems,
Industrial and Payload Processing Areas
PCN 98860

Technical Specifications

Architect / Engineer of Record
Certification

Project Title:	Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Processing Areas
Project Control Number:	98860
Project Drawing Number:	79K39135
Project Specification Number:	79K39136 Revision A

Discipline	Name	ST	License No.	Signature
Civil	Vicki Hartman	FL	54611	VM Hartman 1/14/13
Architectural	Domenick Morelli	OH	9820	D Morelli 1/14/13
Structural	Saeed Hassani	FL	42590	Saeed Hassani 1/14/13
Electrical	Garret Kerly	FL	54952	Garret Kerly 1/14/13
Electrical	Glenn Davis	FL	66443	Glenn A Davis 1/14/13

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-- End of Project Table of Contents --

SECTION 01 11 00

SUMMARY OF WORK
08/11

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

1.1.1 Project Description

The work to be performed under this project consists of providing all labor, equipment, and materials, tools, test equipment, specialized services, and subcontracts to revitalize various medium and low voltage power systems in the KSC Industrial Area as indicated and specified.

The work includes but is not limited to the following:

a. Demolition, replacement, and installation of underground medium voltage cable systems, 5kV and 15kV.

b. Installation of underground duct systems (including directional boring) for medium voltage and low voltage cable systems.

c. Demolition, replacement, and installation of 5kV medium voltage cable systems and low voltage cable systems in conduit and cable tray systems.

d. Installing new and replacing various 15kV load break switches with SF6 Insulated Pad-Mounted Switchgear of the Vacuum Interrupter and Vault Style Load Break types.

e. Demolition of existing secondary unit substations (5kV and 480V).

f. Replacing various transformer and substation (5kV and 480V) equipment including reconnection to existing electrical distribution.

g. Incidental and miscellaneous power system work including medium and low voltage equipment connections, medium and low voltage wiring splices, low voltage power distribution, labeling, painting, and grounding.

h. Site work (excavation, backfill, concrete, bollards, de-watering, water utility, etc.) associated with underground electrical, medium voltage switch, transformer, and substation work. Contractor shall provide new bollards in the locations specified on the drawings to receive bollards. During construction, the Contractor may inquire as to the availability of salvage bollards from the KSC Landfill on Schwartz Road, and may make use of salvage bollards pending availability.

i. Hazardous material sampling and abatement (paint, oil, and asbestos).

j. Installation of communications equipment and wiring for power metering and control equipment.

k. Installation of power metering equipment.

l. Switchgear control power and control systems including the use of programmable logic controllers and Schweitzer Engineering protective relay systems.

m. Power system analysis, coordination studies, arc-flash studies, and protective relay settings.

n. Power system equipment testing and validation including factory testing, customized field testing, and NETA testing.

o. Specialized software integration and communications work to connect, monitor, and control, power metering, PLC, and protective relays from KSC's existing KCCS system (Citect based SCADA system).

1.1.2 Work Sequencing

The work shall be sequenced as follows:

a. Feeder 202/203, Feeder 204/205, and Feeder 212 work required to install and energize new VFI-31, VFI-32, and VFI-212 shall be expedited and performed first. Install and mark duct stub outs for connection of parallel timeline work installing a new high rise "Central Campus" facility.

b. Connection of existing M7-355 (O&C) medium voltage Feeder 202/203 and 204/205 distribution (Feeders 6 and 8) from Substation 159 A and B transformers to new VFI-31 and VFI-32 (including new metering) before any modifications occur on M7-355 Feeders 6 and 8 supplied by existing VFI-18 and VFI-19.

c. At M7-355 (O&C), demolish existing Substations B and C to provide space for installation of new 480V Substations A and B. Transition existing Substations D, E, and F loads to Substations A and B one at a time. Demolish existing Substations D, E, and F after all loads are transferred.

d. M7-355 (O&C) MCC A which serves the M7-407 Industrial Area Chiller Plant condenser water system must not be de-energized unless all condenser water equipment supplied by Substation 119 is energized.

e. The new M7-407 Industrial Area Chiller Plant Substation 119 must be completely installed and all loads transferred prior to demolishing the existing Substation 119. Generally, the plant shall run on A-Bus load while B-Bus loads are being transferred and vice-versa.

f. Feeder 202/203 outages cannot occur during 204/205/212 work and vice-versa; these feeders back each other up.

g. Feeder 101 outages cannot occur during 102 work and vice-versa; these feeders back each other up.

h. Feeder 213 outages cannot occur during 215 work and vice-versa; these feeders back each other up.

i. Unless no spare ducts are available, new feeder cable shall be installed and energized prior to the demolition of the cable replaced.

1.1.3 Location

The work shall be located at the John F. Kennedy Space Center, Florida.

1.2 CONTRACT DRAWINGS

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

Drawing No. 79K39135 (Sheets 1 through 92) including
Drawing No. EO1-79K39135 (Sheets 1 through 22)

1.3 EPA DESIGNATED ITEMS INCORPORATED IN THE WORK

Various sections of the specifications contain requirements for materials that have been designed by EPA as being products which are or can be made with recovered recycled materials. These items, when incorporated into the work under this contract, shall contain at least the specified percentage of recycled or recovered material.

1.4 AVAILABILITY OF CADD DRAWING FILES

After award and upon request, the electronic "Computer-Aided Drafting and Design (CADD)" drawing files will only be made available to the Contractor for use in preparation of shop submittal and record drawings and data related to the referenced contract subject to the following terms and conditions.

a. Data contained on these electronic files shall not be used for any purpose other than as a convenience in the preparation of construction drawings and data for the referenced project. Use or reuse of these drawings shall be at the sole risk of the Contractor.

b. These electronic CADD drawing files are not construction documents. Differences may exist between the CADD files and the corresponding construction documents. The Government makes no representation regarding the accuracy or completeness of the electronic CADD files, nor does it make representation to the compatibility of these files with the Contractor's hardware or software. In the event that a conflict arises between the signed and sealed construction documents prepared by the Government and the furnished CADD files, the signed and sealed construction documents shall govern. The Contractor is responsible for determining if any conflict exists. Use of these CADD files does not relieve the Contractor of duty to fully comply with the contract documents, including and without limitation, the need to check, confirm and coordinate the work of all Contractors for the project.

c. If the Contractor uses, duplicates and/or modifies these electronic CADD files for use in producing construction drawings and data related to this contract, all previous indicia of ownership (seals, logos, signatures, initials and dates) shall be removed.

1.5 ELECTRONIC MAIL (E-MAIL) ADDRESS

The Contractor shall establish and maintain electronic (e-mail) capability along with the capability to open various electronic attachments in Microsoft, Adobe Acrobat, and other similar formats. Within 10 days after contract award, the Contractor shall provide the Contracting Officer a single (only one) e-mail address for electronic communications from the Contracting Officer related to this contract including, but not limited to contract documents, invoice information, request for proposals, and other correspondence. The Contracting Officer may also use e-mail to notify the Contractor of Base access conditions when emergency conditions warrant,

such as hurricanes, terrorist threats, etc. Multiple e-mail addresses will not be allowed.

It is the Contractor's responsibility to make timely distribution of all Contracting Officer initiated e-mail with its own organization including field office(s). The Contractor shall promptly notify the Contracting Officer, in writing, of any changes to this e-mail address.

1.6 OCCUPANCY OF PREMISES

Building(s) will be occupied during performance of work under this Contract.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 33 00

SUBMITTAL PROCEDURES
05/11

PART 1 GENERAL

1.1 SUMMARY

Contractor's Quality Control (CQC) System Manager and the Designer of Record, if applicable, to check and approve all items prior to submittal and stamp, sign, and date indicating action taken. Proposed deviations from the contract requirements are to be clearly identified. Include within submittals items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals.

Submittals requiring Government approval are to be scheduled and made prior to the acquisition of the material or equipment covered thereby. Pick up and dispose of samples not incorporated into the work in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

1.2 DEFINITIONS

1.2.1 Submittal Descriptions (SD)

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

SD-01 Preconstruction Submittals

Submittals which are required prior to a notice to proceed.

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.

All shop drawings shall be produced using Bentley Microstation or AutoCad (.DXF or .DWG format). Final record shop drawing submittals shall include both digital media source files and .pdf files for all shop drawings.

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-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

SD-05 Design Data

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

Design submittals, design substantiation submittals and extensions of design submittals.

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.

Investigation reports.

Daily logs and checklists.

Final acceptance test and operational test procedure.

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.

Document required of Contractor, or of a manufacturer, supplier, installer or Subcontractor through Contractor, the purpose of which is to further quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

Confined space entry permits.

Text of posted operating instructions.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and (MSDS)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.

Interim "DD Form 1354" with cost breakout for all assets 30 days prior to facility turnover.

1.2.2 Approving Authority

Office or designated person authorized to approve submittal; Contracting Officer (CO) or when designated the Contracting Officer's Technical

Representative (COTR).

1.2.3 Work

As used in this section, on- and off-site construction required by contract documents, including labor necessary to produce submittals, except those SD-01 Pre-Construction Submittals noted above, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor QC approval. Submit the following in accordance with this section.

SD-01 Preconstruction Submittals

Certificates of Insurance

Surety Bonds; G

List of Proposed Subcontractors; G

Construction Schedule; G

Schedule of Values; G

Health and Safety Plan; G

Demolition Plan; G

Quality Control Plan; G

Environmental Protection Plan; G

1.4 PRE-CONSTRUCTION SUBMITTALS

Submit the following:

- Surety Bonds
- List of Proposed Subcontractors
- Construction Schedule
- Schedule of Values
- Health and Safety Plan
- Demolition Plan
- Quality Control Plan
- Environmental Protection Plan

1.5 PREPARATION

1.5.1 Transmittal Form

Transmit submittals with transmittal form prescribed by Contracting Officer and standard for project. On the transmittal form identify Contractor, indicate date of submittal, and include information prescribed by transmittal form and required in paragraph entitled, "Identifying Submittals," of this section.

1.5.2 Identifying Submittals

When submittals are provided by a Subcontractor, the Prime Contractor is to prepare, review and stamp with Contractor's approval all specified submittals prior to submitting for Government approval.

Identify submittals, except sample installations and sample panels, with the following information permanently adhered to or noted on each separate component of each submittal and noted on transmittal form. Mark each copy of each submittal identically, with the following:

a. Project title and location.

b. Construction contract number.

c. Date of the drawings and revisions.

d. Name, address, and telephone number of subcontractor, supplier, manufacturer and any other subcontractor associated with the submittal.

e. Section number of the specification section by which submittal is required.

f. Submittal description (SD) number of each component of submittal.

g. When a resubmission, add alphabetic suffix on submittal description, for example, submittal 18 would become 18A, to indicate resubmission.

h. Product identification and location in project.

1.5.3 Format for SD-02 Shop Drawings

Shop drawings are not to be less than 8 1/2 by 11 inches nor more than 30 by 42 inches, 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.

Present 8 1/2 by 11 inch sized shop drawings as part of the bound volume for submittals required by section. Present larger drawings in sets.

Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to information required in paragraph entitled, "Identifying Submittals," of this section.

Number drawings in a logical sequence. 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.

Reserve a blank space, no smaller than 3 inches on the right hand side of each sheet for the Government disposition stamp.

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.

Include the nameplate data, size and capacity on drawings. Also include applicable federal, military, industry and technical society publication references.

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

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.

Indicate, by prominent notation, each product which is being submitted; indicate specification section number and paragraph number to which it pertains.

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.

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.

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.

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 without prior approval of KSC.

Submit manufacturer's instructions prior to installation.

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

Provide design data and certificates on 8 1/2 by 11 inch paper. Provide a bound volume for submittals containing numerous pages.

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

Provide reports on 8 1/2 by 11 inch paper in a complete bound volume.

Indicate by prominent notation, each report in the submittal. Indicate specification number and paragraph number to which it pertains.

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

Comply with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA for O&M Data format.

1.5.8 Format of SD-01 Preconstruction Submittals and SD-11 Closeout Submittals

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.

1.6 QUANTITY OF SUBMITTALS

Submit twelve (12) copies of submittals of shop drawings requiring review and approval. Four (4) sets marked with review notations by the Contracting Officer will be returned to the Contractor.

All submittals shall be approved prior to the start of work detailed by the submittals.

1.7 VARIATIONS

Variations from contract requirements require a Deviation Waiver (DW).

1.8 GOVERNMENT REVIEW

1.8.1 Review Notations

Contracting Officer review will be completed within 28 calendar days after date of submission. Submittals will be returned to the Contractor with the following notations:

a. Submittals marked "approved" or "accepted" authorize the Contractor to proceed with the work covered.

b. Submittals marked "approved as noted" "or approved except as noted, resubmittal not required," authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections.

c. Submittals marked "not approved" or "disapproved," or "revise and resubmit," indicate noncompliance with the contract requirements or design concept, or that submittal is incomplete. Resubmit with appropriate changes. No work shall proceed for this item until resubmittal is approved.

1.9 DISAPPROVED OR REJECTED SUBMITTALS

Contractor shall make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned

submittals to constitute a change to the contract drawings or specifications; notice as required under the clause entitled, "Changes," is to be given to the Contracting Officer. Contractor is responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Government requiring rejection and removal of such work at the Contractor's expense.

If changes are necessary to submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change is to be accomplished until the changed submittals are approved.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS
08/10

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 B564 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.

AMERICAN CONCRETE INSTITUTE 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
444 North Capital Street, NW, Suite 249
Washington, DC 20001
Ph: 202-624-5800
Fax: 202-624-5806
E-Mail: info@aashto.org
Internet: http://www.aashto.org

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)
1330 Kemper Meadow Drive
Cincinnati, OH 45240
Ph: 513-742-2020 or 513-742-6163
Fax: 513-742-3355
E-mail: mail@acgih.org
Internet: http://www.acgih.org

AMERICAN HARDBOARD ASSOCIATION (AHA)
1210 West Northwest Highway
Palatine, IL 60067
Ph: 847-934-8800
Fax: 847-934-8803

E-mail: aha@hardboard.org
Internet: http://www.hardboard.org

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)
One East Wacker Drive, Suite 700
Chicago, IL 60601-1802
Ph: 312-670-2400
Fax: 312-670-5403
Publications: 800-644-2400
E-mail: pubs@aisc.org
Internet: http://www.aisc.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 RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)
10003 Derekwood Lane, Suite 210
Lanham, MD 20706
Ph: 301-459-3200
Fax: 301-459-8077
Internet: http://www.arema.org

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)
1800 East Oakton Street
Des Plaines, IL 60018-2187
Ph: 847-699-2929
Fax: 847-768-3434
E-mail: customerservice@asse.org
Internet: http://www.asse.org

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

AMERICAN WELDING SOCIETY (AWS)
550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353 - 305-443-9353
Fax: 305-443-7559
E-mail: info@aws.org or customerservice@awspubs.com
Internet: http://www.aws.org

ASPHALT INSTITUTE (AI)
Research Park Drive
P.O. Box 14052
Lexington, KY 40512-4052
Ph: 859-288-4960
Fax: 859-288-4999
E-mail: info@asphaltinstitute.org

Internet: http://www.asphaltinstitute.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
E-Mail: aeicdir@bellsouth.net
Internet: http://www.aeic.org

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9585
Fax: 610-832-9555
E-mail: service@astm.org
Internet: http://www.astm.org

COMPRESSED GAS ASSOCIATION (CGA)
4221 Walney Road, 5th Floor
Chantilly, VA 20151
Ph: 703-788-2700
Fax: 703-961-1831
E-mail: cga@cganet.com
Internet: http://www.cganet.com

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)
933 North Plum Grove Road
Schaumburg, IL 60173-4758
Ph: 847-517-1200 or 800-328-6306
Fax: 847-517-1206
Internet: http://www.crsi.org/

FLORIDA ADMINISTRATIVE CODE (FAC)
Florida Department of State
R.A. Gray Building
Mail Station 22
Tallahassee, FL 32399-0250
Ph: 850-245-6270
Fax: 850-245-6282

FM GLOBAL (FM)
270 Central Avenue
P.O. Box 7500
Johnston, RI 02919
Ph: 401-275-3000 ext. 1945
Fax: 401-275-3029
E-mail: servicedesk.myrisk@fmglobal.com
Internet: http://www.fmglobal.com

FOREST STEWARDSHIP COUNCIL (FSC)
212 Third Avenue North
Suite 280
Minneapolis, MN 55401
Ph: 612-353-4511
Fax: 612-208-1565
E-mail: info@fscus.org

Internet: http://www.fscus.org

GREEN SEAL (GS)
1001 Connecticut Avenue, NW
Suite 827
Washington, DC 20036-5525
Ph: 202-872-6400
Fax: 202-872-4324
E-mail: greenseal@greenseal.org
Internet: http://www.greenseal.org

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)
703 Waterford Way (NW 62nd Avenue), Suite 600
Miami, FL 33126
Ph: 305-264-7772
Fax: 305-264-8088
Internet: http://www.iata.org

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
445 Hoes Lane or 2001 L Street, NW. Suite 700
Piscataway, NJ 08855-1331 or Washington, DC 20036-4910 USA
Ph: 732-981-0060 or 800-701-4333
Fax: 732-562-6380
E-mail: onlinesupport@ieee.org or ieeeusa@ieee.org
Internet: http://www.ieee.org

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
P.O. Box 1568
Carrollton, GA 30112
Ph: 1 800 447 3352
Fax: 1 303 397 2599
E-mail: global@ihs.com
Internet: http://www.icea.net

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)
3166 South River Road, Suite 132
Des Plaines, IL 60018
Ph: 847-827-0830
Fax: 847-827-0832
Internet: http://www.icri.org

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

3050 Centre Ave. Suite 102
Portage, MI 49024
Ph: 269-488-6382
Fax: 269-488-6383
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
E-mail: custserv@iec.ch
Internet: http://www.iec.ch

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)
3000 Lakeside Drive, 309S
Bannockburn, IL 60015
Ph: 847-615-7100
Fax: 847-615-7105
E-mail: webmaster@ipc.org
Internet: http://www.ipc.org

JOHN F. KENNEDY SPACE CENTER (KSC)
National Aeronautics and Space Administration
Center Operations (TA)
Kennedy Space Center
Kennedy Space Center, FL 32899

MASTER PAINTERS INSTITUTE (MPI)
2800 Engleton Avenue
Burnaby, BC CANADA V5C 6G7
Ph: 604-298-7578
Fax: 604-298-7571
E-mail: info@paintinfo.com,jody@mpi.net,bgl@mpi.net
Internet: http://www.paintinfo.com/mpi

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
1300 North 17th Street, Suite 1752
Rosslyn, VA 22209
Ph: 703-841-3200
Fax: 703-841-5900
Internet: http://www.nema.org/

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
1 Batterymarch Park
Quincy, MA 02169-7471
Ph: 617-770-3000 or 800-344-3555
Fax: 617-770-0700
E-mail: webmaster@nfpa.org
Internet: http://www.nfpa.org

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)
Mail Stop C-34
4676 Columbia Parkway
Cincinnati, OH 45226
Ph: 513-533-8611
Fax: 513-533-8285
E-mail: nioshdocket@cdc.gov
Internet: http://www.cdc.gov/nchs/products.htm

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)
100 Bureau Drive
Stop 1070
Gaithersburg, MD 20899-1070
Ph: 301-975-NIST (6478
E-mail: inquiries@nist.gov
Internet: http://www.nist.gov

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)
2, rue Andre Pascal
F-75775 Paris Cedex 16, France
Ph: + 33 1 45 24 82 00

Fax: 33 1 45 24 85 00
E-mail: bookshop@oecd.org
Internet: http://www.oecd.org
U.S. Contact Center
OECD Washington Center
2001 L Street, NW, Suite 650
Washington, DC 20036-4922
Ph: 202-785-6323
Fax: 202-785-0350
E-mail: washington.contact@oecd.org

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)
2200 Powell Street, Suite 725
Emeryville, CA 94608
Ph: 510-452-8000
Fax: 510-452-8001
Internet: http://www.scs1.com

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT (SJRWMD)
P.O. Box 1429
Palatka, FL 32178-1429
Ph: 386-329-4500

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)
40 24th Street, 6th Floor
Pittsburgh, PA 15222-4656
Ph: 412-281-2331
Fax: 412-281-9992
E-mail: info@sspc.org
Internet: http://www.sspc.org

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)
2500 Wilson Blvd,. Suite 300
Arlington, VA 22201
Ph: 703-907-7700
Fax: 703-907-7727
Internet: http://www.tiaonline.org

TURFGRASS PRODUCERS INTERNATIONAL (TPI)
2 East Main Street
East Dundee, IL 60118
Ph: 847-649-5555
Fax: 847-649-5678
E-mail: info@turfgrasssod.org
Internet: http://www.turfgrasssod.org

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Camas, WA 98607-8542
Ph: 877-854-3577
Fax: 360-817-6278
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Internet: http://www.ul.com/

U.S. ARMY CORPS OF ENGINEERS (USACE)
Order CRD-C DOCUMENTS from:
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Washington, DC 20314-1000
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or http://www.hnd.usace.army.mil/techinfo/engpubs.htm

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Fax: 704-852-4189
E-mail: seed.ams@usda.gov
Internet: http://www.ams.usda.gov/lsg/seed.htm
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Washington, DC 20250
Ph: 202-720-2791
Fax: 202-720-2166
Internet: http://www.usda.gov/rus

U.S. DEPARTMENT OF COMMERCE (DOC)
1401 Constitution Avenue, NW
Washington, DC 20230
Ph: 202-482-2000
Fax: 703-605-6900
E-mail: webmaster@doc.gov
Internet: http://www.commerce.gov/
Order Publications From:
National Technical Information Service (NTIS)
5301 Shawnee Road
Alexandria, VA 22312
Ph: 703-605-6050 or 1-888-584-8332
Fax: 703-605-6900
E-mail: info@ntis.gov
Internet: http://www.ntis.gov

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)
Order from:
HUD User
P.O. Box 23268
Washington, DC 20026-3268
Ph: 800-245-2691 or 202-708-9981
Fax: 202-708-9981
E-mail: helpdesk@Huduser.org
Internet: http://www.huduser.org

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)
Ariel Rios Building
1200 Pennsylvania Avenue, N.W.
Washington, DC 20004
Ph: 202-272-0167
for Fax and E-mail see below
Internet: http://www.epa.gov
--- Some EPA documents are available only from:
National Technical Information Service (NTIS)
5301 Shawnee Road
Alexandria, VA 22312
Ph: 703-605-6050 or 1-688-584-8332
Fax: 703-605-6900
E-mail: info@ntis.gov
Internet: http://www.ntis.gov

U.S. GENERAL SERVICES ADMINISTRATION (GSA)
General Services Administration
1800 F Street, NW
Washington, DC 20405
Ph: 202-501-0800
Internet: www.GSA.gov
Obtain documents from:
Acquisition Streamlining and Standardization Information System (ASSIST)
Department of Defense Single Stock Point (DODSSP)
Document Automation and Production Service (DAPS)
Building 4/D
700 Robbins Avenue
Philadelphia, PA 19111-5094
Ph: 215-697-6396 - for account/password issues
Internet: http://assist.daps.dla.mil/online/start/; account registration required

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
8601 Adelphi Road
College Park, MD 20740-6001
Ph: 866-272-6272
Fax: 301-837-0483
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Internet: http://www.archives.gov
Order documents from:
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732 North Capitol Street, NW
Washington, DC 20401
Ph: 202-512-1800
Fax: 202-512-2104
E-mail: contactcenter@gpo.gov
Internet: http://www.gpoaccess.gov

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

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SECTION 01 57 20.00 10

ENVIRONMENTAL PROTECTION

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.

FLORIDA ADMINISTRATIVE CODE (FAC)

Rule 62-701.200(14)	(2004) Definitions - Class III Waste
Chapter 62-730	(2006) Hazardous Waste
Chapter 62-737	(1998) Management of Spent Mercury-Containing Lamps and Devices Destined for Recycling
Section 62-340.300	(1994) Delineation of Wetlands

JOHN F. KENNEDY SPACE CENTER (KSC)

FAR Clause KSC 52.223-97	(2004) Hazardous Wastes
KNPR 8500.1, REV A-1	(2007) Environmental Requirements

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT (SJRWMD)

Chapter 40C-22, F.A.C.	(1996) Noticed General Permits for Consumptive Uses

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

33 CFR 328	Definitions of Waters of the United States
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 279	Standards for the Management of Used Oil
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 355	Emergency Planning and Notification
40 CFR 68	Chemical Accident Prevention Provisions
49 CFR 171 - 178	Hazardous Materials Regulations

1.2 ADDITIONAL REQUIREMENTS

The following are incorporated herein to the extent explicable to the

extent of the project:

Rule 62-701.200(14)	(2004) Definitions - Class III Waste
Chapter 62-730	(2006) Hazardous Waste
Chapter 62-737	(1998) Management of Spent Mercury-Containing Lamps and Devices Destined or Recycling
Section 62-340.300	(1994) Delineation of Wetlands
FAR Clause KSC 52.223-97	(2004) Hazardous Wastes
KNPR 8500.1, REV A-1	(2007) Environmental Requirements
Chapter 40C-22, F.A.C.	(1996) Noticed General Permits for Consumptive Uses

1.3 DEFINITIONS

1.3.1 Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally and/or historically.

1.3.2 Environmental Protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.3.3 Contractor Generated Hazardous Waste

Contractor generated hazardous waste means materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste streams would typically consist of material brought on site by the Contractor to execute work, but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e. methyl ethyl ketone, toluene etc.), waste thinners,excess paints, excess solvents, waste solvents, and excess pesticides, and contaminated pesticide equipment rinse water.

1.3.4 Land Application for Discharge Water

The term "Land Application" for discharge water implies that the Contractor shall discharge water at a rate which allows the water to percolate into the soil. No sheeting action, soil erosion, discharge into storm sewers, discharge into defined drainage areas, or discharge into the "Waters of the United States" shall occur. Land Application shall be in compliance with all applicable Federal and State regulations and NASA KSC policy.

1.3.5 Surface Discharge

The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers,creeks, and/or "Waters of the United States" and would require a permit to discharge water from the governing agency.

1.3.6 Waters of the United States

All waters which are under the jurisdiction of the Clean Water Act, as defined in 33 CFR 328.

1.4 GENERAL REQUIREMENTS

Minimize environmental pollution and damage that may occur as the result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of this contract. Comply with all applicable environmental Federal, State, and local laws and regulations. Any delays resulting from failure to comply with environmental laws and regulations will be the Contractor's responsibility.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Environmental Protection Plan; G

The environmental protection plan as indicated below.

1.6 ENVIRONMENTAL PROTECTION PLAN

Prior to commencing construction activities or delivery of materials to the site, submit an Environmental Protection Plan for review and approval by the Contracting Officer and NASA Environmental. The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental issues which the Contractor must address during construction. Issues of concern must be defined within the Environmental Protection Plan as outlined in this section. Address each topic at a level of detail commensurate with the environmental issue and required construction task(s). Topics or issues which are not identified in this section, but are considered necessary, must be identified and discussed after those items formally identified in this section. Prior to submittal of the Environmental Protection Plan, meet with the Contracting Officer for the purpose of discussing the implementation of the initial Environmental Protection Plan; possible subsequent additions and revisions to the plan including any reporting requirements; and methods for administration of the Contractor's Environmental Plans. The Environmental Protection Plan must be current and maintained onsite by the Contractor.

1.6.1 Compliance

No requirement in this Section will relieve the Contractor of any

applicable Federal, State, and local environmental protection laws and regulations. During Construction, the Contractor will be responsible for identifying, implementing, and submitting for approval any additional requirements to be included in the Environmental Protection Plan.

1.6.2 Contents

Include in the environmental protection plan, but not limit it to, the following:

a. Name(s) of person(s) within the Contractor's organization who is(are) responsible for ensuring adherence to the Environmental Protection Plan.

b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site, if applicable.

c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

d. Description of the Contractor's environmental protection personnel training program.

e. An erosion and sediment control plan which identifies the type and location of the erosion and sediment controls to be provided. The plan must include monitoring and reporting requirements to assure that the control measures are in compliance with the erosion and sediment control plan, Federal, State, and local laws and regulations. A Storm Water Pollution Prevention Plan (SWPPP) may be substituted for this plan.f. Drawings showing locations of haul roads, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on the site.

f. Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plan shall include measures to minimize the amount of mud transported onto paved public roads by vehicles or runoff.

g. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas including methods for protection of features to be preserved within authorized work areas.

h. A spill control plan with the procedures, instructions, and reports to be used in the event of an unforeseen spill of a substance regulated by 40 CFR 68, 40 CFR 302, 40 CFR 355, and/or regulated under State or Local laws and regulations and KSC Special Condition contract clauses. Include in this plan, as a minimum:

    1. The name of the individual who will report any spills or hazardous substance releases and who will follow up with complete documentation. This individual will immediately notify the Contracting Officer and NASA Environmental. Include in the plan a list of the required reporting channels and telephone numbers.

    2. The name and qualifications of the individual who will be responsible for implementing and supervising the containment and cleanup.

3. Training requirements for Contractor's personnel and methods of accomplishing the training.

4. A list of materials and equipment to be immediately available at the job site, tailored to cleanup work of the potential hazard(s) identified.

5. The names and locations of suppliers of containment materials and locations of additional fuel oil recovery, cleanup, restoration, and material-placement equipment available in case of an unforeseen spill emergency.

6. The methods and procedures to be used for expeditious contaminant cleanup.

i. A hazardous waste disposal plan identifying methods and locations for hazardous waste and universal waste training, identification, collection management, and disposal.

j. A non-hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris and schedules for disposal.

1. Identify any subcontractors responsible for the transportation and disposal of solid waste. Submit licenses or permits for solid waste disposal sites that are not a commercial operating facility.

2. Evidence of the disposal facility's acceptance of the solid waste must be attached to this plan during the construction. Attach a copy of each of the Non-hazardous Solid Waste Diversion Reports to the disposal plan. Submit the report for the previous quarter on the first working day after the first quarter that non-hazardous solid waste has been disposed and/or diverted (e.g. the first working day of January, April, July, and October).

3. Indicate in the report the total amount of waste generated and total amount of waste diverted in cubic yards or tons along with the percent that was diverted.

k. A recycling and solid waste minimization plan with a list of measures to reduce consumption of energy and natural resources. Detail in the plan the Contractor's actions to comply with and to participate in Federal, State, Regional, and local government sponsored recycling programs to reduce the volume of solid waste at the source.

l. An air pollution control plan detailing provisions to assure that dust, debris, materials, trash, etc., do not become air borne and travel off the project site.

m. A contaminant prevention plan that: identifies potentially hazardous substances to be used on the job site; identifies the intended actions to prevent introduction of such materials into the air, water, or ground; and details provisions for compliance with Federal, State, and local laws and regulations for storage and handling of these materials. A copy of the Material Safety Data Sheets (MSDS) and the maximum quantity of each hazardous material to be onsite at any given time must be included in the contaminant prevention plan. Update the plan as new hazardous materials are brought onsite or removed from the site.

n. A wastewater management plan that identifies the methods and procedures for management and/or discharge of wastewaters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines. If a settling/retention pond is required, the plan must include the design of the pond including drawings, removal plan, and testing requirements for possible pollutants. If land application will be the method of disposal for the wastewater, the plan must include a sketch showing the location for land application along with a description of the pretreatment methods to be implemented. If surface discharge will be the method of disposal, include a copy of the permit and associated documents as an attachment prior to discharging the wastewater. If disposal is to a sanitary sewer, the plan must include documentation that the Wastewater Treatment Plant Operator has approved the flow rate, volume, and type of discharge.

1.6.3 Appendix

Attach to the Environmental Protection Plan, as an appendix, copies of all required environmental permits, permit application packages, approvals to construct, notifications, certifications, reports, and termination documents.

1.7 ENVIRONMENTAL ASSESSMENT OF CONTRACT DEVIATIONS

Any deviations from the drawings, plans and specifications, requested by the Contractor and which may have an environmental impact will be subject to approval by the Contracting Officer and may require an extended review, processing, and approval time. The Contracting Officer reserves the right to disapprove alternate methods, even if they are more cost effective, if the Contracting Officer determines that the proposed alternate method will have an adverse environmental impact.

1.8 NOTIFICATION

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with Federal, State or local environmental laws or regulations, permits, and other elements of the Contractor's Environmental Protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or equitable adjustments allowed to the Contractor for any such suspensions. This is in addition to any other actions the Contracting Officer may take under the contract, or in accordance with the Federal Acquisition Regulation or Federal Law.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 LAND RESOURCES

3.1.1 Contractor Facilities and Work Areas

The Contractor's field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only when approved.

3.2 WATER RESOURCES

Monitor all water areas affected by construction activities to prevent pollution of surface and ground waters. Do not apply toxic or hazardous chemicals to soil or vegetation unless otherwise indicated. For construction activities immediately adjacent to impaired surface waters, the Contractor must be capable of quantifying sediment or pollutant loading to that surface water when required by State or Federally issued Clean Water Act permits.

3.3 AIR RESOURCES

Equipment operation, activities, or processes performed by the Contractor shall be in accordance with all Federal and State air emission and performance laws and standards.

3.3.1 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from abrasive blasting; shall be controlled at all times. The Contractor shall maintain stockpiles, haul roads, permanent and temporary access roads, spoil areas, and other work areas within or outside the project boundaries free from particulates which would cause the Federal, State, and local air pollution standards to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. Provide sufficient, competent equipment available to accomplish these tasks. Perform particulate control as the work proceeds and whenever a particulate nuisance or hazard occurs. The Contractor shall comply with all State and local visibility regulations.

3.3.2 Burning

Burning is prohibited on the Government premises.

3.4 MATERIALS MANAGEMENT AND WASTE DISPOSAL

Disposal of wastes shall be as directed below, unless otherwise specified in other sections and/or shown on the drawings.

3.4.1 Solid Wastes

Place solid wastes (excluding clearing debris) in containers which are emptied on a regular schedule. Handling, storage, and disposal must be conducted to prevent contamination. Employ segregation measures so that no

hazardous or toxic waste will become co-mingled with solid waste.

3.4.2 Chemicals and Chemical Wastes

Chemicals shall be dispensed ensuring no spillage to the ground or water. Periodic inspections of dispensing areas to identify leakage and initiate corrective action shall be performed and documented. This documentation will be periodically reviewed by the Government. Chemical waste shall be collected in corrosion resistant, compatible containers. Collection drums shall be monitored and removed to a staging or storage area when contents are within 6 inches of the top. Wastes shall be classified, managed, stored, and disposed of in accordance with Federal, State, and local laws and regulations.

3.4.3 Contractor Generated Hazardous Wastes/Excess Hazardous Materials

Hazardous wastes are defined in 40 CFR 261, or are as defined by applicable Federal, State and local regulations and KSC Special Condition contract clauses. Hazardous materials are defined in 49 CFR 171 - 178. Manage and store hazardous waste in compliance with Federal and State regulations and KSC Special Condition contract clauses. Take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing.

3.4.4 Fuel and Lubricants

Storage, fueling and lubrication of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spill and evaporation. Fuel, lubricants and oil shall be managed and stored in accordance with all Federal, State, Regional, and local laws and regulations. Used lubricants and used oil to be discarded must be stored in marked corrosion-resistant containers and recycled or disposed of in accordance with 40 CFR 279, State and local laws and regulations, and KSC Special Condition contract clauses.

3.4.5 Wastewater

Disposal of wastewater shall be as specified below.

a. Wastewater from construction activities, such as onsite material processing, concrete curing, foundation and concrete clean-up, water used in concrete trucks, forms, etc. shall be disposed of in accordance with NASA KSC Special Condition contract clauses.

3.5 CONSTRUCTION AND DEMOLITION PROJECTS REPORT

The Contractor shall maintain an inventory of non-hazardous solid waste diversion and disposal of construction and demolition debris. The Contractor shall submit a report (KSC Form 7-648 NS (02/07),to NASA Environmental through the Contracting Officer on a monthly basis and keep a log on site per direction of the Contracting Officer. The following shall be included in the report:

a. Construction and Demolition (C&D) Debris Disposed = _____ in cubic yards or tons, as appropriate.

b. Construction and Demolition (C&D) Debris Recycled = _____ in cubic yards or tons, as appropriate.

c. Total C&D Debris Generated = _____ in cubic yards or tons, as

appropriate.

d. Waste Sent to Waste-To-Energy Incineration Plant (This amount should not be included in the recycled amount) = _____ in cubic yards or tons, as appropriate.

e. Metal Recycled = in tons, as appropriate.

3.6 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

Refer to NASA KSC Special Condition contract clauses.

3.7 PREVIOUSLY USED EQUIPMENT

Clean all previously used construction equipment prior to bringing it onto the project site. Ensure that the equipment is free from soil residuals, egg deposits from plant pests, noxious weeds, and plant seeds. Consult with the USDA jurisdictional office for additional cleaning requirements.

3.8 MAINTENANCE OF POLLUTION FACILITIES

The Contractor shall maintain permanent and temporary pollution control facilities and devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.9 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel shall be trained in all phases of environmental protection and pollution control. The Contractor shall conduct environmental protection/pollution control meetings for all Contractor personnel prior to commencing construction activities. Additional meetings shall be conducted for new personnel and when site conditions change. The training and meeting agenda shall include: methods of detecting and avoiding pollution; familiarization with statutory and contractual pollution standards; installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental protection/pollution control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of archaeological sites, artifacts, wetlands, and endangered species and their habitat that are known to be in the area.

3.10 POST CONSTRUCTION CLEANUP

The Contractor shall clean up all areas used for construction. The Contractor shall, unless otherwise instructed in writing by the Contracting Officer, obliterate all signs of temporary construction facilities such as haul roads, work area, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the work. The disturbed area shall be graded, filled and the entire area sodded unless otherwise indicated.

-- End of Section --

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SECTION 01 74 19

CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT
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 E 1609	(2001) Development and Implementation of a Pollution Prevention Program

JOHN F. KENNEDY SPACE CENTER (KSC)

Article J-D-25	Recycling and Salvaging Materials
Article J-C-38	Non-Hazardous Waste Diversion Report

1.2 GOVERNMENT POLICY

Government policy is to apply sound environmental principles in the design, construction and use of facilities. As part of the implementation of that policy the Contractor shall: (1) practice efficient waste management when sizing, cutting, and installing products and materials and (2) use all reasonable means to divert construction and demolition waste from landfills and incinerators and to facilitate their recycling or reuse. Solid waste shall be diverted from the landfill by recycling means wherever possible.

1.3 MANAGEMENT

Develop and implement a waste management program in accordance with ASTM E 1609 and as specified. Take a pro-active, responsible role in the management of construction and demolition waste and require all subcontractors, vendors, and suppliers to participate in the effort. Construction and demolition waste includes products of demolition or removal, excess or unusable construction materials, packaging materials for construction products, and other materials generated during the construction process but not incorporated into the work. In the management of waste consideration shall be given to the availability of viable markets, the condition of the material, the ability to provide the material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates. The Contractor is responsible for implementation of any special programs involving rebates or similar incentives related to recycling of waste. Revenues or other savings obtained for salvage, or recycling accrue to the Contractor. Appropriately permit firms and facilities used for recycling, reuse, and disposal for the intended use to the extent required by federal, state, and local regulations. Also, provide on-site instruction of appropriate separation, handling, recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Waste Management Plan; G

SD-11 Closeout Submittals

Records; G

1.5 MEETINGS

Conduct Construction Waste Management issues during preconstruction, pre-demolition, and regular project status meetings. After award of the Contract and prior to commencement of work, schedule and conduct a meeting with the Contracting Officer to discuss the proposed Waste Management Plan and to develop a mutual understanding relative to the details of waste management. At a minimum, environmental and waste management goals and issues shall be discussed at the regular project status meetings:

1.6 WASTE MANAGEMENT PLAN

A waste management plan shall be submitted within 30 days after contract award and not less than 10 days before the pre-demolition meeting. The plan shall demonstrate how the project waste diversion goal shall be met and shall include the following:

a. Name of individuals on the Contractor's staff responsible for waste prevention and management.

b. Actions that will be taken to reduce solid waste generation, including coordination with subcontractors to ensure awareness and participation.

c. Description of the regular meetings to be held to address waste management.

d. Description of the specific approaches to be used in recycling/reuse of the various materials generated, including the areas on site and equipment to be used for processing, sorting, and temporary storage of wastes.

e. Characterization, including estimated types and quantities, of the waste to be generated. The following wastes related to existing building systems are expected on this project include but are not limited to the following (list does not include Contractor generated waste):

1. Insulated wire is to be removed from KSC by the Contractor for recycling or disposal.

2. Unpainted metal is to be returned to the government for recycling.

3. Painted metals are to segregated and disposed of in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION and Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS.

4. Sealed lead-acid batteries are to have terminals tape, be palletized one-high on plastic sheets and shrink-wrapped. Lead acid batteries to be taken to Ransom Road Material Reutilization Yard. Contractor shall coordinate with URS Construction Inspector to obtain required paperwork.

5. Electronic components used on Simplex network communications (network related electronic circuit cards and power supplies) are to be returned to the government for re-use.

6. Any removed electronic rack equipment is to be returned to the government for reuse.

f. Name of landfill and/or incinerator to be used and the estimated costs for use, assuming that there would be no salvage or recycling on the project.

g. List of specific waste materials that will be salvaged for resale, salvaged and reused on the current project, salvaged and stored for reuse on a future project, or recycled. Recycling facilities that will be used shall be identified by name, location, and phone number, including a copy of the permit or license for each facility.

h. Identification of materials that cannot be recycled/reused with an explanation or justification, to be approved by the Contracting Officer.

i. Description of the means by which any waste materials identified in item (h) above will be protected from contamination.

j. Description of the means of transportation of the recyclable materials (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site).

k. Anticipated net cost savings determined by subtracting Contractor program management costs and the cost of disposal from the revenue generated by sale of the materials and the incineration and/or landfill cost avoidance.

Revise and resubmit Plan as required by the Contracting Officer. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations or meeting project cumulative waste diversion requirement. Distribute copies of the Waste Management Plan to each subcontractor, the Quality Control Manager, and the Contracting Officer.

1.7 RECORDS

Records shall be maintained to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the Construction and Demolitions Project Form (KSC 7-648)

1.8 REPORTS

Submit the Construction and Demolition Projects Report (KSC Form 7-648 NS (02/07)) to the NASA Environmental Management Branch through the

Contracting Officer (CO) on a monthly basis and keep a log on site per direction of the Contracting Officer in accordance with environmental contract clause, Article J-D-25, Recycling and Salvaging Materials.

1.9 COLLECTION

Separate, store, protect, and handle at the site identified recyclable and salvageable waste products in a manner that maximizes recyclability and salvagability of identified materials. Provide the necessary containers, bins and storage areas to facilitate effective waste management and clearly and appropriately identify them. Provide materials for barriers and enclosures around recyclable material storage areas which are nonhazardous and recyclable or reusable. Locate out of the way of construction traffic. Provide adequate space for pick-up and delivery and convenience to subcontractors. Recycling and waste bin areas are to be kept neat and clean, and recyclable materials shall be handled to prevent contamination of materials from incompatible products and materials. Clean contaminated materials prior to placing in collection containers. Use cleaning materials that are nonhazardous and biodegradable. Handle hazardous waste and hazardous materials in accordance with applicable regulations and coordinate with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION and Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS. Separate materials by the following method:

1.9.1 Source Separated Method

Waste products and materials that are recyclable shall be separated from trash and sorted as described below into appropriately marked separate containers and then transported to the respective recycling facility for further processing. Deliver materials in accordance with recycling or reuse facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process). Separate materials into the following category types as appropriate to the project waste and in accordance with environmental contract clause Article J-C-19:

a. Concrete and masonry

b. Metal (e.g. banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized, stainless steel, aluminum, copper, zinc, lead brass, bronze).

(1) Ferrous.

(2) Non-ferrous.

c. Wood (nails and staples allowed).

d. Debris.

e. Glass (colored glass allowed).

f. Paper.

(1) Bond.

(2) Newsprint.

(3) Cardboard and paper packaging materials.

g. Plastic.

(1) Type 1: Polyethylene Terephthalate (PET, PETE).

(2) Type 2: High Density Polyethylene (HDPE).

(3) Type 3: Vinyl (Polyvinyl Chloride or PVC).

(4) Type 4: Low Density Polyethylene (LDPE).

(5) Type 5: Polypropylene (PP).

(6) Type 6: Polystyrene (PS).

(7) Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

h. Gypsum.

i. Non-hazardous paint and paint cans.

j. Beverage containers.

k. Sealed lead-acid batteries.

1.9.2 Other Methods

Other methods proposed by the Contractor may be used when approved by the Contracting Officer.

1.10 DISPOSAL

Control accumulation of waste materials and trash. Recycle or dispose of collected materials off-site at intervals approved by the Contracting Officer and in compliance with waste management procedures. Except as otherwise specified in other sections of the specifications, disposal shall be in accordance with the following:

1.10.1 Reuse

First consideration shall be given to salvage for reuse since little or no re-processing is necessary for this method, and less pollution is created when items are reused in their original form. Coordinate reuse with the Contracting Officer. Sale or donation of waste suitable for reuse shall be considered.

1.10.2 Recycle

Waste materials not suitable for reuse, but having value as being recyclable, shall be made available for recycling whenever economically feasible. For additional information, please contact the NASA/KSC Recycling Manager.

The Contractor shall participate in State and local government sponsored recycling programs. The Contractor is further encouraged to minimize solid waste generation throughout the duration of the project in accordance with

environmental contract clause, Article J-C-19.

1.10.3 Waste

Materials with no practical use or economic benefit shall be disposed at a landfill or incinerator.

1.10.4 Return

Set aside and protect mis-delivered and substandard products and materials and return to supplier for credit.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 DISPOSAL

Disposal of wastes not recycled or salvaged shall be in accordance with 01 57 20.00 10 ENVIRONMENTAL PROTECTION and SECTION 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS. Notify the Contracting Officer prior to taking disposal action for any hazardous waste.

3.2 RECYCLING AND WASTE MINIMIZATION

3.2.1 Reuse

First consideration shall be given to salvage for reuse since little or no re-processing is necessary for this method, and less pollution is created when items are reused in their original form. Sale or donation of waste suitable for reuse shall be considered. Salvaged materials, other than those specified in other sections to be salvaged and reinstalled, shall not be used in this project.

3.2.2 Recycle

Waste materials not suitable for reuse, but having value as being recyclable, shall be made available for recycling whenever economically feasible. For additional information, please contact the NASA/KSC Recycling Manager.

The Contractor shall participate in State and local government sponsored recycling programs. The Contractor is further encouraged to minimize solid waste generation throughout the duration of the project in accordance with environmental contract clause, Article J-D-25.

3.3 NON-HAZARDOUS SOLID WASTE DIVERSION REPORT

Maintain an inventory of non-hazardous solid waste diversion and disposal of construction and demolition debris. Submit the Construction and Demolition Projects Report (KSC Form 7-648 NS (02/07)) to the NASA Environmental Management Branch through the Contracting Officer (CO) on a monthly basis and keep a log on site per direction of the Contracting Officer in accordance with environmental contract clause, Article J-C-38, Non-Hazardous Waste Diversion Report.

-- End of Section --

SECTION 01 78 00

CLOSEOUT SUBMITTALS
08/11

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 E 1971	(2005) Stewardship for the Cleaning of Commercial and Institutional Buildings

GREEN SEAL (GS)

GS-37	(2000; R 2009) Industrial and Institutional Cleaners

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

As-Built Record of Equipment and Materials
Warranty Management Plan
Final Cleaning
Spare Parts Data

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

SD-11 Closeout Submittals

Record Drawings
System Software
Certification of EPA Designated Items; G

1.3 PROJECT RECORD DOCUMENTS

1.3.1 Record Drawings

Drawings showing final as-built conditions of the project. 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. The final CAD record drawings must consist of one set of electronic CADD

drawing files in the specified format, 2 sets of prints, and one set of the approved working record drawings.

1.3.1.1 Government Furnished Materials

One set of electronic CADD files in the specified software and format revised to reflect all bid amendments will be provided by the Government at the preconstruction conference for projects requiring CADD file record drawings.

1.3.1.2 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). The working as-built marked prints and final record (as-built) drawings will be jointly reviewed for accuracy and completeness by the Contracting Officer and the Contractor prior to submission of each monthly pay estimate. If the Contractor fails to maintain the working and final record drawings as specified herein, the Contracting Officer will deduct from the monthly progress payment an amount representing the estimated cost of maintaining the record drawings. This monthly deduction will continue until an agreement can be reached between the Contracting Officer and the Contractor regarding the accuracy and completeness of updated drawings. 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.

b. The location and dimensions of any changes within the building structure.

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.

h. Systems designed or enhanced by the Contractor, such as power systems.

i. Modifications (include within change order price the cost to change working and final record drawings to reflect modifications) and compliance with the following procedures.

1. Follow directions in the modification for posting descriptive changes.

2. Place a Modification Delta at the location of each deletion.

3. For new details or sections which are added to a drawing, place a Modification Delta by the detail or section title.

4. For minor changes, place a Modification Delta by the area changed on the drawing (each location).

5. For major changes to a drawing, place a Modification Delta by the title of the affected plan, section, or detail at each location.

6. For changes to schedules or drawings, place a Modification Delta either by the schedule heading or by the change in the schedule.

7. The Modification Delta size shall be 1/2 inch diameter unless the area where the circle is to be placed is crowded. Smaller size circle shall be used for crowded areas.

1.3.1.3 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.

1.3.1.4 Computer Aided Design and Drafting (CADD) Drawings

Only employ personnel proficient in the preparation of CADD drawings to modify the contract drawings or prepare additional new drawings. Additions and corrections to the contract drawings must be equal in quality and detail to that of the originals. Line colors, line weights, lettering, layering conventions, and symbols must be the same as the original line colors, line weights, lettering, layering conventions, and symbols. If additional drawings are required, prepare them using the specified electronic file format applying the same graphic standards specified for original drawings. The title block and drawing border to be used for any new final record drawings must be identical to that used on the contract drawings. Accomplish additions and corrections to the contract drawings using CADD files. The Contractor will be furnished "as-designed" drawings

in AutoCad Release 2011 format compatible with a Windows 7 operating system. The electronic files will be supplied on compact disc, read-only memory (CD-ROM). Provide all program files and hardware necessary to prepare final record drawings. The Contracting Officer will review final record drawings for accuracy and return them to the Contractor for required corrections, changes, additions, and deletions.

a. Provide CADD "base" colors of red, green, and blue. Color code for changes as follows:

   1. Deletions (Red) - Over-strike deleted graphic items (lines), lettering in notes and leaders.

   2. Additions (Green) - Added items, lettering in notes and leaders.

   3. Special (Blue) - Items requiring special information, coordination, or special detailing or detailing notes.

b. Rename the Contract Drawing files in a manner related to the contract number (i.e., 98-C-10.DGN) as instructed in the Pre-Construction conference. Use only those renamed files for the Marked-up changes. All changes shall be made on the layer/level as the original item.

c. When final revisions have been completed, show the wording "RECORD DRAWINGS / AS-BUILT CONDITIONS" followed by the name of the Contractor in letters at least 3/16 inch high on the cover sheet drawing. Mark all other contract drawings either "Record" drawing denoting no revisions on the sheet or "Revised Record" denoting one or more revisions. Date original contract drawings in the revision block.

d. Within 21 days after Government approval of all of the working record drawings for a phase of work, prepare the final CADD record drawings for that phase of work and submit two sets of blue-lined prints of these drawings for Government review and approval. The Government will promptly return one set of prints annotated with any necessary corrections. Within 14 days revise the CADD files accordingly at no additional cost and submit one set of final prints for the completed phase of work to the Government. Within 21 days of substantial completion of all phases of work, submit the final record drawing package for the entire project. Submit one set of electronic files on compact disc, read-only memory (CD-ROM), two sets of blue-line prints and one set of the approved working record drawings. They must be complete in all details and identical in form and function to the contract drawing files supplied by the Government. Any transactions or adjustments necessary to accomplish this is the responsibility of the Contractor. The Government reserves the right to reject any drawing files it deems incompatible with the customer's CADD system. Paper prints, drawing files and storage media submitted will become the property of the Government upon final approval. Failure to submit final record drawing files and marked prints as specified 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.

1.3.2 As-Built Record of Equipment and Materials

Furnish one copy of preliminary record of equipment and materials used on the project 15 days prior to final inspection. This preliminary submittal will be reviewed and returned 2 days after final inspection with Government

comments. Submit two sets of final record of equipment and materials 10 days after final inspection. Key the designations to the related area depicted on the contract drawings. List the following data:

RECORD OF DESIGNATED EQUIPMENT AND MATERIALS DATA				
Description	Specification Section	Manufacturer and Catalog, Model, and Serial Number	Composition and Size	Where Used

1.3.3 Final Approved Shop Drawings

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

1.3.4 System Software

Furnish final record (as-built)electronic copies of programming code and configuration settings for all hardware furnished on (2) compact discs, 30 days after transfer of the completed facility.

1.4 SPARE PARTS DATA

Submit two copies of the Spare Parts Data list.

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

1.5 CERTIFICATION OF EPA DESIGNATED ITEMS

Submit the Certification of EPA Designated Items as required by FAR 52.223-9, "Certification and Estimate of Percentage of Recovered Material Content for EPA Designated Items." Include on the certification form the following information: project name, project number, Contractor name, license number, Contractor address, and certification. The certification will read as follows and be signed and dated by the Contractor. "I hereby certify the information provided herein is accurate and that the requisition/procurement of all materials listed on this form comply with current EPA standards for recycled/recovered materials content. The following exemptions may apply to the non-procurement of recycled/recovered content materials: 1) The product does not meet appropriate performance standards; 2) The product is not available within a reasonable time frame; 3) The product is not available competitively (from two or more sources); 4) The product is only available at an unreasonable price (compared with a comparable non-recycled content product)."

1.6 WARRANTY MANAGEMENT

1.6.1 Warranty Management Plan

Develop a warranty management plan for this project. At least 30 days before the planned pre-warranty conference, submit one set of the warranty management plan. Include within the warranty management plan all required actions and documents to assure that the Government receives all warranties to which it is entitled. The plan must be in narrative form and contain

sufficient detail to render it suitable for use by future maintenance and repair personnel, whether tradesmen, or of engineering background, not necessarily familiar with this contract. The term "status" as indicated below must include due date and whether item has been submitted or was accomplished. Warranty information made available during the construction phase must be submitted to the Contracting Officer for approval prior to each monthly pay estimate. Assemble approved information in a binder and turn over to the Government upon acceptance of the work. The construction warranty period will begin on the date of project acceptance and continue for the full product warranty period. A joint 4 month and 9 month warranty inspection will be conducted, measured from time of acceptance, by the Contractor, Contracting Officer and the Customer Representative. Include within the warranty management plan, but not limited to, the following:

a. Roles and responsibilities of all personnel associated with the warranty process, including points of contact and telephone numbers within the organizations of the Contractors, subcontractors, manufacturers or suppliers involved.

b. Furnish with each warranty the name, address, and telephone number of each of the guarantor's representatives nearest to the project location.

c. Listing and status of delivery of all Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors, transformers, and for all commissioned systems such as fire protection and alarm systems, sprinkler systems, lightning protection systems, etc.

d. 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, including the starting date of 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.
    12. Typical response time and repair time expected for various warranted equipment.

e. The Contractor's plans for attendance at the 4 and 9 month post-construction warranty inspections conducted by the Government.

f. Procedure and status of tagging of all equipment covered by extended warranties.

1.7 OPERATION AND MAINTENANCE MANUALS

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.

1.7.1 Configuration

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 0.3937-inch 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.

1.7.2 Training and Instruction

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.

1.8 CLEANUP

Provide final cleaning in accordance with ASTM E 1971 and submit two copies of the listing of completed final clean-up items. Leave premises "broom clean." Comply with GS-37 for general purpose cleaning and bathroom cleaning. Use only nonhazardous cleaning materials, including natural cleaning materials, in the final cleanup. Clean interior and exterior glass surfaces exposed to view; remove temporary labels, stains and foreign substances; polish transparent and glossy surfaces; vacuum carpeted and soft surfaces. Clean equipment and fixtures to a sanitary condition. Replace filters of operating equipment and comply with the Indoor Air Quality (IAQ) Management Plan. Clean debris from roofs, gutters, downspouts and drainage systems. Sweep paved areas and rake clean landscaped areas. Remove waste and surplus materials, rubbish and construction facilities from the site. Recycle, salvage, and return construction and demolition waste from project in accordance with the Waste Management Plan. Promptly and legally transport and dispose of any trash. Do not burn, bury, or otherwise dispose of trash on the project site.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA
07/06

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.

ASTM INTERNATIONAL (ASTM)

ASTM E 1971	(2005) Stewardship for the Cleaning of Commercial and Institutional Buildings

1.2 SUBMISSION OF OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data specifically applicable to this contract and a complete and concise depiction of the provided equipment, product, or system, stressing and enhancing the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation. The subcontractors shall compile and prepare data and deliver to the Contractor prior to the training of Government personnel. The Contractor shall compile and prepare aggregate O&M data including clarifying and updating the original sequences of operation to as-built conditions. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section and Section 01 33 00 SUBMITTAL PROCEDURES.

1.2.1 Package Quality

Documents must be fully legible. Poor quality copies and material with hole punches obliterating the text or drawings will not be accepted.

1.2.2 Package Content

Data package content shall be as shown in the paragraph titled "Schedule of Operation and Maintenance Data Packages." Comply with the data package requirements specified in the individual technical sections, including the content of the packages and addressing each product, component, and system designated for data package submission, except as follows. Commissioned items without a specified data package requirement in the individual technical sections shall use Data Package 5. Commissioned items with a Data Package 1 or 2 requirement shall use instead Data Package 5.

1.2.3 Changes to Submittals

Manufacturer-originated changes or revisions to submitted data shall be furnished by the Contractor if a component of an item is so affected subsequent to acceptance of the O&M Data. Changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data, shall be submitted by the Contractor within 30 calendar days of the notification of this change requirement.

1.2.4 Review and Approval

The Contractor shall review systems and equipment submittals for completeness and applicability. The Contractor shall verify that the systems and equipment provided meet the requirements of the Contract documents and design intent, particularly as they relate to functionality, energy performance, water performance, maintainability, sustainability, system cost, indoor environmental quality, and local environmental impacts.

1.3 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES

1.3.1 Operating Instructions

Include specific instructions, procedures, and illustrations for the following phases of operation for the installed model and features of each system:

1.3.1.1 Safety Precautions

List personnel hazards and equipment or product safety precautions for all operating conditions.

1.3.1.2 Operator Prestart

Include procedures required to install, set up, and prepare each system for use.

1.3.1.3 Startup, Shutdown, and Post-Shutdown Procedures

Provide narrative description for Startup, Shutdown and Post-shutdown operating procedures including the control sequence for each procedure.

1.3.1.4 Normal Operations

Provide narrative description of Normal Operating Procedures. Include Control Diagrams with data to explain operation and control of systems and specific equipment.

1.3.1.5 Emergency Operations

Include Emergency Procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include Emergency Shutdown Instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance and procedures for emergency operation of all utility systems including required valve positions, valve locations and zones or portions of systems controlled.

1.3.1.6 Operator Service Requirements

Include instructions for services to be performed by the operator such as lubrication, adjustment, inspection, and recording gage readings.

1.3.1.7 Environmental Conditions

Include a list of Environmental Conditions (temperature, humidity, and other relevant data) that are best suited for the operation of each product, component or system. Describe conditions under which the item

equipment should not be allowed to run.

1.3.2 Preventive Maintenance

Include the following information for preventive and scheduled maintenance to minimize corrective maintenance and repair for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials.

1.3.2.1 Lubrication Data

Include preventative maintenance lubrication data, in addition to instructions for lubrication provided under paragraph titled "Operator Service Requirements":

a. A table showing recommended lubricants for specific temperature ranges and applications.

b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.

c. A Lubrication Schedule showing service interval frequency.

1.3.2.2 Preventive Maintenance Plan and Schedule

Include manufacturer's schedule for routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation and to minimize corrective maintenance. Provide manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft. For periodic calibrations, provide manufacturer's specified frequency and procedures for each separate operation.

1.3.2.3 Cleaning Recommendations

Provide environmentally preferable cleaning recommendations in accordance with ASTM E 1971.

1.3.3 Corrective Maintenance (Repair)

Include manufacturer's recommended procedures and instructions for correcting problems and making repairs for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials.

1.3.3.1 Troubleshooting Guides and Diagnostic Techniques

Include step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

1.3.3.2 Wiring Diagrams and Control Diagrams

Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and

pneumatic control tubing and the terminals for each type, identically to actual installation configuration and numbering.

1.3.3.3 Maintenance and Repair Procedures

Include instructions and a list of tools required to repair or restore the product or equipment to proper condition or operating standards.

1.3.3.4 Removal and Replacement Instructions

Include step-by-step procedures and a list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Instructions shall include a combination of text and illustrations.

1.3.3.5 Spare Parts and Supply Lists

Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead-time to obtain.

1.3.4 Corrective Maintenance Work-Hours

Include manufacturer's projection of corrective maintenance work-hours including requirements by type of craft. Corrective maintenance that requires completion or participation of the equipment manufacturer shall be identified and tabulated separately.

1.3.5 Appendices

Provide information required below and information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. Include the following:

1.3.5.1 Product Submittal Data

Provide a copy of all SD-03 Product Data and SD-02 Shop Drawings submittals required in the applicable technical sections.

1.3.5.2 Manufacturer's Instructions

Provide a copy of all SD-08 Manufacturer's Instructions submittals required in the applicable technical sections.

1.3.5.3 O&M Submittal Data

Provide a copy of all SD-10 Operation and Maintenance Data submittals required in the applicable technical sections.

1.3.5.4 Parts Identification

Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further

identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number that will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies in accordance with the manufacturer's standard practice. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as typically shown in a master parts catalog

1.3.5.5 Warranty Information

List and explain the various warranties and clearly identify the servicing and technical precautions prescribed by the manufacturers or contract documents in order to keep warranties in force. Include warranty information for primary components such as the compressor of air conditioning system.

1.3.5.6 Personnel Training Requirements

Provide information available from the manufacturers that is needed for use in training designated personnel to properly operate and maintain the equipment and systems.

1.3.5.7 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.3.5.8 Testing and Performance Data

Include completed prefunctional checklists, functional performance test forms, and monitoring reports. Include recommended schedule for retesting and blank test forms.

1.3.5.9 Contractor Information

Provide a list that includes the name, address, and telephone number of the General Contractor and each Subcontractor who installed the product or equipment, or system. For each item, also provide the name address and telephone number of the manufacturer's representative and service organization that can provide replacements most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

1.4 TYPES OF INFORMATION REQUIRED IN CONTROLS O&M DATA PACKAGES

Include Data Package 5 and the following for control systems:

a. Narrative description on how to perform and apply all functions, features, modes, and other operations, including unoccupied operation, seasonal changeover, manual operation, and alarms. Include detailed technical manual for programming and customizing control loops and algorithms.

b. Full as-built sequence of operations.

c. Copies of all checkout tests and calibrations performed by the Contractor (not Cx tests).

d. Full print out of all schedules and set points after testing and acceptance of the system.

e. Full as-built print out of software program.

f. Electronic copy on disk or CD of the entire program for this facility.

1.5 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

Furnish the O&M data packages specified in individual technical sections. The required information for each O&M data package is as follows:

1.5.1 Data Package 5

a. Safety precautions

b. Operator prestart

c. Start-up, shutdown, and post-shutdown procedures

d. Normal operations

e. Environmental conditions

f. Preventive maintenance plan and schedule

g. Troubleshooting guides and diagnostic techniques

h. Wiring and control diagrams

i. Maintenance and repair procedures

j. Removal and replacement instructions

k. Spare parts and supply list

l. Product submittal data

m. Manufacturer's instructions

n. O&M submittal data

o. Parts identification

p. Testing equipment and special tool information

q. Warranty information

r. Testing and performance data

s. Contractor information

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

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SECTION 02 41 00

SELECTIVE DEMOLITION
10/06

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 SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.6	(2006) Safety Requirements for Demolition Operations

1.2 GENERAL REQUIREMENTS

Do not begin demolition or deconstruction until authorization is received from the Contracting Officer; refer to Section "Summary of Work" for additional requirements and the proposed sequence of work. Remove rubbish and debris from the project site daily; do not allow accumulations inside or outside the buildings. The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Existing Conditions; G

SD-07 Certificates

Demolition Plan; G

1.4 REGULATORY AND SAFETY REQUIREMENTS

Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSE/SAFE A10.6.

1.5 DUST AND DEBRIS CONTROL

Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water. Vacuum and dust the work area daily.

All painted materials are assumed contaminated with heavy metals and PCBs.

Demolition and work methods involving these materials shall not inherently produce dust; saw-cutting or grinding is prohibited. Reference Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS for related work and disposal requirements.

Work required on the project is in the vicinity of asbestos containing materials (ACM). The Contractor shall locate all ACM in any work area prior to starting work and avoid all contact with such materials during the progress of the work. Asbestos abatement shall be handled in accordance with established change procedures, or by KSC under a separate contract, as directed by KSC.

1.6 PROTECTION

1.6.1 Traffic Control Signs

Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Anchor barricades in a manner to prevent displacement by wind. Notify the Contracting Officer prior to beginning such work.

1.6.2 Existing Conditions Documentation

Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work. Notify the Contracting Officer of any conditions that will prevent execution of the work as specified in the Contract documents. It is the Contractor's responsibility to verify and submit all required outages which will be required during the course of work.

Selected existing conditions are depicted graphically on the drawings. Graphical depictions are approximate in nature, do not indicate the exact size or location of the element shown, nor indicate any or all surrounding work. Drawings are diagrammatic in nature. The Contractor is responsible for confirming the actual existing conditions and making site measurements for the purpose of the procurement and installation of equipment and materials needed to execute the work and to coordinate with constraints imposed by the existing conditions.

1.6.3 Items to Remain in Place

Take necessary precautions to avoid damage to existing items (including but not limited to building elements, furniture, equipment, fixtures, and finishes) to remain in place, to be reused, or to remain the property of the Government. Repair or replace damaged items as approved by the Contracting Officer. Coordinate the work of this section with all other work indicated. Ensure that structural elements are not overloaded. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer prior to performing such work.

1.6.4 Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove dust, dirt, and debris from work areas daily.

1.6.5 Weather Protection

For portions of the building to remain, protect building interior and materials and equipment from the weather at all times. Where removal of existing roofing is necessary to accomplish work, have materials and workmen ready to provide adequate and temporary covering of exposed areas.

1.6.6 Facilities

Protect electrical and mechanical services and utilities. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.

1.6.7 Protection of Personnel

Before, during and after the demolition work, the Contractor shall continuously evaluate the condition of the project, and take immediate action to protect all personnel working in and around the project site.

1.7 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.8 FOREIGN OBJECT DAMAGE (FOD)

Space flight hardware and ground support equipment are subject to FOD from debris and waste material lying in the vicinity of such hardware. Remove all such materials that may appear due to the Contractor's operations. If necessary, the Contracting Officer may require the Contractor to install a temporary barricade at the Contractor's expense to control the spread of FOD potential debris. Anchor the fence and fabric to prevent displacement by wind. Remove barricade when no longer required.

1.9 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Items to be relocated which are damaged by the Contractor shall be repaired or replaced with new undamaged items as approved by the Contracting Officer.

1.10 REQUIRED DATA

Prepare a Demolition Plan. Include in the plan procedures for careful removal, disposition of materials specified to be salvaged or disposed of, work sequence, and utility outages required. Coordinate with Waste Management, Environmental Protection, Safety, and PCB Removal/Disposal Plans.

1.11 USE OF EXPLOSIVES

Use of explosives will not be permitted.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 EXISTING FACILITY MODIFICATIONS

3.1.1 Utilities and Related Equipment

3.1.1.1 General Requirements

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Contracting Officer. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition or deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.1.2 Masonry

Core drill and remove masonry so as to prevent damage to surfaces to remain and to facilitate the installation of new work. Fire-seal to original rating.

3.1.3 Acoustic Ceiling Tile

Remove, neatly stack, and reuse acoustic ceiling tiles. Provide new tiles where broken or damaged. New tiles shall match existing.

3.1.4 Patching

Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces, using on-site materials when available. Where new work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new work. Finished surfaces of patched area shall be flush with the adjacent existing surface and shall match the existing adjacent surface as closely as possible as to texture and finish. Patching shall be as specified and indicated, and shall include:

a. Concrete and Masonry: Completely fill and fire seal holes and depressions, left as a result of removals in existing masonry walls to remain, with an approved masonry patching material, applied in accordance with the manufacturer's printed instructions.

b. Where installation results in damaged or missing resilient tile flooring, patch to match the existing floor tile.

3.1.5 Fire Alarm Equipment

Salvage fire alarm devices and equipment and turn over to the Government. Salvaging of batteries will require hazardous waste handling.

3.2 DISPOSITION OF MATERIAL

3.2.1 Title to Materials

Except for salvaged, re-used, toxic, and hazardous waste items specified in related Sections, all materials and equipment removed shall become the property of the Contractor and shall be removed from Government property.

Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition, deconstruction, and removal procedures, and authorization by the Contracting Officer to begin demolition and deconstruction. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

Items designated 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 located within 10 miles of the construction site.

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.

3.2.2 Government Materials and Equipment

Remove materials and equipment that are indicated to be removed by the Contractor and that are to remain the property of the Government, and deliver to a storage or disposal site, as directed within 15 miles of the work site. The following wastes related to existing building systems are expected on this project include but are not limited to the following (list does not include Contractor generated waste):

a. Insulated wire is to be removed from KSC by the Contractor for recycling or disposal. The Contractor shall assume ownership of existing cable demolished as part of this project. Demolished cable shall be stored on-site until released to the Contractor by KSC for removal and disposal. The Contractor shall not remove any demolished cable from its stored location on-site until the Contractor receives a written release from KSC. Demolished cable shall be tested for PCBs in accordance with specified environmental testing requirements. Tests for PCBs shall be performed on representative samples of each different type of cable demolished. Demolished cable that is determined not to contain PCBs or other hazardous material, shall be released to the Contractor, shall be immediately removed from the KSC by the Contractor, and shall be disposed of by the Contractor in a lawful manner. The ownership of demolished cable that is determined to contain PCBs or other hazardous material shall revert to KSC and such cable shall not be released to the Contractor. Demolished cable that is not released to the Contractor, and is oil filled, shall undergo further environmental testing. Demolished cable that is not released to the Contractor shall, when directed to do so by KSC, be transported by the Contractor to the KSC Recycling Center on Ransom Road for disposal by KSC. The salvage value for demolished cable not released to the Contractor shall be handled in accordance with established change procedures.

b. Unpainted metal is to be returned to the government for recycling.

c. Painted metals are to segregated and disposed of in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

d. Sealed lead-acid batteries are to have terminals tape, be palletized one-high on plastic sheet and shrink wrap. Lead acid batteries to be taken to Ransom Road Material Reutilization Yard. Contractor shall coordinate with URS Construction Inspector to obtain required paperwork.

3.3 CLEANUP

Remove debris and rubbish from work site(s) daily. Remove and transport in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.4 DISPOSAL OF REMOVED MATERIALS

3.4.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other non-salvageable materials resulting from removal operations in accordance with the following applicable specification sections:

01 57 20.00 10	ENVIRONMENTAL PROTECTION
01 74 19	CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT
02 81 00	TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS

-- End of Section --

SECTION 02 81 00

TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS
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. Publications are referenced in the text by basic designation only.

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

IATA DGR	(2004) Dangerous Goods Regulations

JOHN F. KENNEDY SPACE CENTER (KSC)

Article J-C-20	Spills
Article J-C-18	PCB Management
Article J-C-24	Hazardous Wastes

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 273	Standards for Universal Waste Management
40 CFR 279	Standards for the Management of Used Oil

40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 178	Specifications for Packagings

1.2 DEFINITIONS

1.2.1 Hazardous Material

A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated pursuant to the Hazardous Materials Transportation Act, 49 U.S.C. Appendix Section 1801 et seq. The term includes materials designated as hazardous materials under the provisions of 49 CFR 172, Sections .101 and .102 and materials which meet the defining criteria for hazard classes and divisions in 49 CFR 173. EPA designated hazardous wastes are also hazardous materials.

1.2.2 Hazardous Waste

A waste which meets criteria established in RCRA or specified by the EPA in 40 CFR 261 or which has been designated as hazardous by a RCRA authorized state program.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

On-site Hazardous Waste Management Plan; G

Prior to start of work, a plan detailing the manner in which hazardous wastes, (to include PCB and hazardous materials containing wastes), shall be managed. Written documentation of weekly hazardous waste inspections shall be submitted on a monthly basis.

SD-06 Test Reports

Recordkeeping

Information necessary to file state annual or EPA biennial reports for all hazardous waste transported, treated, stored, or disposed of under this contract. The Contractor shall not forward these data directly to the regulatory agency but to the Contracting Officer at the specified time. The submittal shall contain all the information necessary for filing of the formal reports in the form and format required by the governing Federal or state regulatory agency. A cover letter shall accompany the data to include the contract number, Contractor name, and project location.

Spill Response

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), or pollutant or contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), the Contractor shall notify the Contracting Officer immediately. If the spill exceeds a reporting threshold, the Contractor shall follow the pre-established procedures for immediate reporting to the Contracting Officer.

Packaging Notifications

In accordance with 49 CFR 178.2(c), the Contractor shall acquire the appropriate notifications from the package manufacturers or any other persons certifying compliance with the packaging provisions and provide these to the Government.

SD-07 Certificates

Certification

Copies of the current certificates of registration required by 49 CFR 107, Subpart G issued to the Contractor and/or Subcontractors or written statements certifying exemption from these requirements.

Shipping Documents and Packagings Certification

All transportation related shipping documents to the Contracting Officer, including draft hazardous waste manifests, draft land disposal restriction notifications, draft asbestos waste shipment records, draft manifests for PCBs, draft bill of ladings for hazardous materials, lists of corresponding proposed labels, packages, marks, and placards to be used for shipment, waste profiles, supporting waste analysis documents, for review a minimum of 14 days prior to anticipated pickup. Packaging assurances shall be furnished prior to transporting hazardous material; "generator copies" of hazardous waste manifests, land disposal restriction notifications, asbestos waste shipment records, "generator copies" of manifests used for initiating shipments of PCBs, bill of ladings, supporting waste analysis documents shall be furnished when shipments are originated; and "receipt copies" of hazardous waste manifests, PCB manifests and asbestos waste shipment records at the designated disposal facility shall be furnished not later than 35 days after

acceptance of the shipment.

1.4 QUALIFICATIONS

1.4.1 Training

The Contractor's hazardous materials employees shall be trained, tested, and certified to safely and effectively carry out their assigned duties. The Contractor's employees transporting hazardous materials or preparing hazardous materials for transportation, including samples, shall be trained, tested, and certified in accordance with 49 CFR 172, Subpart H, including security awareness and any applicable security plans.

1.5 LAWS, REGULATIONS AND CONTRACT REQUIREMENTS

Work shall meet or exceed the minimum requirements established by Federal, state, and local laws and regulations which are applicable. These requirements are amended frequently and the Contractor shall be responsible for complying with amendments as they become effective. In the event that compliance exceeds the scope of work or conflicts with specific requirements of the contract, the Contractor shall notify the Contracting Officer immediately.

Requirements of Contract clause Article J-C-20 Spills, Article J-C-24 Hazardous Wastes, and Article J-C-18 PCB Management apply to hazardous materials handled, transported, and disposed of on this project.

PART 2 PRODUCTS

2.1 MATERIALS

The Government shall provide all of the materials required for containerizing, labeling, marking, and transportation of hazardous wastes and hazardous materials in conformance with Department of Transportation standards and IATA DGR and USACE EP 415-1-266. Details in this specification shall not be construed as establishing the limits of the Contractor's responsibility.

2.1.1 Packagings

The Government shall provide bulk and non-bulk containers for packaging hazardous materials/wastes consistent with the authorizations referenced in the Hazardous Materials Table in 49 CFR 172, Section .101, Column 8. Bulk and non-bulk packaging shall meet the corresponding specifications in 49 CFR 173 referenced in the Hazardous Materials Table, 49 CFR 172, Section .101. Each packaging shall conform to the general packaging requirements of Subpart B of 49 CFR 173, to the requirements of 49 CFR 178 at the specified packing group performance level, to the requirements of special provisions of column 7 of the Hazardous Materials Table in 49 CFR 172, Section .101, and shall be compatible with the material to be packaged as required by 40 CFR 262. The Contractor shall also provide other packaging related materials such as materials used to cushion or fill voids in over packed containers, etc. Sorbent materials shall not be capable of reacting dangerously with, being decomposed by, or being ignited by the hazardous materials being packaged. Additionally, sorbents used to treat free liquids to be disposed of in landfills shall be non-biodegradable as specified in 40 CFR 264, Section .314. In addition, packaging notifications will be provided to the Government in accordance with 49 CFR 172, Section .178.2(c) regarding type and dimensions of closures, including gaskets, needed to

satisfy performance test requirements.

2.1.2 Markings

The Government shall provide markings for each hazardous material/waste package, freight container, and transport vehicle consistent with the requirements of 49 CFR 172, Subpart D and 40 CFR 262, Section .32 (for hazardous waste) 40 CFR 761, Section .45 (for PCBs) 40 CFR 61, Section .149(d) (for asbestos) USACE EP 415-1-266 (for FUSRAP radionuclides). Markings shall be capable of withstanding, without deterioration or substantial color change, a 180 day exposure to conditions reasonably expected to be encountered during container storage and transportation.

2.1.3 Labeling

The Government shall provide primary and subsidiary labels for hazardous materials/wastes consistent with the requirements in the Hazardous Materials Table in 49 CFR 172, Section .101, Column 6. Labels shall meet design specifications required by 49 CFR 172, Subpart E including size, shape, color, printing, and symbol requirements. Labels shall be durable and weather resistant and capable of withstanding, without deterioration or substantial color change, a 180 day exposure to conditions reasonably expected to be encountered during container storage and transportation.

2.1.4 Spill Response Materials

The Contractor shall provide spill response materials including, but not limited to, containers, adsorbent, shovels, and personal protective equipment. Spill response materials shall be available at all times in which hazardous materials/wastes are being handled or transported. Spill response materials shall be compatible with the type of material being handled.

2.2 EQUIPMENT AND TOOLS

The Contractor shall provide miscellaneous equipment and tools necessary to manage hazardous materials and hazardous wastes in a safe and environmentally sound manner.

PART 3 EXECUTION

3.1 ON-SITE HAZARDOUS WASTE MANAGEMENT PLAN

These paragraphs apply to Government owned waste only. Contractors are prohibited by 10 U.S.C. 2692 from storing Contractor owned waste on site for any length of time. The Contractor shall be responsible for ensuring compliance with all Federal, state, and local hazardous waste laws and regulations and shall verify those requirements when preparing reports, waste shipment records, hazardous waste manifests, or other documents. Hazardous and controlled waste shall be managed in accordance with all applicable statutes, rules, orders, and regulations which may include but are not limited to 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, 40 CFR 268, 40 CFR 273, 40 CFR 279, 40 CFR 761, and KNPR 8500.1 Rev A-1. In no case shall the Contractor or the Contractor's representative transport hazardous waste from KSC.

The Contractor shall be responsible for identifying processes and operations and the location and nature of all potentially hazardous and controlled waste including any chemicals, paints, solvents, aerosol cans,

petroleum, oil and lubricant (POL) products, lamps, mercury switches, etc. and their containers, as defined in 40 CFR 261, 40 CFR 273, 40 CFR 279, or 40 CFR 761. The Contractor shall prepare copies of Material Safety Data Sheets (MSDS) and a completed KSC Form 25-551 "Process Waste Questionnaire" (PWQ) for each material which may be generated as a waste and provides these to the Contracting Officer (CO) thirty (30) days before the start of the waste generation process. No substances shall be delivered to KSC without the appropriate Material Safety Data Sheets.

The Contractor shall obtain a Technical Response Package (TRP) from the CO within thirty (30) days after receipt of PWQ. The TRP will contain a hazard determination and analytical, packaging, labeling, and disposal requirements according to KNPR 8500.1 (as revised) and will provide site-specific waste management requirements to be followed by the Contractor.

The Government will provide DOT-compliant storage containers and labels. The CO will arrange for the containers to be available at the POL Supply Building, M6-894, at the request of the Contractor. The Contractor shall request storage containers in writing from the CO a minimum of three (3) days before the required need date. The Contractor shall be responsible for transporting the containers from Building M6-744 to the project site.

The Contractor shall establish an on-site satellite waste accumulation area within 50 feet (ft) of and within sight of any point where hazardous or controlled wastes may be generated. If a satellite accumulation area must be more than 50 ft from the point of generation, or out of sight of the generator, the Contractor shall provide a written request to the CO thirty (30) days before the start of the waste generating process. The CO will send a notification to the NASA Environmental Assurance Branch, TA-B1B, for their review and concurrence. The Contractor shall not place the satellite site in service before receiving written approval of the variance. The Contractor shall store potential or identified hazardous and/or controlled wastes in the appropriate properly labeled containers inside the accumulation area in accordance with KNPR 8500.1 (as revised).

The Environmental Protection Agency (EPA) has set the following standards for wastes collected at satellite accumulation areas:

a. Hazardous wastes at satellite accumulation areas must be collected in approved containers.

b. No more than 55 gallons per waste stream of hazardous waste or 1 quart per stream of acutely hazardous wastes may be accumulated.

c. Containers must be labeled with the words "Hazardous Waste" and with other words which identify the contents of the drum.

d. The waste being placed in the container must be compatible with the container.

e. A container holding hazardous waste must always be kept closed during accumulation except when adding or removing wast

f. The site must be equipped with emergency equipment per 40 CFR 265.32.

g. A written contingency plan must be maintained for the site.

Personnel generating and managing the waste must have hazardous waste

training per 40 CFR 265.16. The Contracting Officer may at any time during the course of the contract performance period require the Contractor to provide individual training records for any employee involved in the performance of this contract, and the contents of the course or courses completed to satisfy the training requirements. Attendance at KSC Training Course QG-211 "Hazardous Waste Management" will satisfy the above training requirements.

If more than 55 gallons per waste stream of hazardous waste are generated at a satellite accumulation site, documentation, including the waste type, quantity, locations, and organization responsible for the waste shall be provided on KSC Form 28-809 "Waste Support Request", to the Medical and Environmental Support Contract (MESC) Waste Management. The Contractor shall fax the waste support request to the Contracting Officer and MESC Waste Management at fax 867-9466.

If a hazardous/non-hazardous waste determination cannot be made by process knowledge and no MSDS is available for the waste stream, the container of waste shall be marked with a Hazardous Waste Determination In Progress (HWDIP) label until chemical analysis is completed. At the request of the Contractor, the CO will provide any analytical support required by the TRP. The CO will arrange for all sampling and testing of potentially hazardous or controlled waste.

Universal Waste (UW) - The EPA established Universal Waste regulations to ease the requirements for managing hazardous wastes that can be recycled. Items which meet the definition of UW can be collected and managed under requirements found in 40 CFR 273 and Chapter 62-730 and Chapter 62-737, FAC. Waste streams currently adopted by the State for management as UW are batteries, mercury-containing lamps and devices, and certain pesticides.

UW generators are called handlers and must comply with the following requirements:

a. Handlers shall manage UW using the PWQ/TRP.

b. Handlers shall manage UW in a way that prevents releases to the environment. Non-leaking containers in good condition shall be used if the UW is damaged or leaking.

c. Handlers shall use the KSC Universal Waste Label and shall not accumulate universal wastes for more than six months.

d. Handlers shall clearly show the length of time that the wastes have been accumulated by marking or labeling the container with the earliest date that the waste was generated or received.

e. Handlers shall be familiar with proper waste handling and emergency response procedures. Attendance at the KSC training course QG-299 "Universal Waste Rule" will satisfy the above.

Used Oil - Any lubricant that has been refined from crude oil (or synthetic oil) that has been "used", and as a result of such use is contaminated by physical or chemical impurities shall be considered Used Oil. Used oil is managed according to regulations established in 40 CFR 279 and Chapter 62-710, FAC. The following waste generator standards shall apply to the management of used oil:

a. Used oil containers, tanks, and associated piping must be marked "Used

Oil".

b. Used oil containers, tanks, and associated piping must be in good condition with no severe rusting, structural defects, deterioration, or leaks.

c. Used oil containers must be kept in secondary containment.

d. Containers storing used oil must be sealed or otherwise protected from the weather and stored on an oil-impermeable surface such as polyethylene sheeting, rigid plastic secondary containment, or epoxy-coated concrete.

Within 48 hours of having waste ready for disposal, the Contractor shall contact the CO to have MESC Waste Management pick-up and remove hazardous waste. Documentation including the waste type, quantity, locations, and organization responsible for the waste will be provided on KSC Form 28-809 "Waste Support Request" to MESC Waste Management when requesting waste disposal. The Contractor shall fax the waste support request to the Contracting Officer and to MESC Waste Management at fax 867-9466.

The Contractor shall only use containers in good condition and compatible with the waste to be stored. The Contractor shall be responsible for ensuring containers are closed except when adding or removing waste. The Contractor shall be responsible for immediately marking all hazardous waste containers with the words "hazardous waste" and other information required by 40 CFR 262, Section .32 and environmental contract clause Article J-C-24 Hazardous Wastes as soon as the waste is containerized. The Contractor shall be responsible for inspecting containers for signs of deterioration and shall be responsible for responding to any spills or leaks. The Contractor shall inspect all hazardous waste areas weekly and shall provide written documentation of the inspection. Inspection logs shall contain date and time of inspection, name of individual conducting the inspection, problems noted, and corrective actions taken.

3.1.1 Management Plan

The Contractor shall prepare a plan detailing the manner in which hazardous wastes will be managed and describing the types and volumes of hazardous wastes anticipated to be managed as well as the management practices to be utilized. The plan shall identify the method to be used to ensure accurate piece counts and/or weights of shipments; shall identify waste minimization methods; shall propose facilities to be utilized for treatment, storage, and/or disposal; shall identify areas on-site where hazardous wastes are to be handled; shall identify whether transfer facilities are to be utilized; and if so, how the wastes will be tracked to ultimate disposal.

3.2 SPECIAL REQUIREMENTS FOR ASBESTOS WASTES

Work required on the project is in the vicinity of asbestos containing materials (ACM). The Contractor shall locate all ACM in any work area prior to starting work and avoid all contact with such materials during the progress of the work. Asbestos abatement shall be handled in accordance with established change procedures, or by KSC under a separate contract, as directed by KSC.

3.3 WASTE MINIMIZATION

The Contractor shall minimize the generation of hazardous waste to the

maximum extent practicable. The Contractor shall take all necessary precautions to avoid mixing clean and contaminated wastes. The Contractor shall identify and evaluate recycling and reclamation options as alternatives to land disposal. Requirements of 40 CFR 266 shall apply to: hazardous wastes recycled in a manner constituting disposal; hazardous waste burned for energy recovery; lead-acid battery recycling; and hazardous wastes with economically recoverable precious metals.

3.4 RECORDKEEPING

The Contractor shall be responsible for maintaining adequate records to support information provided to the Contracting Officer regarding exception reports, annual reports, and biennial reports. The Contractor shall be responsible for maintaining asbestos waste shipment records for a minimum of 3 years from the date of shipment or any longer period required by any applicable law or regulation or any other provision of this contract. The Contractor shall be responsible for maintaining bill of ladings for a minimum of 375 days from the date of shipment or any longer period required by any applicable law or regulation or any other provision of this contract.

3.5 EMERGENCY CONTACTS

The Contractor shall be responsible for complying with the emergency contact provisions in 49 CFR 172, Section .604.

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ASBESTOS ABATEMENT
02/12

PART 1 GENERAL

1.1 SUMMARY

No asbestos abatement work is in the contract scope, but the Contractor shall avoid and address existing asbestos-containing materials in the work area as indicated in Section 1.2 of this specification section.

This section specifies the asbestos abatement requirements and the Contractor's applicable asbestos procedures, which include demolition or salvage of structures where asbestos is present, removal or encapsulation of materials containing asbestos, construction, alteration, repair, maintenance,or renovation of structures, substrates, or portions thereof, that contain asbestos, installation of products containing asbestos, asbestos spill/emergency cleanup, transportation, disposal, storage, containment of and housekeeping activities involving asbestos or products containing asbestos, on the site or location at which construction activities are performed.

Asbestos abatement work is categorized into four classes:

Class I Work: Activities involving the removal of Thermal System Insulation (TSI) and surfacing Asbestos Containing Materials (ACM) and Presumed Asbestos Containing Material (PACM).

Class II Work: Activities involving the removal of ACM is not TSI or surfacing material. This includes wallboard, floor tile and sheeting, roofing, siding, shingles, and construction mastics.

Class III Work: Repair and maintenance operations where ACM, including TSI and surfacing ACM and PCM, is likely to be disturbed.

Class IV Work: Maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean up dust, waste, and debris from Class I, II, and III activities.

Conduct abatement work in accordance with the Class I, II, III, or IV Methods of Compliance as required by 29 CFR 1910, 29 CFR 1926, 40 CFR 61-SUBPART M, 49 CFR 171, 49 CFR 172, FAC CHAPTER 62-257, and FL-STAT 469.

1.2 ASBESTOS AVOIDANCE

No asbestos abatement work is in the contract scope, but the Contractor shall avoid and address existing asbestos-containing materials in the work area as follows:

This work plan addresses areas associated with the revitalization of the medium-voltage electrical distribution systems in and around the Industrial and Payload Processing Areas of the KSC. Asbestos-containing gypsum wall board, ceiling tiles, pipe insulation, joint compound, and floor tiles may be present and/or disturbed during the performance of this work. The Contractor shall plan and execute work to avoid all known or suspected

asbestos-containing materials. Where avoidance is not possible and abatement is not indicated on the drawings, the Contractor shall immediately notify the Contracting Officer.

The Contractor shall be responsible for confirming the presence of ACM at the time actual work is performed in each facility.

The work of the project includes installation of control equipment and associated conduit/wiring which may be in the vicinity of asbestos-containing materials, but does not require the direct contact or disturbance of any asbestos-containing materials, and no asbestos-containing materials will be disturbed by any aspects of the work being conducted. The following protocol elements may be applied in lieu of abatement work and requirements identified in this specification section.

Protocol Elements for Work Conducted in the Vicinity of Asbestos-Containing Materials.

a. The Contractor shall have a designated Competent Person as defined by OSHA 29 CFR 1926.1101 for Class IV work on the job site at all times unless otherwise authorized by the Contracting Officer.

b. For Class IV work, the Competent Person shall have received documented training that is equivalent in curriculum and training method to the 16-hour Operations and Maintenance course developed by the EPA. Such course shall include "hands-on" training in the use of respiratory protection and work practices.

c. All employees involved in conducting work in the vicinity of asbestos-containing materials shall have received documented training equivalent in curriculum and training method to the Awareness training course developed by the EPA for maintenance workers who work in buildings containing asbestos. Such a course shall take at least 2 hours.

d. Prior to conducting any work in the area, the Contractor shall have developed and implemented an Emergency Response Plan (ERP) that addresses the accidental disturbance of asbestos-containing materials. The ERP can be included in the Contractor's Contingency Plan (Section 1.5). The ERP shall present emergency response procedures for the workers and require that as a minimum the following equipment is in the work area at all times that work is being conducted where asbestos-containing materials could be accidentally disturbed or damaged in any way:

    1. Penetrating encapsulant

    2. Polyethylene sheeting

    3. Duct tape

    4. HEPA equipped vacuum cleaner

    5. Barricade tape

    6. Respiratory protection for the Competent Person

    7. Asbestos waste disposal bag

e. Prior to conducting work in the area, the Competent Person shall review and be familiar with the requirements of the ERP and the Contingency Plan.

f. Prior to conducting work in the area, the Competent Person shall assure that the workers are familiar with the requirements and procedures of the ERP and the Contingency Plan.

g. Prior to conducting work in the area, the Competent Person shall review the drawings and specifications to determine what, if any, asbestos-containing materials will be encountered in the work area.

h. Upon developing the desire route for all conduits, the Competent Person shall visually identify the location of all asbestos-containing materials defined in the drawings and specifications.

i. The Competent Person shall be fully responsible for ensuring that all workers know the exact location of all asbestos-containing materials in the work area and avoid the direct contact or disturbance of same as all the work of the project is conducted.

j. As long as all of the protocol elements for work to be conducted in the vicinity of asbestos-containing materials described above are rigorously followed, and no asbestos-containing materials are directly contracted or disturbed, there will be no respiratory protection requirements for workers involved with these tasks.

Where work on the project requires abatement of or direct contact with asbestos-containing materials, the Contractor shall stop work and immediately notify the Contracting Officer. When an asbestos abatement contact change is approved, The Contractor shall comply with all of the following requirements of asbestos abatement indicated in this specification section.

1.3 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.

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7.1	(2011) Commodity Specification for Air; 5th Edition

FLORIDA ADMINISTRATIVE CODE (FAC)

FAC CHAPTER 62-257	(2008) Florida Administrative Code, Asbestos Program

FLORIDA STATUTES (FL-STAT)

FL-STAT 469	(2010) Asbestos Abatement

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 8500.1	KSC Environmental Requirements
KNPR 1840.19	KSC Industrial Hygiene Programs

KNPR 8715.3	KSC Safety Practices Procedural Requirements

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 7400	(1994) Standard Test Method for Asbestos and Other Fibers by PCM
NIOSH 2003-154	(2003; 4th Ed; Supple 3) NIOSH Manual of Analytical Methods

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.1101	Asbestos
40 CFR 61-SUBPART M	National Emission Standard for Asbestos
40 CFR 763	Asbestos
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements

1.4 DEFINITIONS

FLAC - Florida Licensed Asbestos Consultant as defined within the FL-STAT 469 ASBESTOS ABATEMENT.

IH - Contractor's independent Industrial Hygienist. This person is responsible for the oversight, approval of the abatement procedures, and the health, safety, and welfare of those who it affects.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Licenses and Permits

Submit a copy of asbestos consultant's license to the Contracts Administrator. Ensure that the FLAC possesses a current license and complies with all Federal, State and Local Regulations. Only those consultants who are certified and licensed by DBPR are permitted to perform Asbestos Surveys or abatement specifications and plans as per Florida Statute 469.

Also submit a copy of Asbestos Contractor's License. Possession of a current asbestos contractor's license is mandatory, as well as securing all necessary licenses and permits associated with asbestos removal, transportation, and disposal as may be required by federal, state, and local regulations. Only those Contractors who are certified and licensed by the State of Florida DBPR will be permitted to perform asbestos

abatement activities at Kennedy Space Center.

Obtain and submit a copy of waste disposal permit and all disposal shipping manifests and tickets as they are obtained.

1.5.2 Certificates

Submit the following certificates:

a. Certification of participation (documentation showing current and 2 previous consecutive proficiency analytical test (PAT) round results) in a PAT program such as or equivalent to the American Industrial Hygiene Association PAT or Asbestos Analytical Registry (AAR) accreditation certificate and Interlab QA/QC Program participation for the independent air monitoring agency selected by the Contractor before starting work.

b. Training Certifications and accreditation certificates for the independent air monitoring agency's on-site personnel and a copy of independent air monitoring agency's Quality Control Program.

c. Certification documents by the Contractor verifying that employees have been provided current respirator fit test, training, and medical examinations in compliance with 29 CFR 1926.

1.5.3 Material Safety Data Sheets (MSDS)

Submit Material Safety Data Sheets (MSDS) as required for materials to be used on the specified project.

1.5.4 Notification

When applicable, submit Florida Department of Environmental Protection (DEP) "Notice of Demolition or Asbestos Renovation" (DEP Form 62-257.900(1)) to DEP District Office. A copy of the notification is to be provided to the Government as part of the Implementation Plan.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Asbestos Consultant's License; G

Asbestos Contractor's License; G

Training Certifications; G

Implementation Plan; G

Air Monitoring Plan; G

Contingency Plan for Emergencies; G

Written (OSHA Compliant) Respiratory Protection Plan; G

Work Schedule; G

Notification of Demolition/Renovation; G

SD-02 Shop Drawings

Coordination Drawings; G

Detailed Drawings; G

SD-06 Test Reports

Initial Exposure Assessments; G

Notification of Demolition/Renovation; G

Air Monitoring Reports; G

Work Site Entry Logs; G

Daily Site Inspection Logs; G

Waste Inventory; G

Waste Shipment Record (WSR); G

SD-07 Certificates

Training Certifications; G

Proficiency Analytical Test; G

SD-08 Manufacturer's Instructions

Material Safety Data Sheets; G

Implementation Plan; G

SD-11 Closeout Submittals

Notification of Demolition/Renovation; G

Waste Disposal Permit; G

Disposal Shipping Manifests and Tickets; G

Daily Site Inspection Logs; G

Negative Pressure Logs; G

OSHA Compliance Inspection Records; G

Air Monitoring Reports; G

Independent Monitoring Data; G

Calibration Records; G

Waste Stream Inventory; G

1.7 IMPLEMENTATION PLAN

Prepare and submit a detailed, written Implementation Plan created, signed and sealed by a FLAC to the Government for approval, prior to the start of work, that includes the following:

a. Coordination drawings, in .DWG or .DGN electronic format, including site specific drawings of proposed work areas, clean room/change areas, mini-enclosures, shower, equipment room, waste loading/staging areas, locations of High Efficiency Particulate Air (HEPA) filtered negative pressure devices and exhaust points, work areas, emergency egress, and areas to be modified.

b. Detailed drawings for asbestos abatement systems consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents.

c. A copy of the applicable DEP Notification of Demolition/Renovation (DEP Form 62-257.900(1)).

d. Plan of action, including proposed procedures to be used in complying with the requirements of this specification, 29 CFR 1926, and other applicable regulatory requirements, sequence of asbestos abatement work, the interfaces of trades involved in the performance of work, posting of licenses, permits, etc., methods to be used to assure the safety of building occupants and visitors to the site, disposal plan including location of approved disposal site, a detailed description of the methods employed to control pollution, and a detailed work schedule. Expand upon the method for removal of ACM, the use of portable HEPA ventilation systems, closing out of the buildings HVAC system, method of removal to prohibit visible emissions in the work area, and packaging of removed debris.

e. Details of the decontamination areas and procedures, locations of staging areas, posting of warning signs, and details of negative air system to be used in the work area.

f. Sketch(s) or drawing(s) of complete contract area(s) showing the shower room, clean room, drum staging area, decontamination and containment areas, the negative air system, and exits. Indicate designation of the "Competent Person" (CP) and Site Supervisor.

1.7.1 Air Monitoring Plan

Provide a written Air Monitoring Plan to be prepared under the direction of and signed/stamped by a Certified Industrial Hygienist (CIH) or FLAC specifying the air monitoring criteria and an action plan for implementation by the Competent Person. Identify in the plan the Competent Person to be on site at all times (unless otherwise authorized by the Contracts Administrator) during asbestos abatement operations. The FLAC or his/her representative/Competent Person is responsible for ensuring applicable regulatory compliance during all phases of the asbestos abatement activities. The Competent Person has the authority to stop work for unsafe conditions and for not adhering to applicable regulations. Provide a qualified back-up person in the event that the Competent Person is absent from job site.

Provide certification that the Contractor, his staff, and abatement workers (including Supervisors) have attended and successfully completed (an) asbestos abatement course(s) including refresher courses as set forth in FL-STAT 469 and in accordance with 29 CFR 1926 and 40 CFR 763.

Provide a written (OSHA compliant) Respiratory Protection Plan in accordance with 29 CFR 1910 including training in the care, use, and maintenance of respirators and fit test certification.

Provide a written description of respiratory equipment (name, type, model number) and protective clothing provided to the abatement workers.

1.7.2 Personnel Examination

Provide documentation that all personnel assigned to the abatement project have been examined annually by a physician. Submit the physician's written opinion containing the results of the employee's medical examination in compliance with 29 CFR 1926. Establish, maintain, and make readily available for review all work site entry logs of all personnel entering and leaving the regulated work area by the on-site Competent Person indicating the date and time of entry and egress.

1.7.3 Procedures for Enforcement of Personal Hygiene Practices

Prepare and submit a Contingency Plan for Emergencies including fire, accident, power failure, heating or cooling, negative air system failure, respirator supplied air system failure, or any other event that may require modification of the work area isolation procedures. Include in the plan specific procedures for decontamination or work area isolation, safe exiting, and the need for medical attention in the event of an emergency.

1.7.4 Additional Procedures

Submit any additional procedures (fall protection, confined space, etc.) and policies that are in effect to ensure worker safety and environmental, KNPR 8500.1, and KNPR 8715.3 requirements are met.

1.8 AIR MONITORING REPORTS

Obtain the services of an independent Air Monitoring Agency accredited by the American Industrial Hygiene Association (AIHA), for analysis of airborne asbestos concentration levels, and submittal of Independent Monitoring Data taken during the abatement. Provide a copy of the monitoring agency's Quality Control Program to Contracts Administrator prior to commencement of the abatement activities. Ensure the individual performing the on-site air monitoring meets the requirements as set forth in FL-STAT 469 and 40 CFR 763, and performs sample collections in accordance with the approved Air Monitoring Plan.

Perform all Air Monitoring under the direction of the FLAC using an independent Air Monitoring Contractor, in compliance with Florida Statute 469 requirements.

Calibrate pumps before and after each air sample and submit calibration records to the Government.

Submit daily Air Monitoring Reports. Include in the Air Monitoring Report the following information for each sample:

a. Sample identification, Sample location

b. Employee Name, Social Security Number

c. Description of task being monitored

d. Exposure level results in (f/cc)

e. Monitoring instrument identification number

f. Pre-calibration, post calibration, and average flow rate of each sample

g. Sample date, start and stop times

h. Type of protective devices worn (if any)

i. Project identification number, Facility number and name

j. Sampling and Analytical Methods used

k. Contact name and company, and name of individual performing the sampling

1.8.1 Air Sample Analytical Method

Airborne fiber sampling and analytical procedures are to be analyzed by Phase Contrast Microscopy (PCM) in accordance with 29 CFR 1926 and NIOSH 2003-154 7400 method.

1.8.2 Air Sampling Rate, Volumes and Frequency

Conduct daily monitoring utilizing sample rates, volumes and frequency in accordance with 29 CFR 1926 and retain for final submittal at closeout. The minimum number of samples or sample volumes may not be less than those specified below:

Type of Sample	Volume	Minimum No. Samples	Location
Prior to set-up (within 24 hrs)	1200L	2	Regulated Area
Personal, During work	400L	2	Personal B.Z.
Area samples, Adjacent to work area	1200L	2	Regulated Area
Area samples at Negative Air Unit Exhaust	1200L	1	In area of outlets

NOTE: The KSC IH will perform air sampling outside the regulated work area.

1.9 WORKER PROTECTION

Perform Initial Exposure Assessments and Employee Exposure Monitoring in accordance with 29 CFR 1926, part 1926.1101, with input and approval of the FLAC.

Select and provide respiratory protection to employees and ensure they are utilized in accordance with 29 CFR 1926.

Submit the work schedule indicating the work days, hours, and the number of workers per shift. Include a bar chart to identify the individual milestones through to the completion of the project (i.e., number of days to complete work site preparation, number of days to complete ACM removal, number of days to complete final cleaning and lockdown, etc.).

Submit the OSHA compliance inspection records as part of the closeout documents.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES AND SERVICES

The Government will make available at the work site, water at hose bibs and 120 Volt AC at receptacles for the Contractor's use. Provide waterproof safety lighting where necessary for safe, adequate illumination.

Ensure all electrical equipment to be used inside the work areas is powered from an Underwriters Laboratory (UL) approved Ground Fault Circuit Interrupter (GFCI). Do not exceed the manufacturers limits per GFCI. Make all necessary connections and restore the site connections to their original condition or better, prior to project completion.

Ensure all energized or pressurized systems inside the work area have been locked out, tagged out, or otherwise rendered safe.

Provide temporary water from the existing building water source to control the generation of airborne dust; to allow for area, personnel, and equipment decontamination; and to supply decontamination unit needs. Also provide a backflow preventer at the source.

Provide temporary sanitary drainage piping to the decontamination unit sump and to the shower unit at a minimum slope of 2.0 percent, and temporary drainage piping to waste water pump and existing drain in accordance with local standards and as approved by the Contracts Administrator.

3.2 WORK AREA PREPARATION

The Government will re-arrange equipment and storage areas to the extent of providing a direct and unobstructed path to the work area(s). During ACM removal, confine equipment and employees to the designated work area(s).

Unless otherwise directed by the Contracts Administrator, the Contractor is to establish and maintain a 25-foot access control barrier zone(s) around the designated work area(s). Interference with the functional operation of the building occupants outside these areas is not permitted.

Ensure all building supply and return air ducts from the mechanical system are isolated to eliminate air flow into or out of containment area(s).

3.2.1 Pre-Cleaning

Shut down HVAC systems and seal all critical barriers prior to initiating pre-cleaning actions. Seal, with 6 mil minimum thickness plastic sheeting,

all openings, including but not limited to, windows, corridors, doorways, elevator openings, skylights, ducts, grilles, diffusers, and any other penetrations between the contaminated work areas and uncontaminated areas.

Pre-clean all movable objects identified as contaminated by the Contracts Administrator or his/her representative within the work area using a HEPA filtered vacuum and wet cleaning methods as appropriate. Remove these objects after cleaning and store in a protected area.

Pre-clean all surfaces in the work area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Methods that would raise dust, such as dry sweeping or vacuuming with equipment not equipped with HEPA filters, are PROHIBITED. Pay detailed attention to machinery or areas behind grilles and gratings.

Do not remove or otherwise disturb asbestos-containing building materials during the pre-cleaning phase.

3.2.2 Work Area(s) Notification

Inform all other Contractors and personnel on the site of the abatement work of the nature of the Contractor's work with ACM and/or PACM, of the existence of and requirements pertaining to regulated areas, and the measures taken to ensure that employees of such other Contractor employers are not exposed to asbestos in accordance with 29 CFR 1926.

Use industry controls and work practice methods in accordance with 29 CFR 1926. Ensure daily site inspection logs are posted at the jobsite by the on-site Competent Person.

Use flame resistant, 6 mil polyethylene sheeting when constructing Negative Pressure Enclosures (NPE) or decontamination areas.

3.3 WASTE LOAD-OUT UNIT

Establish a waste load-out unit to provide for interim secure storage. Include an equipment room for storage of asbestos-contaminated items (drums, tools, equipment). Decontaminate all equipment and waste containers prior to being taken out of the work area(s).

All asbestos-containing waste material is to be sealed in leak-tight disposal containers. Thoroughly wet all waste within the disposal containers. Maintain proper labeling protocols for all running and final inventory of filled disposable containers.

3.4 SIGNS AND MARKINGS

Post signs prior to commencing asbestos work as required in 29 CFR 1926. Post signs at the perimeter of the asbestos work areas, along the route of the temporary waste material holding (Drum Staging) area, and at all entrances to asbestos work areas. Ensure signs are conspicuous and legible.

Post telephone numbers and locations of emergency services including, but not limited to, fire, ambulance, doctor, and hospital, at the regulated area.

Post one copy of all permits at the work site perimeter in a accessible location outside the regulated area.

Post one copy of the Abatement Contractors current license at the work site perimeter in a accessible location outside the regulated area.

Post hazard communication notification signs in accordance with KNPR 1840.19 requirements.

3.5 NEGATIVE AIR SYSTEM

Construct Negative Pressure Enclosures (NPEs) as required by 29 CFR 1926.

Duct each of the negative air units through the containment barrier walls to the outside of the work area(s). When the building is occupied, ensure that the ducts exhaust into the outside air; otherwise, they may exhaust into an area of the building beyond the critical barriers. Never exhaust the units into the work area(s).

Provide each unit with temporary back-up electrical power (120 Volt AC) in the event of power failures or outages.

3.5.1 Testing

Design the negative air system to provide a minimum of four (4) air changes per hour and test before any work is begun. After the work area has been prepared, the decontamination unit set up, and the negative air units(s) installed, test the system. Prior to beginning abatement activities, an Asbestos Abatement Pre-Work Inspection checklist (KSC Form 28-1230NS) will be completed by the KSC IH to verify the adequacy of the containment system and work area. Once activated, ensure the negative air exhaust unit(s) remain in operation until final clearance air monitoring has been performed and the KSC IH has approved their shutdown/removal. Maintain daily negative pressure logs for review by the FLAC and submit as part of the closeout documents.

Install a differential pressure meter or manometer to continuously measure pressure differential between inside and outside the work area for all Class I activities which utilize a NPE. Maintain a minimum pressure differential of 0.02 inch of water column.

3.6 RESPIRATORY PROTECTION

Instruct and train each worker involved in asbestos abatement in proper respirator use and care. Fit all respirators by approved qualitative or quantitative test. Use respiratory protection appropriate for the fiber level encountered in the work area and as specified herein, or as required for other situations encountered.

3.6.1 Air Quality for Supplied Air Respiratory Systems

The Contractor is to provide air used for breathing in Type "C" supplied air respiratory systems that meets or exceeds CGA G-7.1, standards for Grade D air.

3.7 REMOVAL OF ASBESTOS

Use industry controls and work practices for all operations in accordance with 29 CFR 1926 Methods of Compliance for Class I, II, III, or IV asbestos work. The FLAC or his/her representative are responsible for these practices.

Ensure all Class I, II, III, and IV work is supervised by an on site Competent Person at all times that work is in progress.

Following removal of contaminated items and asbestos material, seal the edges of adjacent surfaces, which were exposed when asbestos was removed, with an asbestos bridging sealant/encapsulant.

3.8 DAILY HOUSEKEEPING

Maintain a clean work area in accordance with 29 CFR 1926. Perform the following housekeeping functions at the end of each shift or prior to leaving the work site unattended:

a. Prepare contaminated waste for disposal by packaging the waste and removing it from the work area.

b. HEPA vacuum the work area.

c. Visually inspect polyethylene in the work area and other high traffic areas.

3.9 CLEANING PROCEDURES

Clean the work area at the end of each day's abatement activities. Designate a separate, secured area within the work area for storage of debris until it can be properly disposed. Secure the work area after termination of the work day to prevent entry. Regularly dispose and replace disposable supplies, such as mop heads, sponges, and rags. Clean all equipment by HEPA vacuuming and wet wiping.

Clean all work areas in which abatement operations have been completed, starting at the ceiling and working down to the floors, by HEPA vacuuming and wet wiping. Prior to removal of worksite access controls and re-occupancy inspection by the Government, and upon satisfactory final clearance air sampling, and removal of polyethylene sheeting, perform a final cleaning (wet wipe) of all surfaces within the work area.

3.10 INSPECTION

Do not commence removal of asbestos-containing materials prior to satisfactory KSC IH, concurrence to proceed on the Asbestos Abatement Pre-Work Inspection (checklist KSC Form 28-1230NS).

3.10.1 Initial Inspection

The Contractor and the independent IH will conduct a walk-through of the work area prior to beginning the abatement work to review existing conditions and ensure safe and practical conditions for the work to be implemented. Any damage to structures, surfaces, and equipment, which could be misconstrued as damage resulting from work, is to be documented by the Contractor and immediately submitted to the Contracts Administrator.

Perform background sampling for work areas in accordance with 29 CFR 1926 prior to beginning the abatement work.

3.10.2 Daily Inspection

Maintain a work site entry log of all personnel who enter the regulated work area. Through continuous surveillance and inspections of the

worksite, ensure the integrity of containment, proper function of the negative pressure system, and posting of signs and labels. Also ensure, through frequent inspections during each work shift, that negative pressure is maintained, appropriate work practices are followed, appropriate protective clothing and equipment are used, and worker decontamination procedures are being followed.

Ensure that critical barriers and negative pressure enclosures remain effectively sealed and taped. Take immediate action to remedy defects immediately upon discovery. Details of the inspections are to be included in the Contractor's daily inspection log and posted in an accessible location outside the regulated area.

Provide updated copies of the Air Monitoring Reports, daily site inspection logs and waste stream inventory to the Contracts Administrator at the end of each week of the abatement work.

NASA/Kennedy Space Center reserves the right to conduct periodic inspections and air monitoring in the work area(s). If the work area is unsafe as determined by the Contracts Administrator for KSC IH, the Contracts Administrator will require the Contractor to stop work until the unsafe conditions are corrected.

3.10.3 Final Inspection

The thoroughness of asbestos removal is to be evaluated by visually inspecting the affected surfaces for residual asbestos material and accumulated dust followed by air sampling. Evidence of residual asbestos or asbestos debris on any adjacent surfaces upon completion of the work is not acceptable.

Upon completion of the work, conduct a thorough visual inspection of the work area by the Abatement Contractor and by the KSC IH to ensure no residual asbestos material, dust or debris remains. Document final inspections on the Asbestos Abatement Clearance Inspection Checklist (KSC Form 28-1231NS), which will be completed by KSC IH.

If applicable, final aggressive air sampling is to be performed by the KSC IH for each NPE work area after completion of a satisfactory visual inspection. The clearance criteria is 0.01 fibers per cubic centimeter (f/cc) of air as determined by PCM. Satisfactory fiber counts from all final samples are to be less than 0.01 f/cc. If any of the final air samples contain greater than 0.01 f/cc, repeat the final cleaning operation and re-test the area until satisfactory clearance levels are obtained.

Collect five (5) PCM final air samples for the first 5,000 square feet of containment plus one (1) additional PCM final air sample for each additional 5,000 square feet or one (1) air sample per room, whichever is greater. The number of final air samples may be reduced for small enclosures of less than approximately 2,500 square feet. In no case may fewer than two (2) final samples be collected for any enclosure.

Ensure clearance air sample volumes meet the minimum volumes as indicated for analysis by NIOSH 7400 method.

3.11 ASBESTOS WASTE AND CONTAMINATED MATERIALS

3.11.1 Removal of Asbestos Waste Materials

For purposes of this paragraph, asbestos waste materials are defined as those materials which contain or have been contaminated by asbestos and are not planned to be encapsulated and remain at the job site. They are primarily removed asbestos, disposable clothing and safety equipment, polyethylene sheeting, contaminated amended water, vacuum cleaner contents, and filtration media.

Contain all asbestos waste material in two (2) 6 mil polyethylene disposal bags, or two (2) 6 mil disposal bags and a sealed leak-tight container such as, but not limited to, a steel or fiberboard drum. Pack the asbestos waste material while still wet. Clean the external surface of the waste containers by HEPA vacuuming and wet wiping before moving from the work area. Protect the interior of truck or dumpster with two layers of polyethylene sheeting.

3.11.1.1 Waste Inventory

Maintain Waste Inventory records of all generated waste drums or containers indicating the location and approximate quantity of material in each container. Clearly label and mark all disposal containers, dumpsters, and trucks, in accordance with 40 CFR 61-SUBPART M, 29 CFR 1910 of OSHA's Hazard Communications Standard, and 49 CFR 171 and 49 CFR 172, Hazardous Substances.

Provide conspicuous, legible labels, affixed to plastic bags and drums indicating the name of the waste generator and the location (facility name and number) where the waste was generated.

For non-friable asbestos that will be disposed at the KSC/Schwartz Road Landfill, provide a completed landfill disposal verification form (KSC Form 28-1064NS) send to Contracts Administration. NOTE: Regulated ACM is not permitted for disposal at KSC/Schwartz Road Landfill.

Provide a Waste Shipment Record (WSR) to the waste site owner in accordance with the instructions in 40 CFR 61-SUBPART M.

3.11.2 Work Area Disposal

After final inspection has been completed and the work area is released for occupancy, shut off and remove the Negative Air System units. Unseal all entrances and exits. Dispose of all plastic sheeting, tape, and any other trash and debris, except for critical barriers, in sealable plastic bags, or in drums and moved to the staging area. After final wet wipe of the work area and satisfactory clearance air sampling, dismantle critical barriers and the decontamination unit.

3.11.3 Decontamination Area and Support Area Disposal

Dismantle the decontamination area after the work area is released by the KSC IH for re-occupancy. Vacuum all surfaces of the decontamination unit before it is disassembled.

3.12 WASTE TRANSPORTATION AND DISPOSAL

Transport and dispose of asbestos waste in full compliance with

40 CFR 61-SUBPART M, SUBPART A, 49 CFR 171, and 49 CFR 172.

3.13 ASBESTOS ABATEMENT NOTICE AND CHECKLIST

An Asbestos Abatement Pre-Work Inspection form (KSC Form 28-1230NS) and an Asbestos Abatement Clearance Checklist (KSC Form 28-1231NS) will be provided by the KSC IH. Send copies to the Contracts Administrator upon satisfactory completion of the work. Notify KSC IH and the Contracts Administrator at least three days prior to the planned commencement of work. Coordinate and schedule all Pre-Work and Clearance Site inspections with KSC IH. The completed forms are to be used to establish approval of the containment, work practices, and final acceptance/re-occupancy of the work area(s).

3.14 FINAL ACCEPTANCE

3.14.1 Closeout Submittals

Within 10 days after the completion of work, submit to the Contracts Administrator a written summary and copies of the following items:

a. Notification of Demolition/Renovation

b. Waste Disposal Permit

c. Disposal Shipping Manifests and Tickets

d. Daily Site Inspection Logs

e. Negative Pressure Logs

f. OSHA Compliance Inspection Records

g. Air Monitoring Reports

h. Independent Monitoring Data

i. Calibration Records

j. Waste Stream Inventory

The work will not be considered complete until the asbestos-containing materials identified herein have been abated, the areas cleaned, satisfactory clearance air monitoring completed, all asbestos contaminated waste has been properly disposed of, and all project closeout documents have been received and approved by the Contracts Administrator.

-- End of Section --

SECTION 02 82 33.13 20

REMOVAL/CONTROL AND DISPOSAL OF PAINT WITH LEAD
02/10

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 Z88.2	(1992) Respiratory Protection

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

HUD 6780	(1995; Errata Aug 1996;Rev Ch. 7 - 1997) Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 1840.19	KSC Industrial Hygiene Programs
KNPR 8500.1	KSC Environmental Requirements
KNPR 8715.3	KSC Safety Practices Procedural Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.103	Respiratory Protection
29 CFR 1926.21	Safety Training and Education
29 CFR 1926.33	Access to Employee Exposure and Medical Records
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts, and Mists
29 CFR 1926.59	Hazard Communication
29 CFR 1926.62	Lead
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 745	Lead-Based Paint Poisoning Prevention in Certain Residential Structures

UNDERWRITERS LABORATORIES (UL)

UL 586 (2009) Standard for High-Efficiency Particulate, Air Filter Units

1.2 DEFINITIONS

1.2.1 Abatement

Any set of measures designed to permanently eliminate lead-based paint hazards in accordance with standards established by appropriate Federal agencies. Such term includes:

a. The removal of lead-based paint and lead-contaminated dust, the permanent containment or encapsulation of lead-based paint, the replacement of lead-painted surfaces or fixtures, and the removal or covering of lead contaminated soil; and

b. All preparation, cleanup, disposal, and post-abatement clearance testing activities associated with such measures.

1.2.2 Action Level

Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period in a work environment.

1.2.3 Area Sampling

Sampling of lead concentrations within the lead control area and inside the physical boundaries, which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel.

1.2.4 Competent Person (CP)

As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, State, and local regulations. A Certified Industrial Hygienist (CIH) certified for comprehensive practice by the American Board of Industrial Hygiene is the best choice.

1.2.5 Contaminated Room

Refers to a room for removal of contaminated personal protective equipment (PPE).

1.2.6 Decontamination Shower Facility

That facility that encompasses a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.

1.2.7 Deleading

Activities conducted by a person who offers to eliminate lead-based paint or lead-based paint hazards or to plan such activities in commercial buildings, bridges or other structures.

1.2.8 Eight-Hour Time Weighted Average (TWA)

Airborne concentration of lead to which an employee is exposed, averaged over an 8 hour workday as indicated in 29 CFR 1926.62.

1.2.9 High Efficiency Particulate Air (HEPA) Filter Equipment

HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron or larger size particles.

1.2.10 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps.

1.2.11 Lead-Based Paint (LBP)

Paint or other surface coating that contains lead.

1.2.12 Lead-Based Paint Activities

Lead-based paint activities include; a lead-based paint inspection, a risk assessment, and abatement of lead-based paint hazards.

1.2.13 Lead-Based Paint Hazard (LBP Hazard)

Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-based paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects.

1.2.14 Paint with Lead (PWL)

Any paint that contains lead as determined by the testing laboratory using a valid test method. The requirements of this section does not apply if no detectable levels of lead are found using a quantitative method for analyzing paint using laboratory instruments with specified limits of detection (usually 0.01%). An X-Ray Fluorescence (XRF) instrument is not considered a valid test method.

1.2.15 Lead Control Area

A system of control methods to prevent the spread of lead dust, paint chips or debris to adjacent areas that may include temporary containment, floor or ground cover protection, physical boundaries, and warning signs to prevent unauthorized entry of personnel. HEPA filtered local exhaust equipment may be used as engineering controls to further reduce personnel exposures or building/outdoor environmental contamination.

1.2.16 Lead Permissible Exposure Limit (PEL)

Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a workday, the PEL shall be determined by the following formula:

PEL (micrograms/cubic meter of air) = 400/No. hrs worked per day

1.2.17 Personal Sampling

Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and centered at the nose or mouth of an employee.

1.2.18 Physical Boundary

Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside the physical boundary."

1.3 DESCRIPTION

1.3.1 Description of Work

Remove/control lead-based paint/paint with lead as indicated on the drawings. Remove paint in accordance with this Section and recycle, handle, and/or dispose of materials with lead paint in accordance with Federal and State regulations, this Section, and NASA/KSC Special Condition contract clauses. If a painted surface has not been tested for lead paint assume lead is present to determine Personnel Protective Equipment (PPE).

1.3.2 Coordination with Other Work

The contractor shall coordinate with work being performed in adjacent areas. Coordination procedures shall be explained in the Removal/Control Plan and shall describe how the Contractor will prevent lead exposure to other contractors and/or Government personnel performing work unrelated to lead activities.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Vacuum Filters

Respirators

SD-06 Test Reports

Sampling results

Occupational and Environmental Assessment Data Report

SD-07 Certificates

Qualifications of CP; G

Testing Laboratory qualifications; G

Occupant Notification

Training Certification of workers and supervisors; G

Third Party Consultant Qualifications; G

Lead-based paint/paint with lead removal/control plan including CP approval (signature, date, and certification number); G

Rental equipment notification

Respiratory Protection Program; G

Hazard Communication Program; G

Clearance Certification; G

SD-11 Closeout Submittals

KSC Waste Management Contractor is responsible for disposal of all Hazardous, Controlled, and Universal wastes.

Certification of Medical Examinations; G

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

1.5.1.1 Qualifications of CP

Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained, licensed, and certified in accordance with Federal, State, and local laws.

1.5.1.2 Training Certification

Submit a certificate for each employee and supervisor, signed and dated by the training provider meeting 40 CFR 745 (Subpart L) requirements, stating that the employee or supervisor has received the required lead training and is certified to perform or supervise deleading or lead removal. Submit proof that the work will be performed by a certified firm.

1.5.1.3 Testing Laboratory

Submit the name, address, and telephone number of the testing laboratory selected to perform the air and wipe sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis. Laboratories selected to perform blood lead analysis shall be OSHA approved.

1.5.1.4 Third Party Consultant Qualifications

Submit the name, address, and telephone number of the third party consultant selected to perform the wipe sampling for determining concentrations of lead in dust or soil sampling. Submit proper documentation that the consultant is trained and certified as an inspector technician or inspector/risk assessor by the USEPA authorized State (or local) certification and accreditation program.

1.5.2 Requirements

1.5.2.1 Competent Person (CP) Responsibilities

a. Verify training meets all federal, State, and local requirements.

b. Review and approve lead-based paint/paint with lead removal/control plan for conformance to the applicable standards. Ensure work is performed in strict accordance with specifications at all times.

c. Continuously inspect lead-based paint removal/control work for conformance with the approved plan.

d. Perform air and wipe sampling.

e. Control work to prevent hazardous exposure to human beings and to the environment at all times.

f. Certify the conditions of the work as called for elsewhere in this specification.

1.5.2.2 Lead-Based Paint/Paint with Lead Removal/Control Plan (LBP/PWL R/CP)

Submit a detailed job-specific plan of the work procedures to be used in the removal/control of LBP/PWL. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include a description of equipment and materials, controls and job responsibilities for each activity from which lead is emitted. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that lead is not released outside the lead control area. Include site preparation, cleanup and clearance procedures. Include occupational and environmental sampling, training, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan. Include a description of arrangements made among contractors on multi-contractor worksites to inform affected employees and to clarify responsibilities to control exposures.

The Removal/Control Plan shall be developed by a certified planner/project designer.

In occupied buildings, the Removal/Control Plan shall also include an occupant protection program that describes the measures that will be taken during the work to protect the building occupants.

1.5.2.3 Occupational and Environmental Assessment Data Report

If initial monitoring is necessary, submit occupational and environmental sampling results to the Contracting Officer within three working days of collection, signed by the testing laboratory employee performing the analysis, the employee that performed the sampling, and the CP.

In order to reduce the full implementation of 29 CFR 1926.62, the Contractor shall provide documentation. Submit a report that supports the determination to reduce full implementation of the requirements of 29 CFR 1926.62 and supporting the Lead Removal/Control Plan.

a. The initial monitoring shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures per 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead for stated work.

b. Submit worker exposure data gathered during the task based trigger operations of 29 CFR 1926.62 with a complete process description. This includes manual demolition, manual scraping, manual sanding, heat gun, power tool cleaning, rivet busting, cleanup of dry expendable abrasives, abrasive blast enclosure removal, abrasive blasting, welding, cutting and torch burning where lead containing coatings are present.

c. The initial assessment shall determine the requirement for further monitoring and the need to fully implement the control and protective requirements including the lead compliance plan per 29 CFR 1926.62.

1.5.2.4 Medical Examinations

Initial medical surveillance as required by 29 CFR 1926.62 shall be made available to all employees exposed to lead at any time (1 day) above the action level. Full medical surveillance shall be made available to all employees on an annual basis who are or may be exposed to lead in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62. Adequate records shall show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, and 29 CFR 1926.103. Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.

1.5.2.5 Training

Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations where appropriate.

1.5.2.6 Respiratory Protection Program

a. Provide each employee required to wear a respirator a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62.

b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.

1.5.2.7 Hazard Communication Program

Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.

1.5.2.8 Waste Management

The Waste Management Plan shall be in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION and NASA/KSC Special Condition contract clauses.

1.5.2.9 Environmental, Safety and Health Compliance

In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, local authorities, KNPR 1840.19, KNPR 8715.3, and KNPR 8500.1 regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply. The following Federal and State laws, ordinances, criteria, rules and regulations regarding removing, handling, storing, transporting, and disposing of lead-contaminated materials apply:

a. 40 CFR 745 (Subpart L)

b. 29 CFR 1926.62

Licensing and certification in the State of Florida is required.

1.5.3 Pre-Construction Conference

Along with the CP, meet with the Contracting Officer to discuss in detail the waste management plan and the lead-based paint/paint with lead removal/control plan, including work procedures and precautions for the removal plan.

1.6 EQUIPMENT

1.6.1 Respirators

Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.

1.6.2 Special Protective Clothing

Furnish personnel who will be exposed to lead-contaminated dust with proper disposable protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.

1.6.3 Rental Equipment Notification

If rental equipment is to be used during lead-based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the

Contracting Officer.

1.6.4 Vacuum Filters

UL 586 labeled HEPA filters.

1.6.5 Equipment for Government Personnel

Furnish the Contracting Officer with two complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor. The Government will provide respiratory protection for the Contracting Officer.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Protection of Existing Work to Remain

Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better. Ensure that no paint chips are released to the environment and that there are no emissions from the control area.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

3.1.1.1 Notification

a. Notify the Contracting Officer 20 days prior to the start of any paint removal work.

b. Occupant Notification

Submit occupant written acknowledgment of the delivery of lead hazard information pamphlet (EPA 747-K-99-001 "Protect Your Family From Lead in Your Home") prior to commencing the renovation work for each affected unit per 40 CFR 745 Subpart E.

3.1.1.2 Boundary Requirements

a. Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that lead will not escape outside the lead control area.

b. Warning Signs - Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.

3.1.1.3 Heating, Ventilating and Air Conditioning (HVAC) Systems

Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area.

3.1.1.4 Decontamination Facility

Provide clean and contaminated change rooms in accordance with this specification and 29 CFR 1926.62.

3.1.1.5 Eye Wash Station

Where eyes may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes shall be provided within the work area.

3.1.1.6 Mechanical Ventilation System

a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62.

b. To the extent feasible, use local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be evaluated and maintained in accordance with 29 CFR 1926.62.

c. Vent local exhaust outside the building only and away from building ventilation intakes.

d. Use locally exhausted, power actuated, paint removal tools.

3.1.1.7 Personnel Protection

Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.

3.2 ERECTION

3.2.1 Lead Control Area Requirements

Full containment - Contain removal operations by the use of critical barriers and HEPA filtered exhaust or a negative pressure enclosure system with decontamination facilities and with HEPA filtered exhaust if required by the CP. For containment areas larger than 1,000 square feet install a minimum of two 18 inch square viewing ports. Locate ports to provide a view of the required work from the exterior of the enclosed contaminated area. Glaze ports with laminated safety glass.

3.3 APPLICATION

3.3.1 Work Procedures

Perform removal of lead-based paint in accordance with approved lead-based paint/paint with lead removal/control plan. Use procedures and equipment

required to limit occupational and environmental exposure to lead when lead-based paint is removed in accordance with 29 CFR 1926.62. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), State, and local requirements and NASA KSC Special Condition contract clauses.

3.3.2 Lead-Based Paint Removal/Control/Deleading

Manual or power sanding of interior and exterior surfaces is not permitted unless tools are equipped with HEPA attachments or wet methods. The dry sanding or grinding of surfaces that contain lead is prohibited. Provide methodology for LBP removal/control in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate.

Avoid deterioration of the substrate. Provide surface preparations for painting.

Provide methodology for LBP/PWL removal and abatement/control and processes to minimize contamination of work areas outside the control area with lead-contaminated dust or other lead-contaminated debris/waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead. Describe this LBP/PWL removal/control process in the LBP/PWL Removal/Control Plan.

3.3.2.1 Indoor Paint Removal

Perform mechanical or chemical paint removal in lead control areas using enclosures, barriers, or containments. Collect residue or debrisfor disposal in accordance with federal, State, and local requirements.

3.3.2.2 Outdoor Paint Removal

Perform outdoor removal as indicated in Federal, State, and local regulations and in the LBP/CPR/CP. The worksite preparation (barriers or containments) shall be job dependent and presented in the LBP/PWL Removal/Control Plan.

3.3.3 Personnel Exiting Procedures

Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

a. Vacuum themselves off.

b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.

c. Shower.

d. Change to clean clothes prior to leaving the physical boundary designated around the lead control area.

3.4 FIELD QUALITY CONTROL

3.4.1 Tests

3.4.1.1 Air and Wipe Sampling

Air sample for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.

a. The CP shall be on the job site directing the air and non-clearance wipe sampling and inspecting the lead-based paint removal/control work to ensure that the requirements of the contract have been satisfied during the entire lead-based paint removal operation.

b. Collect personal air samples on employees who are expected to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.

c. Submit results of air samples, within 72 hours after the air samples are taken.

d. Before any work begins, a third party consultant shall collect and analyze baseline wipe samples in accordance with methods defined in Federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead-based paint removal/control.

e. Collect surface wipe samples at a location no greater than 10 feet outside the lead control area at a frequency of once per day while lead removal work is conducted. Surface wipe results shall meet criteria in paragraph "Clearance Certification."

3.4.1.2 Air Sampling During Paint Removal Work

Conduct area air sampling daily, on each shift in which lead-based paint removal operations are performed, in areas immediately adjacent to the lead control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Notify the Contracting Officer immediately. Determine if condition(s) require any further change in work methods. Removal work shall resume only after the CP and the Contracting Officer give approval. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.

3.4.1.3 Sampling After Paint Removal/Control

After the visual inspection, collect wipe samples according to the HUD protocol contained in HUD 6780 to determine the lead content of settled dust and dirt in micrograms per square meter foot of surface area.

3.4.1.4 Testing of Removed Paint and Used Abrasive

Test removed paint and used abrasive in accordance with 40 CFR 261 for hazardous waste.

3.5 CLEANING AND DISPOSAL

3.5.1 Cleanup

Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP. Reclean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.

3.5.1.1 Clearance Certification

The CP shall certify in writing that air samples collected outside the lead control area during paint removal operations are less than 30 micrograms per cubic meter of air; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of material and dust containing lead left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the Contracting Officer's acknowledgement of receipt of the CP certification.

For lead-based paint hazard abatement work, surface wipe shall be conducted and clearance determinations made according to the work practice standards presented in 40 CFR 745.227.

3.5.2 Disposal

a. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing that may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 262. Dispose of lead-contaminated waste material in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION paragraph "Materials Management and Waste Disposal" and NASA/KSC Special Condition contract clauses.

b. Transport all waste materials in accordance with Federal and State regulations.

-- End of Section --

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SECTION 02 84 33

REMOVAL AND DISPOSAL OF POLYCHLORINATED BIPHENYLS (PCBs)
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.

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 8500.1	KSC Environmental Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants
29 CFR 1910.145	Accident Prevention Signs and Tags
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 174	Carriage by Rail
49 CFR 175	Carriage by Aircraft
49 CFR 176	Carriage by Vessel
49 CFR 177	Carriage by Public Highway
49 CFR 178	Specifications for Packagings
49 CFR 179	Specifications for Tank Cars

1.2 REQUIREMENTS

The work includes the removal and disposal of material containing PCBs in paint coatings, caulking, and electrical equipment as indicated on the contract drawings. Perform work in accordance with 40 CFR 761 and the requirements specified herein.

1.3 DEFINITIONS

1.3.1 Leak

Leak or leaking means any instance in which a PCB Article, PCB Container, or PCB Equipment has any PCBs on any portion of its external surface.

1.3.2 PCBs

PCBs as used in this specification shall mean the same as PCBs, PCB Article, PCB Article Container, PCB Container, PCB Equipment, PCB Item, PCB Transformer, PCB-Contaminated Electrical Equipment, as defined in 40 CFR 761, Section 3, Definitions.

1.3.3 Spill

Spill means both intentional and unintentional spills, leaks, and other uncontrolled discharges when the release results in any quantity of PCBs running off or about to run off the external surface of the equipment or other PCB source, as well as the contamination resulting from those releases.

1.4 QUALITY ASSURANCE

1.4.1 Training

Instruct employees on the dangers of PCB exposure, on respirator use, decontamination, and applicable OSHA and EPA regulations.

1.4.2 Competent Person (CP)

A Competent Person hired by the Contractor is one who is trained in identifying existing and predictable PCB hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to control PCB hazards. A Certified Industrial Hygienist (CIH), certified by the American Board of Industrial Hygiene, is the recommended choice.

1.4.3 Regulation Documents

Maintain at all times one copy each at the office and one copy each in view at the job site 29 CFR 1910.1000, 40 CFR 761, and Contractor work practices for removal, storage and disposal of PCBs.

1.4.4 Surveillance Personnel

Surveillance personnel may enter PCB control areas for brief periods of time provided they wear disposable polyethylene gloves and disposal polyethylene foot covers, as a minimum. Additional protective equipment may be required if respiratory hazard is involved or if skin contact with PCB is involved.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Training certification

Qualifications of CP

PCB removal work plan

PCB disposal plan

Notification

Certification of Decontamination for PCB Spill

1.6 EQUIPMENT

1.6.1 Special Clothing

Work clothes shall consist of PPE as required by OSHA regulations, including, but not limited to the following:

a. Disposable coveralls

b. Gloves (Disposable rubber gloves may be worn under these)

c. Disposable foot covers (polyethylene)

d. Chemical safety goggles

e. Half mask cartridge respirator.

1.6.2 Special Clothing for Government Personnel

Provide PPE specified in paragraph entitled "Special Clothing" to the Contracting Officer as required for inspection of the work.

1.6.3 PCB Spill Kit

Assemble a spill kit to include the following items:

	ITEM	MINIMUM QUANTITY
1.	Disposable gloves (polyethylene)	6 prs
2.	Gloves with a high degree of impermeability to PCB	6 prs
3.	Disposable coveralls with permeation resistance to PCB	4 ea
4.	Chemical safety goggles	2 ea
5.	Disposable foot covers (polyethylene)	6 prs
6.	PCB Caution Sign: "PCB Spill--Authorized Personnel Only"	2 ea
7.	Banner guard or equivalent banner material	100 feet
8.	Absorbent material	5 bags
9.	Blue polyethylene waste bags	5 ea
10.	Cloth backed tape	1 roll
11.	Area access logs, blank	10 ea
12.	Brattice cloth, 6' x 6'	1 piece
13.	Rags	20 ea

	ITEM	MINIMUM QUANTITY
14.	Ball point pens	2 ea
15.	Herculite, 4' x 4' and 8' x 8'	1 ea
16.	Blank metal signs and grease pencils	2 ea
17.	Waste containers 55 gallon drum, may be used as container for kit)	1 ea

1.7 QUALITY ASSURANCE

1.7.1 Training Certification

Submit certificates, prior to the start of work but after the main abatement submittals, signed and dated by the CP and by each employee stating that the employee has received training. Certificates shall be organized by individual worker, not grouped by type of certificates.

1.7.2 Qualifications of CP

Submit the name, address, and telephone number of the Competent Person selected to perform the duties in paragraph entitled "Competent Person (CP)." Provide documented construction project-related experience with implementation of OSHA 29 CFR 1910.1000 which shows ability to assess occupation and environmental exposure to PCB hazards, experience with the use of respirators, personal protective equipment, and other exposure reduction methods to protect employee health. Submit proper documentation that the CP is trained and certified in accordance with federal, State, and local laws.

1.7.3 PCB Removal Work Plan

Submit a detailed job-specific plan of the work procedures to be used in the removal of PCB-containing materials, not to be combined with other hazardous abatement plans.

1.7.4 PCB Disposal Plan

Submit a PCB Disposal Plan within 45 calendar days after award of contract for Contracting Officer's approval. The PCB Disposal Plan shall comply with applicable requirements of Federal, State, and local PCB waste regulations and address:

a. Identification of PCB wastes associated with the work.

b. Estimated quantities of wastes to be generated and disposed of.

c. List of waste handling equipment to be used in performing the work, include cleaning, pump out of oil, and transport equipment to holding area.

d. Spill prevention, containment, and cleanup contingency measures to be implemented.

e. Work plan and schedule for PCB waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.

1.7.5 Notification

Notify the Contracting Officer 20 days prior to the start of PCB removal work.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Decontamination Room, Clean Room and Shower Facilities

a. Provide material and labor for construction of a decontamination room, a clean room, and shower facilities. Provide rooms with doors and attach to the exit ways of PCB work areas. Rooms shall be of sufficient size to accommodate the Contractor's operation within. Provide portable toilet and shower facilities. Locate shower facilities between the clean room and decontamination room. Provide separate clothing lockers or containers in each room to prevent contamination of street and work clothes.

b. Remove PCB-contaminated PPE in the decontamination room. Workers shall then proceed to showers. Workers shall shower before lunch and at the end of each day's work. Hot water, towels, soap, and hygienic conditions are the responsibility of the Contractor.

3.1.2 PCB Control Area

Isolate PCB control area by physical boundaries to prevent unauthorized entry of personnel. Food, drink and smoking materials shall not be permitted in areas where PCBs are handled or PCB items are stored.

3.1.3 Personnel Protection

Workers shall wear and use PPE, as recommended by the Industrial Hygienist, upon entering a PCB control area. If PPE is not required per the CP, specify in the PCB removal work plan.

3.1.4 Footwear

Work footwear shall remain inside work area until completion of the job.

3.1.5 Permissible Exposure Limits (PEL)

PEL for PCBs is 3.1 E-08 lb/cubic foot on an 8-hour time weighted average basis.

3.1.6 Special Hazards

a. PCBs shall not be exposed to open flames or other high temperature sources since toxic decomposition by-products may be produced.

b. PCBs shall not be heated to temperatures of 135 degrees F or higher without Contracting Officer's concurrence.

3.1.7 PCB Caution Label

40 CFR 761, Subpart C. Affix labels to PCB waste containers and other PCB-contaminated items. Provide label with sufficient print size to be clearly legible, with bold print on a contrasting background, displaying the following: CAUTION: Contains PCBs (Polychlorinated Biphenyls).

3.1.8 PCB Caution Sign

29 CFR 1910.145. Provide signs at approaches to PCB control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area.

3.2 WORK PROCEDURE

Furnish labor, materials, services, and equipment necessary for the complete removal of PCBs located at the site as indicated or specified in accordance with local, State, or Federal regulations. Package and mark PCB as required by EPA and DOT regulations and dispose of off Government property in accordance with NASA KNPR 8500.1 and Property Disposal at a permitted site.

3.2.1 No Smoking

Smoking is not permitted within 50 feet of the PCB control area. Provide "No Smoking" signs as directed by the Contracting Officer.

3.2.2 Work Operations

Ensure that work operations or processes involving PCB or PCB-contaminated materials are conducted in accordance with 40 CFR 761 and the applicable requirements of this section, including but not limited to:

a. Obtaining advance approval of PCB storage sites.

b. Notifying Contracting Officer prior to commencing the operation.

c. Reporting leaks and spills to the Contracting Officer.

d. Cleaning up spills.

e. Maintaining an access log of employees working in a PCB control area and providing a copy to the Contracting Officer upon completion of the operation.

f. Inspecting PCB and PCB-contaminated items and waste containers for leaks and forwarding copies of inspection reports to the Contracting Officer.

g. Maintaining a spill kit as specified in paragraph entitled "PCB Spill Kit."

h. Maintaining inspection, inventory and spill records.

3.3 PCB TRANSFORMERS

3.3.1 Draining of Transformer Liquid

Perform work in accordance with 49 CFR 171, 49 CFR 172, 49 CFR 173,

49 CFR 174, 49 CFR 175, 49 CFR 176, 49 CFR 177, 49 CFR 178, and 49 CFR 179, Subchapter C and as specified herein. Drain the transformer, switches, and regulators of free flowing liquid prior to transportation. Place the drained liquids in DOT Spec 17E drums. The drums shall not contain more than 50 gallons of oil. If the equipment cannot be drained, then place it in DOT Spec 17C drums.

3.3.2 Markings

Provide drums and drained PCB-contaminated electrical equipment with caution label markings as specified in paragraph entitled "PCB Caution Label."

3.3.3 Laboratory Analysis

All transformers shall have a laboratory analysis for turn-in.

3.3.4 Markings

3.3.4.1 Transformers, Less Than 50 ppm or Greater Than 50 ppm

Dispose of transformers in accordance with NASA Special Condition Contract Clauses.

3.4 PCB REMOVAL

Select PCB removal procedure to minimize contamination of work areas with PCB or other PCB-contaminated debris/waste. Handle PCBs such that no skin contact occurs. PCB removal process should be described in the work plan.

3.4.1 Confined Spaces

As feasible, do not carry out PCB handling operations in confined spaces. A confined space shall mean a space having limited means of egress and inadequate cross ventilation.

3.4.2 Control Area

Establish a PCB control area around the PCB item as specified in paragraph entitled "PCB Control Area." Only personnel briefed on the elements in the paragraph entitled "Training" and on the handling precautions shall be allowed into the area.

3.4.3 Exhaust Ventilation

If used, exhaust ventilation for PCB operations shall discharge to the outside and away from personnel.

3.4.4 Temperatures

As feasible, handle PCBs at ambient temperatures and not at elevated temperatures.

3.4.5 Solvent Cleaning

Clean contaminated tools, containers, etc., in accordance with NASA KNPR 8500.1.

3.4.6 Drip Pans

Drip pans are required under portable PCB transformers and rectifiers in use or stored for use. The pans shall have a containment volume of at least one and one-half times the internal volume of PCBs in the item.

3.4.7 Evacuation Procedures

Procedures shall be written for evacuation of injured workers. Aid for a seriously injured worker shall not be delayed for reasons of decontamination.

3.5 PCB SPILL CLEANUP REQUIREMENTS

3.5.1 PCB Spills

Immediately report to the Contracting Officer any PCB spills on the ground or in the water, PCB spills in drip pans, or PCB leaks.

3.5.2 PCB Spill Control Area

Rope off an area around the edges of a PCB leak or spill and post a "PCB Spill Authorized Personnel Only" caution sign. Immediately transfer leaking items to a drip pan or other container.

3.5.3 PCB Spill Cleanup

40 CFR 761, Subpart G. Initiate cleanup of spills as soon as possible, but no later than 48 hours of its discovery. To clean up spills, personnel shall wear the PPE prescribed in paragraph entitled "Special Clothing" of this section. If misting, elevated temperatures or open flames are present, or if the spill is situated in a confined space, notify the Contracting Officer. Mop up the liquid with rags or other conventional absorbent. The spent absorbent shall be properly contained and disposed of as solid PCB waste.

3.5.4 Records and Certification

Document the cleanup with records of decontamination in accordance with 40 CFR 761, Section 125, Requirements for PCB Spill Cleanup. Provide certification of decontamination.

3.5.5 Sampling Requirements

Perform post cleanup sampling as required by 40 CFR 761, Section 130, Sampling Requirements. Do not remove boundaries of the PCB control area until site is determined satisfactorily clean by the Contracting Officer.

3.6 STORAGE FOR DISPOSAL

3.6.1 Storage Containers for PCBs

Store PCBs in Government provided containers.

3.6.2 Waste Containers

Label as directed by the Government.

3.6.3 PCB Articles and PCB-Contaminated Items

Label as directed by the Government.

3.6.4 Approval of Storage Site

Storage sites shall be in accordance with NASA Special Condition Contract Clauses.

3.7 CLEANUP

Maintain surfaces of the PCB control area free of accumulations of PCBs. Restrict the spread of dust and debris; keep waste from being distributed over work area.

Do not remove the PCB control area and warning signs prior to the Contracting Officer's approval. Reclean areas showing residual PCBs.

3.8 PCB DISPOSAL AND MANAGEMENT

Comply with disposal requirements and procedures outlined in the contract documents, 40 CFR 761, and NASA Special Condition Contract Clauses.

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SECTION 03 30 00

CAST-IN-PLACE CONCRETE
11/11

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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI/MCP-1	(2011) Manual of Concrete Practice Part 1
ACI/MCP-2	(2011) Manual of Concrete Practice Part 2
ACI/MCP-3	(2011) Manual of Concrete Practice Part 3
ACI/MCP-4	(2011) Manual of Concrete Practice Part 4

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A496/A496M	(2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A497/A497M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A53/A53M	(2010) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A615/A615M	(2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for

Concrete Reinforcement

ASTM A706/A706M	(2009b) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A82/A82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM C1017/C1017M	(2007) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1107/C1107M	(2011) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1260	(2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C143/C143M	(2010a) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2011) Standard Specification for Portland Cement
ASTM C156	(2011) Standard Test Method for Water Retention by Concrete Curing Materials
ASTM C1567	(2011) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2010) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C192/C192M	(2007) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C295	(2011) Petrographic Examination of Aggregates for Concrete
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2010) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C311	(2011a) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
ASTM C33/C33M	(2011a) Standard Specification for

	Concrete Aggregates
ASTM C39/C39M	(2010) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2010a) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C494/C494M	(2011) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2008a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881/C881M	(2010) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM C932	(2006) Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering
ASTM C94/C94M	(2011b) Standard Specification for Ready-Mixed Concrete
ASTM C989	(2010) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 5759	(1995; R 2005) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM D 6690	(2007) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM E 1155	(1996; R 2008) Standard Test Method for Determining Floor Flatness and Floor

Levelness Numbers

ASTM E 1745 (2009) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

ASTM E 329 (2011a) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP (2009; 28th Ed) Manual of Standard Practice

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001 (2000) Principles and Criteria for Forest Stewardship

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1 (2009) DOC Voluntary Product Standard PS 1-07, Structural Plywood

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 572 (1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

U.S. DEPARTMENT OF COMMERCE (DOC)

DOC/NIST PS1 (1995) Construction and Industrial Plywood with Typical APA Trademarks

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-200 (Rev E; Am 1; Notice 1) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

1.2 DEFINITIONS

a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, and ground granulated blast-furnace slag.

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability

depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. 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

Fabrication Drawings for concrete formwork must be submitted by the Contractor in accordance with paragraph entitled, "Shop Drawings," of this section, to include the following:

Reinforcing steel; G

Reproductions of contract drawings are unacceptable.

Provide erection drawings for concrete Formwork that show placement of reinforcement and accessories, with reference to the contract drawings.

SD-03 Product Data

Materials for curing concrete
Joint sealants

Submit manufacturer's product data, indicating VOC content. Manufacturer's catalog data for the following items must include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders, waterstops, and liquid chemical floor hardeners.

Joint filler
Cement
Portland Cement
Ready-Mix Concrete
Vapor barrier
Bonding Materials
Concrete Curing Materials
Reinforcement
Waterstops
Wood Forms

SD-04 Samples

Submit the following samples:

Three samples of each type waterstop, 1/2 inch long.

Dumbbell Type
Polyvinylchloride (PVC)

SD-05 Design Data

Concrete mix design; G

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, ground slag, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which produce a range of strength encompassing those required for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submit copies of the fly ash, and pozzolan test results, in addition. The approval of fly ash and pozzolan test results must be within 6 months of submittal date. Obtain acknowledgement of receipt prior to concrete placement.

SD-06 Test Reports

Concrete mix design; G
Fly ash
Pozzolan
Ground granulated blast-furnace slag
Aggregates
Compressive strength tests
Slump

SD-07 Certificates

Curing concrete elements
VOC Content for form release agents, curing compounds, and concrete penetrating sealers
Material Safety Data Sheets

SD-08 Manufacturer's Instructions

Fly ash
Ground granulated blast-furnace slag
Welding Procedures must be in accordance with AWS D1.4/D1.4M.

Submit mill certificates for Steel Bar according to the paragraph entitled, "Fabrication," of this section.

Provide certificates for Welder Qualifications that are in accordance with the paragraph entitled, "Qualifications for Welding Work," of this section.

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until vapor retarder, vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. ACI/MCP-2 for job site storage of materials. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Drawings

1.6.1.1 Formwork

Drawings showing details of formwork including, but not limited to; joints, supports, studding and shoring, and sequence of form and shoring removal. Reproductions of contract drawings are unacceptable.

Design, fabricate, erect, support, brace, and maintain formwork so that it is capable of supporting without failure all vertical and lateral loads that may reasonably be anticipated to be applied to the formwork.

1.6.1.2 Reinforcing Steel

ACI/MCP-4. Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars.

1.6.2 Control Submittals

1.6.2.1 Curing Concrete Elements

Submit proposed materials and methods for curing concrete elements.

1.6.2.2 Pumping Concrete

Submit proposed materials and methods for pumping concrete. Submittal must include mix designs, pumping equipment including type of pump and size and material for pipe, and maximum length and height concrete is to be pumped.

1.6.2.3 Finishing Plan

Submit proposed material and procedures to be used in obtaining the finish for the concrete floors. Include qualification of person to be used for obtaining floor tolerance measurement, description of measuring equipment to be used, and a sketch showing lines and locations the measuring equipment will follow.

1.6.2.4 VOC Content for form release agents, curing compounds, and concrete penetrating sealers

Submit certification for the form release agent, curing compounds, and concrete penetrating sealers that indicate the VOC content of each product.

1.6.2.5 Material Safety Data Sheets

Submit Material Safety Data Sheets (MSDS) for all materials that are regulated for hazardous health effects. Prominently post the MSDS at the construction site.

1.6.3 Test Reports

1.6.3.1 Concrete Mix Design

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix must be suitable for the job conditions. Include mill test and all other test for cement, aggregates, and admixtures in the laboratory test reports. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the concrete mix design. Obtain approval before concrete placement.

1.6.3.2 Fly Ash and Pozzolan

Submit test results in accordance with ASTM C618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date. Submit manufacturer's policy statement on fly ash use in concrete.

1.6.3.3 Ground Granulated Blast-Furnace Slag

Submit test results in accordance with ASTM C989 for ground granulated blast-furnace slag. Submit test results performed within 6 months of submittal date. Submit manufacturer's policy statement on slag use in concrete.

1.6.3.4 Aggregates

ASTM C1260 for potential alkali-silica reactions, ASTM C295 for petrographic analysis.

1.6.4 Special Finisher Qualifications

For 35 percent or more fly ash content as a percentage of cementitious materials, finisher must have a minimum of 3 years' experience finishing high-volume fly ash concrete.

1.7 ENVIRONMENTAL REQUIREMENTS

Provide space ventilation according to manufacturer recommendations, at a minimum, during and following installation of concrete curing compound and sealer. Maintain one of the following ventilation conditions during the curing compound/sealer curing period or for 72 hours after installation:

a. Supply 100 percent outside air 24 hours a day.

b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 84 degrees F and humidity is between 30 percent and 60 percent.

c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

1.7.1 Submittals for Environmental Performance

a. Provide product data stating the location where all products were manufactured

b. For projects using FSC certified formwork, provide chain-of-custody documentation for all certified wood products.

c. For projects using reusable formwork, provide data showing how formwork is reused.

d. Provide MSDS product information data showing that form release agents meet any environmental performance goals such as using vegetable and soy based products.

e. Provide MSDS product information data showing that concrete adhesives meet any environmental performance goals including low emitting, low volatile organic compound products.

1.8 SUSTAINABLE DESIGN REQUIREMENTS

1.8.1 Forest Stewardship Council (FSC) Certification

Use FSC-certified wood where specified. Provide letter of certification signed by lumber supplier. Indicate compliance with FSC STD 01 001 and identify certifying organization. Submit FSC certification numbers; identify each certified product on a line-item basis. Submit copies of invoices bearing the FSC certification numbers.

1.9 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Perform concrete testing by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency must meet the requirements of ASTM E 329.

1.10 QUALIFICATIONS FOR WELDING WORK

Welding procedures must be in accordance with AWS D1.4/D1.4M.

Verify that Welder qualifications are in accordance with AWS D1.4/D1.4M or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

1.11 CONCRETE SAMPLING AND TESTING

Testing by the Contractor must include sampling and testing concrete materials proposed for use in the work and testing the design mix for each class of concrete. Perform quality control testing during construction.

Sample and test concrete aggregate materials proposed for use in the work in accordance with ASTM C33/C33M.

Sample and test portland cement in accordance with ASTM C150/C150M.

Testing must be performed by a Grade I Testing Technician.

PART 2 PRODUCTS

2.1 MATERIALS FOR FORMS

Provide wood, plywood, or steel. Use plywood or steel forms where a smooth form finish is required.

2.1.1 Wood Forms

Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with DOC/NIST PS1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining. Submit data verifying that composite wood products contain no urea formaldehyde resins. Virgin wood used must be FSC-certified.

2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)

Provide plywood that conforms to NIST PS 1, B-B, high density form overlay, not less than 5/8-inch thick.

2.1.2 Steel Forms

Provide steel form surfaces that do not contain irregularities, dents, or sags.

2.2 FORM TIES AND ACCESSORIES

The use of wire alone is prohibited. Provide form ties and accessories that do not reduce the effective cover of the reinforcement.

2.2.1 Polyvinylchloride Waterstops

COE CRD-C 572.

2.2.2 Dovetail Anchor Slot

Preformed metal slot approximately 1 by 1 inch of not less than 22 gage galvanized steel cast in concrete. Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material.

2.3 CONCRETE

2.3.1 Contractor-Furnished Mix Design

ACI/MCP-1, ACI/MCP-2, and ACI/MCP-3 except as otherwise specified. Indicate the compressive strength (f'c) of the concrete for each portion of the structure(s) and as specified below.

Location	f'c (Min. 28-Day Comp. Strength) (psi)	ASTM C33/C33M Maximum Nominal Aggregate (Size No.)	Range of Slump (inches)	Maximum Water-Cement Ratio (by weight)	Air Entr. (percent)
All areas	4000	67	1-4	0.45	0

Maximum slump shown above may be increased 1 inch for methods of consolidation other than vibration. Slump may be increased to 8 inches when superplasticizers are used. The water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days must not exceed 1.00.

Proportion concrete mixes for strength at 28 days.

2.3.1.1 Mix Proportions for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified are the responsibility of the Contractor. Base mixture proportions on compressive strength as determined by test specimens fabricated in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M. Samples of all materials used in mixture proportioning studies must be representative of those proposed for use in the project and must be accompanied by the manufacturer's or producer's test report indicating compliance with these specifications. Base trial mixtures having proportions and consistencies suitable for the work on methodology described in ACI/MCP-1. In the trial mixture, use at least three different water-cement ratios for each type of mixture, which must produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratio required must be based on equivalent water-cement ratio calculations as determined by the conversion from the weight ratio of water to cement plus pozzolan, and ground granulated blast-furnace slag by weight equivalency method. Design laboratory trial mixture for maximum permitted slump. Each combination of material proposed for use must have separate trial mixture, except for accelerator or retarder use can be provided without separate trial mixture. Report the temperature of concrete in each trial batch. For each water-cement ratio, at least three test cylinders for each test age must be made and cured in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M for 7 and 28 days. From these results, plot a curve showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, plot a curve showing the relationship between 7 and 28 day strengths.

2.3.1.2 Required Average Strength of Mix Design

The selected mixture must produce an average compressive strength exceeding the specified strength by the amount indicated in ACI/MCP-2. When a concrete production facility has a record of at least 15 consecutive tests, the standard deviation must be calculated and the required average compressive strength must be determined in accordance with ACI/MCP-2. When a concrete production facility does not have a suitable record of tests to establish a standard deviation, the required average strength must follow ACI/MCP-2 requirements.

2.3.2 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C94/C94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C94/C94M:

Type and brand cement

Cement content in 95-pound bags per cubic yard of concrete

Maximum size of aggregate

Amount and brand name of admixtures

Total water content expressed by water/cement ratio

2.3.3 Concrete Curing Materials

2.3.3.1 Absorptive Cover

Provide burlap, cotton mats, and other absorbent materials for curing concrete, as described in ACI 308R.

2.3.3.2 Moisture-Retaining Cover

Provide waterproof paper cover for curing concrete conforming to ASTM C171, regular or white, or polyethylene sheeting conforming to ASTM C171, or polyethylene-coated burlap consisting of a laminate of burlap and a white opaque polyethylene film permanently bonded to the burlap; burlap must conform to ASTM C171, Class 3, and polyethylene film must conform to ASTM C171. When tested for water retention in accordance with ASTM C156, weight of water lost 72 hours after application of moisture retaining covering material must not exceed 0.039 gram per square centimeter of the mortar specimen surface.

2.3.3.3 Membrane-Forming Curing Compound

Provide liquid type compound conforming to ASTM C309, Type 1, clear, Type 1D with fugitive dye for interior work and Type 2, white, pigmented for exterior work.

2.4 MATERIALS

2.4.1 Cement

ASTM C150/C150M, Type I or II blended cement except as modified herein. Provide blended cement that consists of a mixture of ASTM C150/C150M, Type II, cement and one of the following materials: ASTM C618 pozzolan or fly ash, ASTM C989 ground granulated blast-furnace slag. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch. For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

2.4.1.1 Fly Ash and Pozzolan

ASTM C618, Type F or C, except that the maximum allowable loss on ignition must be 6 percent for Types N and F. Add with cement. Fly ash content

must be a minimum of 20 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C311. Evaluate and classify fly ash in accordance with ASTM D 5759.

High contents of supplementary cementitious materials can have some detrimental effects on the concrete properties, such as slowing excessively the strength gain rate, and delaying and increasing the difficulty of finishing. The recommended maximum content (by weight of the total cementitious material) for these materials are:

a. For GGBF slag: 50 percent

b. For fly ash or natural pozzolan: 20 percent

2.4.1.2 Ground Granulated Blast-Furnace Slag

ASTM C989, Grade 120. Slag content must be a minimum of 25 percent by weight of cementitious material.

2.4.1.3 Portland Cement

Provide cement that conforms to ASTM C150/C150M, Type I, IA, II, or IIA. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.4.2 Water

Minimize the amount of water in the mix. The amount of water must not exceed 45 percent by weight of cementitious materials (cement plus pozzolans), and in general, improve workability by adjusting the grading rather than by adding water. Water must be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.4.3 Aggregates

ASTM C33/C33M, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement.

Fine and coarse aggregates must show expansions less than 0.08 percent at 16 days after casting when testing in accordance with ASTM C1260. Should the test data indicate an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1567 using the Contractor's proposed mix design. In this case, include the mix design low alkali portland cement and one of the following supplementary cementitious materials:

1. GGBF slag at a minimum of 40 percent of total cementitious

2. Fly ash or natural pozzolan at a minimum of total cementitious of

    a. 30 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 65 percent or more,
    b. 25 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 70 percent or more,

c. 20 percent if (SiO2 plus Al2O3 plus Fe2O3) is 80 percent or more,
d. 15 percent if (SiO2 plus Al2O3 plus Fe2O3) is 90 percent or more.

If a combination of these materials is chosen, the minimum amount must be a linear combination of the minimum amounts above. Include these materials in sufficient proportion to show less than 0.08 percent expansion at 16 days after casting when tested in accordance with ASTM C1567.

Aggregates must not possess properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with ASTM C295.

2.4.3.1 Aggregates/Combined Aggregate Gradation (Floor Slabs Only)

ASTM C33/C33M, uniformly graded and as follows: Nominal maximum aggregate size of 1 inch. A combined sieve analysis must indicate a well graded aggregate from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 (0.3mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50 (0.3mm). Provide sand that is at least 50 percent natural sand.

2.4.4 Nonshrink Grout

ASTM C1107/C1107M.

2.4.5 Admixtures

ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures.

2.4.5.1 High Range Water Reducer (HRWR) (Superplasticizers)

ASTM C494/C494M, Type F and ASTM C1017/C1017M.

2.4.5.2 Pozzolan

Provide fly ash or other pozzolans used as admixtures that conform to ASTM C618.

2.4.6 Vapor Barrier

ASTM E 1745 Class A polyethylene sheeting, minimum 10 mil thickness or other equivalent material.

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.4.7 Materials for Curing Concrete

Use water-based curing compounds, sealers, and coatings with low (maximum 160 grams/liter, less water and less exempt compounds) VOC content.

Consider the use of water based or vegetable or soy based curing agents in lieu of petroleum based products. Consider agents that are not toxic and emit low or no Volatile Organic Compounds (VOC). Consider the use of admixtures that offer high performance to increase durability of the finish

product but also have low toxicity and are made from bio-based materials such as soy, and emit low levels of Volatile Organic Compounds (VOC).

2.4.7.1 Impervious Sheeting

ASTM C171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.4.7.2 Pervious Sheeting

AASHTO M 182.

2.4.7.3 Liquid Membrane-Forming Compound

ASTM C309, white-pigmented, Type 2, Class B.

2.4.8 Expansion/Contraction Joint Filler

ASTM D 1751, ASTM D 1752, cork or 100 percent post-consumer paper meeting ASTM D 1752 (subparagraphs 5.1 to 5.4). Material must be 1/2 inch thick, unless otherwise indicated.

2.4.8.1 Preformed Joint Filler Strips

Provide nonextruding and resilient nonbituminous type filler strips conforming to ASTM D 1752, Type I or II.

2.4.9 Joint Sealants

Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content.

2.4.9.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D 6690 or ASTM C920, Type M, Class 25, Use T.

2.4.9.2 Vertical Surfaces Greater Than 3 Percent Slope

ASTM C920, Type M, Grade NS, Class 25, Use T.

2.4.9.3 Waterstops

Provide waterstops that are flat dumbbell type and not less than 3/8 inch for widths 5 inches and over.

2.4.9.4 Joint Sealant Compound

Provide hot-poured, elastic type compound conforming to ASTM D 6690.

Provide cold-applied, two-component, elastomeric polymer type compound conforming to FS SS-S-200.

2.4.10 Epoxy Bonding Compound

ASTM C881/C881M. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Grade 1 or 2 for horizontal surfaces and Grade 3 for vertical surfaces. Provide Class A if

placement temperature is below 40 degrees F; Class B if placement temperature is between 40 and 60 degrees F; or Class C if placement temperature is above 60 degrees F.

2.5 REINFORCEMENT

Galvanize bars, fabrics, connectors, and chairs.

2.5.1 Reinforcing Bars

ACI/MCP-2 unless otherwise specified. Use deformed steel.

2.5.1.1 Weldable Reinforcing Bars

Provide weldable reinforcing bars that conform to ASTM A706/A706M and ASTM A615/A615M and Supplement S1, Grade 60, except that the maximum carbon content must be 0.55 percent.

2.5.2 Mechanical Reinforcing Bar Connectors

ACI/MCP-2. Provide 125 percent minimum yield strength of the reinforcement bar.

2.5.3 Wire

ASTM A82/A82M or ASTM A496/A496M.

2.5.3.1 Welded Wire Fabric

ASTM A185/A185M or ASTM A497/A497M.

2.5.3.2 Steel Wire

Wire must conform to ASTM A82/A82M.

2.5.4 Reinforcing Bar Supports

Provide bar ties and supports of coated or non corrodible material. Use recycled plastic with 100 percent recycled content or use engineered resins from recycled ABS plastic, polycarbonates, and fiberglass.

2.5.5 Dowels for Load Transfer in Floors

Provide dowels for load transfer in floors of the type, design, weight, and dimensions indicated. Provide dowel bars that are plain-billet steel conforming to ASTM A615/A615M, Grade 40. Provide dowel pipe that is steel conforming to ASTM A53/A53M.

2.5.6 Supports for Reinforcement

Supports include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcing bars and wire fabric in place.

Provide wire bar type supports conforming to ACI/MCP-3, ACI/MCP-4 and CRSI 10MSP.

Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

2.6 BONDING MATERIALS

2.6.1 Concrete Bonding Agent

Provide aqueous-phase, film-forming, nonoxidizing, freeze and thaw-resistant compound agent suitable for brush or spray application conforming to ASTM C932.

2.6.2 Epoxy-Resin Adhesive Binder

Provide two-component, epoxy-polysulfide polymer type binder with an amine-type curing-agent conforming to ASTM C881/C881M.

2.7 CLASSIFICATION AND QUALITY OF CONCRETE

2.7.1 Concrete Classes and Usage

Provide concrete classes, compressive strength, requirements for air entrainment, and usage as follows:

CONCRETE CLASS	MIN. 28-DAY COMPRESSIVE STRENGTH POUNDS PER SQ. IN.	REQUIREMENT FOR AIR ENTRAINMENT	USAGE
4N	4,000	Nonair-entrained	For structural concrete work not exposed to freezing and thawing such as interior columns, beams, supported slabs and other structural members for interior slabs on ground subjected to foot traffic

2.7.2 Limits for Concrete Proportions

Provide limits for maximum water/cement ratio and minimum cement content for each concrete class as follows:

CONCRETE CLASS	MAX. WATER/CEMENT RATIO BY WEIGHT	MIN. CEMENT FOR 3- TO 4-INCH SLUMP, (NO. OF 94-POUND SACKS) PER CU. YD.
4N	0.45	6.0

* Weight of water to weight of cement in pounds in one cubic yard of concrete

2.7.3 Maximum Size of Aggregate

Size of aggregate, designated by the sieve size on which maximum amount of retained coarse aggregate is 5 to 10 percent by weight, must be as follows:

MAXIMUM SIZE OF AGGREGATE	ASTM C33/C33M SIZE NUMBER	TYPE OF CONSTRUCTION
3/4 inch	67	Reinforced walls, columns, girders, beams, and other formed sections having a dimension between forms of not less than 6 inches and clear distance between reinforcing bars or reinforcing bar and face of form of not less than 1 inch
3/4 inch	67	Monolithic concrete slabs and other flatwork having a depth of not less than 2-1/2 inches and a clear distance between reinforcing bars of not less than 1 inch

Maximum size of aggregate may be that required for most critical type of construction using that concrete class.

Specify gradation of aggregates for separate floor topping.

2.7.4 Slump

Provide slump for concrete at time and in location of placement as follows:

TYPE OF CONSTRUCTION	SLUMP
Footings, unreinforced walls	Not less than 1 inch nor more than 3 inches
Columns, beams, reinforced walls, monolithic slabs	Not less than 1 inch nor more than 4 inches
Ramps and other sloping surfaces	0 nor more than 3 inches

PART 3 EXECUTION

3.1 EXAMINATION

Do not begin installation until substrates have been properly constructed; verify that substrates are plumb and true.

If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before processing.

Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Architect/Engineer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

When subgrade material is semiporous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder; this may also be used over semiporous, dry subgrade material instead of water sprinkling.

3.2.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

Previously constructed subgrade or fill must be cleaned of foreign materials and inspected by the Contractor for adequate compaction and surface tolerances as specified.

Actual density of top 12 inches of subgrade soil material-in-place must not be less than 98 percent of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D 1557.

Finish surface of capillary water barrier under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

Prepare subgrade or fill surface under exterior slabs on ground as specified for subgrade under foundations and footings.

3.2.4 Formwork

Complete and approve formwork. Remove debris and foreign material from interior of forms before start of concrete placing.

3.2.5 Edge Forms and Screed Strips for Slabs

Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.6 Reinforcement and Other Embedded Items

Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

3.3 FORMS

ACI/MCP-2. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch unless otherwise indicated. Provide formwork with clean-out openings to permit inspection and removal of debris. Forms submerged in water must be watertight.

3.3.1 General

Construct forms to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms must be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

3.3.2 Design and Construction of Formwork

Provide formwork design and construction that conforms to ACI/MCP-2, Chapter 4.

Provide forms that are tight to prevent leakage of cement paste during concrete placing.

Support form facing materials by structural members spaced close to prevent deflection of form facing material. Fit forms placed in successive units for continuous surfaces to accurate alignment to ensure a smooth completed surface within the tolerances specified. Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, camber formwork for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Chamfer exposed joints, edges, and external corners a minimum of 3/4 inch by moldings placed in corners of column, beam, and wall forms.

Provide shores and struts with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations. Obtain adjustment with wedges or jacks or a combination thereof. When adequate foundations for shores and struts cannot be secured, provide trussed supports.

Provide temporary openings in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Provide forms that are readily removable without impact, shock, or damage to concrete.

3.3.3 Coating

Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.3.4 Reshoring

Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, reshore slabs and beams over 10 feet in span and cantilevers over 4 feet for the remainder of the specified time period in accordance with paragraph entitled "Removal of Forms." Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Provide reshoring elements with the same load-carrying capabilities as original shoring and spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.3.5 Reuse

Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

3.3.6 Forms for Standard Rough Form Finish

Give rough form finish concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish must be the specified concrete form plywood or other approved form facing material that produces concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 1-inch nominal thickness lumber may be used. Provide horizontal joints that are level and vertical joints that are plumb.

3.3.7 Forms for Standard Smooth Form Finish

Give smooth form finish concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, dampproofing, painting, or other similar coating system.

Form facing material for standard smooth finish must be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales must not exceed 0.0025 times the span.

Provide arrangement of form facing sheets that are orderly and symmetrical, and sheets that are in sizes as large as practical.

Arrange panels to make a symmetrical pattern of joints. Horizontal and vertical joints must be solidly backed and butted tight to prevent leakage and fins.

3.3.8 Form Ties

Provide ties that are factory fabricated metal, adjustable in length, removable or snap-off type that do allow form deflection or do not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts must be at least 1-1/2 inches back from concrete surface. Provide form ties that are free of devices that leave a hole larger than 7/8 inch or less than 1/2 inch in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.3.9 Tolerances for Form Construction

Construct formwork to ensure that after removal of forms and prior to patching and finishing of formed surfaces, provide concrete surfaces in accordance with tolerances specified in ACI/MCP-1 and ACI/MCP-2.

3.3.10 Removal of Forms and Supports

After placing concrete, forms must remain in place for the time periods specified in ACI/MCP-4. Do not remove forms and shores (except those used for slabs on grade and slip forms) until the client determines that the concrete has gained sufficient strength to support its weight and superimposed loads. Base such determination on compliance with one of the following:

a. The plans and specifications stipulate conditions for removal of forms and shores, and such conditions have been followed, or

b. The concrete has been properly tested with an appropriate ASTM standard test method designed to indicate the concrete compressive strength, and the test results indicate that the concrete has gained sufficient strength to support its weight and superimposed loads.

Prevent concrete damage during form removal. Clean all forms immediately after removal.

3.4 WATERSTOP SPLICES

Fusion weld in the field.

3.5 FORMED SURFACES

3.5.1 Preparation of Form Surfaces

Coat contact surfaces of forms with form-coating compound before reinforcement is placed. Provide a commercial formulation form-coating compound that does not bond with, stain, nor adversely affect concrete surfaces and impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds. Do not allow excess form-coating compound to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete is placed. Make thinning of form-coating compound with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

3.5.2 Tolerances

ACI/MCP-4 and as indicated.

3.5.3 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Do not use material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which can impair the texture of the concrete surface.

3.6 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

ACI/MCP-2. Provide bars, wire fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

3.6.1 General

Provide details of reinforcement that are in accordance with ACI/MCP-3 and ACI/MCP-4 and as specified.

3.6.2 Vapor Barrier

Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches and tape or cement joints. Remove torn, punctured, or damaged vapor barrier material and provide with new vapor barrier prior to placing concrete. Concrete placement must not damage vapor barrier material.

3.6.3 Reinforcement Supports

Place reinforcement and secure with galvanized or non corrodible chairs, spacers, or metal hangers. For supporting reinforcement on the ground, use concrete or other non corrodible material, having a compressive strength equal to or greater than the concrete being placed.

3.6.4 Splicing

As indicated. For splices not indicated ACI/MCP-2. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus 2 inches. AWS D1.4/D1.4M. Approve welded splices prior to use.

3.6.5 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Calk the depression after the bolt is installed.

3.6.6 Cover

ACI/MCP-2 for minimum coverage, unless otherwise indicated.

3.6.7 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.6.8 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.6.9 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 1/2 inch wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Complete saw joints within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.6.10 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

Provide fabrication tolerances that are in accordance with ACI/MCP-1, ACI/MCP-2 and ACI/MCP-3.

Provide hooks and bends that are in accordance with ACI/MCP-3 and ACI/MCP-4.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Tolerance on nominally square-cut, reinforcing bar ends must be in accordance with ACI/MCP-3.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances

b. Bends or kinks not indicated on drawings or approved shop drawings

c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.6.11 Placing Reinforcement

Place reinforcement in accordance with ACI/MCP-3 and ACI/MCP-4.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire fabric on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than 1 inch from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

Contractor must cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor must notify the Contracting Officer so that conflicts may be reconciled before placing concrete. Anchors and embedded items must be positioned and supported with appropriate accessories.

Handle epoxy-coated reinforcing bars carefully to prevent damage to the coating. Use plastic-coated tie wire and supports of a type to prevent damage to the reinforcing bars.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Provide supports for reinforcing bars that are sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with ACI/MCP-3, ACI/MCP-4 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

Equip supports on ground and similar surfaces with sand-plates.

Support welded wire fabric as required for reinforcing bars.

Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

With the exception of temperature reinforcement, tied to main steel approximately 24 inches on center, reinforcement must be accurately placed, securely tied at intersections with 18-gage annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to ACI/MCP-3.

Bending of reinforcing bars partially embedded in concrete is permitted only as specified in ACI/MCP-3 and ACI/MCP-4.

3.6.12 Spacing of Reinforcing Bars

Spacing must be as indicated. If not indicated, spacing must be in accordance with the ACI/MCP-3 and ACI/MCP-4.

Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to approval.

3.6.13 Concrete Protection for Reinforcement

Concrete protection must be in accordance with the ACI/MCP-3 and ACI/MCP-4.

3.6.14 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

3.7 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ASTM C94/C94M, and ACI/MCP-2, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.7.1 Measuring

Make measurements at intervals as specified in paragraphs entitled "Sampling" and "Testing."

3.7.2 Mixing

ASTM C94/C94M and ACI/MCP-2. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 84 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.7.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.8 PLACING CONCRETE

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 10 foot centers maximum in each direction when pouring interior slabs and on 20 foot centers maximum for exterior slabs.

3.8.1 General Placing Requirements

Deposit concrete continuously or in layers of such thickness that no concrete is placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation.

Concrete to receive other construction must be screeded to proper level to avoid excessive skimming or grouting.

Do not use concrete which becomes nonplastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials. Remove rejected concrete from the site.

3.8.2 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 4 inches greater than indicated.

3.8.3 Vibration

ACI/MCP-2. Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Penetrate the previously placed lift with the vibrator when more than one lift is required. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

3.8.4 Application of Epoxy Bonding Compound

Apply a thin coat of compound to dry, clean surfaces. Scrub compound into the surface with a stiff-bristle brush. Place concrete while compound is stringy. Do not permit compound to harden prior to concrete placement.

Follow manufacturer's instructions regarding safety and health precautions when working with epoxy resins.

3.8.5 Pumping

ACI/MCP-2. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.8.6 Cold Weather

ACI/MCP-2. Do not allow concrete temperature to decrease below 50 degrees F. Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

3.8.7 Hot Weather

Maintain required concrete temperature using Figure 2.1.5 in ACI/MCP-2 to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.8.8 Follow-up

Check concrete within 24 hours of placement for flatness, levelness, and other specified tolerances. Adjust formwork and placement techniques on subsequent pours to achieve specified tolerances.

3.8.9 Placing Concrete in Forms

Deposit concrete placed in forms in horizontal layers not exceeding 24 inches.

Remove temporary spreaders in forms when concrete placing has reached elevation of spreaders.

Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Provide vibrating equipment adequate in number of units and power of each unit to properly

consolidate concrete. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Do not insert vibrator into lower courses of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Do not start placing of concrete in supporting elements until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

3.8.10 Placing Concrete Slabs

Place and consolidate concrete for slabs in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed.

During concrete placing operations, consolidate concrete by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground by mechanical vibrators as specified. Consolidate concrete in remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other approved method. Limit consolidation operations to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated must be as dry as practical and surfaces thereof must not be manipulated prior to finishing operations. Bring concrete correct level with a straightedge and struck-off. Use bull floats or darbies to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface is not permitted.

Provide finish of slabs as specified.

3.8.11 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.

Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per

sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Apply such bonding material to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

3.9 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.9.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than 1 square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI/MCP-4. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise specified.

3.9.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

3.9.3 Formed Surfaces

3.9.3.1 Tolerances

ACI/MCP-1 and as indicated.

3.9.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch these holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 0.25 inch in height.

3.9.3.3 Standard Smooth Finish

Finish must be as-cast concrete surface as obtained with form facing material for standard smooth finish. Repair and patch defective areas as specified; and all fins and remove other projections on surface.

3.10 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

ACI/MCP-2, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Steel trowel and fine-broom finish concrete slabs that are to receive quarry tile, ceramic tile, or paver tile. Where straightedge measurements are specified, Contractor must provide straightedge.

3.10.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper

contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.10.1.1 Floated

Use for exterior slabs where not otherwise specified. After the concrete has been placed, consolidated, struck off, and leveled, do not work the concrete further, until ready for floating. Whether floating with a wood, magnesium, or composite hand float, with a bladed power trowel equipped with float shoes, or with a powered disc, float must begin when the surface has stiffened sufficiently to permit the operation. During or after the first floating, check surface with a 10 foot straightedge applied at no less than two different angles, one of which is perpendicular to the direction of strike off. Cut down high spots and fill low spots during this procedure to produce a surface level within 1/4 inch in 10 feet.

3.10.1.2 Steel Troweled

Use for floors intended as walking surfaces. First, provide a floated finish. Next, the finish must be power troweled two times, and finally hand troweled. The first troweling after floating needs to produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings done by hand after the surface has hardened sufficiently. The final troweling is done when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate the surface by the hand troweling operations. The finished surface must be essentially free of trowel marks and uniform in texture and appearance. The finished surface must produce a surface level to within 1/4 inch in 10 feet. On surfaces intended to support floor coverings, remove any defects of sufficient magnitude to show through the floor covering by grinding.

3.10.1.3 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.10.2 Flat Floor Finishes

3.10.2.1 Measurement of Floor Tolerances

Test slab within 24 hours of the final troweling. Provide tests to Contracting Officer within 12 hours after collecting the data. Floor flatness inspector is required to provide a tolerance report which must include:

a. Key plan showing location of data collected.

b. Results required by ASTM E 1155.

3.10.2.2 Remedies for Out of Tolerance Work

Contractor is required to repair and retest any floors not meeting

specified tolerances. Prior to repair, Contractor must submit and receive approval for the proposed repair, including product data from any materials proposed. Repairs must not result in damage to structural integrity of the floor. For floors exposed to public view, repairs must prevent any uneven or unusual coloring of the surface.

3.10.3 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.10.4 Curbs

Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Perform pavement finish.

3.11 CURING AND PROTECTION

ACI/MCP-2 unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.11.1 General

Protect freshly placed concrete from premature drying and cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

Start initial curing as soon as free water has disappeared from surface of concrete after placing and finishing. Keep concrete moist for minimum 72 hours.

Final curing must immediately follow initial curing and before concrete has dried. Continue final curing until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 50 degrees F has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Prevent rapid drying at end of final curing period.

3.11.2 Moist Curing

Remove water without erosion or damage to the structure. Prevent water run-off.

3.11.2.1 Ponding or Immersion

Continually immerse the concrete throughout the curing period. Water must not be more than 50 degrees F less than the temperature of the concrete. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.11.2.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.11.2.3 Pervious Sheeting

Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6 inches over adjacent sheeting. Provide sheeting that is at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

3.11.2.4 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12 inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.11.3 Liquid Membrane-Forming Curing Compound

Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Apply in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 2.1.5 in ACI/MCP-2 indicates that hot weather conditions cause an evaporation rate exceeding 0.2 pound of water per square foot per hour.

3.11.3.1 Application

Unless the manufacturer recommends otherwise, apply compound immediately after the surface loses its water sheen and has a dull appearance, and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats must be 200 square feet maximum per gallon of undiluted compound

unless otherwise recommended by the manufacturer's written instructions. The compound must form a uniform, continuous, coherent film that does not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Re-spray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.11.3.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.11.4 Requirements for Type III, High-Early-Strength Portland Cement

The curing periods are required to be not less than one-fourth of those specified for portland cement, but in no case less than 72 hours.

3.11.5 Curing Periods

ACI/MCP-2 except 10 days for retaining walls, pavement or chimneys, 21 days for concrete that is in full-time or intermittent contact with seawater, salt spray, alkali soil or waters. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.11.6 Curing Methods

Accomplish curing by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified.

Moist curing:

Accomplish moisture curing by any of the following methods:

Keeping surface of concrete wet by covering with water

Continuous water spraying

Covering concrete surface with specified absorptive cover for curing concrete saturated with water and keeping absorptive cover wet by water spraying or intermittent hosing. Place absorptive cover to provide coverage of concrete surfaces and edges with a slight overlap over adjacent absorptive covers.

Moisture-cover curing:

Accomplish moisture-retaining cover curing by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Place cover directly on concrete in widest practical width, with sides and ends lapped at least 3 inches. Weight cover to prevent displacement; immediately repair tears or holes appearing during curing period by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Accomplish membrane curing by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Apply curing compound uniformly in a two-coat operation by power-spraying equipment using a spray nozzle equipped with a wind guard. Apply second coat in a direction at right angles to direction of first coat. Total coverage for two coats must be not more than 200 square feet per gallon of curing compound. Respray concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied by method and at rate specified. Maintain continuity of coating for entire curing period and immediately repair damage to coating during this period.

Membrane-curing compounds must not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, waterproofing, dampproofing, membrane roofing, painting, and other coatings and finish materials.

3.11.7 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.11.8 Curing Unformed Surfaces

Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.

Unless otherwise specified, accomplish final curing of unformed surfaces by any of curing methods specified above, as applicable.

Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.11.9 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

3.11.10 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.11.11 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.12 FIELD QUALITY CONTROL

3.12.1 Sampling

ASTM C172/C172M. Collect samples of fresh concrete to perform tests specified. ASTM C31/C31M for making test specimens.

3.12.2 Testing

3.12.2.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.

3.12.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.12.2.3 Compressive Strength Tests

ASTM C39/C39M. Make five test cylinders for each set of tests in accordance with ASTM C31/C31M. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two cylinders at 28 days, and hold one cylinder in reserve. Take samples for strength tests of each mix design of concrete placed each day not less than once a day, nor less than once for each 160 cubic yards of concrete, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. If the average of any three consecutive strength test results is less than f'c or if any strength test result falls below f'c by more than 450 psi, take a minimum of three ASTM C42/C42M core samples from the in-place work represented by the low test cylinder results and test. Concrete represented by core test is considered structurally adequate if the average of three cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c. Retest locations represented by erratic core strengths. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

3.12.2.4 Strength of Concrete Structure

Compliance with the following is considered deficient if it fails to meet the requirements which control strength of structure in place, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration

Poor workmanship likely to result in deficient strength

3.12.2.5 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C42/C42M, and as follows:

Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

Test cores after moisture conditioning in accordance with ASTM C42/C42M if concrete they represent is more than superficially wet under service.

Air dry cores, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required must be borne by the Contractor.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.13 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows.

3.13.1 Mixing Equipment

Before concrete pours, designate Company-owned site meeting environmental standards for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.13.2 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.13.3 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material. Institute deconstruction and construction waste separation and recycling for use in manufacturer's programs. When such a program is not available, seek local recyclers to reclaim the materials.

3.14 JOINTS

3.14.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Locate construction joints as follows:

a. In walls at not more than 60 feet in any horizontal direction; at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall

b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier

c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.

d. In slabs on ground, so as to divide slab into areas not in excess of 1,200 square feet

Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

Joints must be perpendicular to main reinforcement. Reinforcement must be continued across construction joints.

3.14.2 Waterstops

Provide waterstops in construction joints as indicated.

Install waterstops to form a continuous diaphragm in each joint. Make adequate provisions to support and protect waterstops during progress of work. Make field joints in waterstops in accordance with waterstop manufacturer's printed instructions, as approved. Protect waterstops protruding from joints from damage.

3.14.3 Isolation Joints in Slabs on Ground

Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

3.14.4 Control Joints in Slabs on Ground

Provide joints to form panels as indicated.

Under and on exact line of each control joint, cut 50 percent of welded wire fabric reinforcement before placing concrete.

Joints must be 1/8-inch wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface or by cutting the concrete with a saw after the concrete has set. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean groove of foreign matter and loose particles.

3.14.5 Sealing Joints in Slabs on Ground

Isolation and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

Sealing is not required for isolation and control joints to be covered with finish flooring material. Groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.15 INSTALLATION OF ANCHORAGE DEVICES

3.15.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, set and build in cast-in-place concrete as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

3.15.2 Placing Anchorage Devices

Anchorage devices and embedded items must be positioned accurately and supported against displacement. Fill openings in anchorage devices such as slots and threaded holes with an approved, removable material to prevent entry of concrete into openings.

3.16 CONCRETE CONVEYING

3.16.1 Transfer of Concrete At Project Site

Handle concrete from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which prevent segregation and loss of concrete mix materials.

3.16.2 Mechanical Equipment for Conveying Concrete

Equipment must ensure a continuous flow of concrete at delivery end, as approved. Provide runways for wheeled concrete-conveying equipment from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment must be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

-- End of Section --

SECTION 05 12 00

STRUCTURAL STEEL
11/11

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 INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 201	(2006) AISC Certification Program for Structural Steel Fabricators
AISC 325	(2011) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 341	(2010) Seismic Provisions for Structural Steel Buildings
AISC 360	(2010) Specification for Structural Steel Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2010) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143/A143M	(2007) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A500/A500M	(2010a) Standard Specification for

	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A53/A53M	(2010) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C1107/C1107M	(2011) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C827/C827M	(2010) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
ASTM F1554	(2007ae1) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F844	(2007a) Washers, Steel, Plain (Flat), Unhardened for General Use

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

1.2 SYSTEM DESCRIPTION

Provide the structural steel system, complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing shall be provided in accordance with AISC 360 and AISC 341 except as modified in this contract.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. 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

Erection Plan, including description of temporary supports; G, AE

Fabrication drawings including description of connections; G, AE

SD-03 Product Data

Welding electrodes and rods

Non-Shrink Grout

Galvanizing repair material and directions

SD-06 Test Reports

eight in ounces per square foot for zinc coating

SD-07 Certificates

Zinc coating

Steel

Bolts, nuts, and washers

Galvanizing

AISC Quality Certification

Welding procedures and qualifications

1.4 AISC QUALITY CERTIFICATION

Work shall be fabricated in an AISC certified Category Std fabrication plant.

1.5 QUALITY ASSURANCE

1.5.1 Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326 and AISC 325. Fabrication drawings shall not be reproductions of contract drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Member substitutions of details shown on the contract drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

1.5.2 Certifications

1.5.2.1 Erection Plan

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing.

1.5.2.2 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welding operator is more than one-year old, the welding operator's qualification certificate shall be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

Conform to all requirements specified in AWS D1.1/D1.1M.

PART 2 PRODUCTS

2.1 STEEL

2.1.1 Structural Steel

ASTM A36/A36M.

2.1.2 Structural Steel Tubing

ASTM A500/A500M, Grade B.

2.1.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B, weight class as shown on drawings.

2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

2.2.1 Structural Steel

2.2.1.1 Bolts

ASTM A307, Grade A. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.2.1.2 Nuts

ASTM A563, Grade and Style for applicable ASTM bolt standard recommended.

2.2.1.3 Washers

ASTM F844 washers for ASTM A307 bolts.

2.2.2 Foundation Anchorage

2.2.2.1 Anchor Bolts

ASTM F1554.

2.2.2.2 Anchor Nuts

ASTM A563, Grade A, hex style.

2.2.2.3 Anchor Washers

ASTM F844.

2.2.2.4 Anchor Plate Washers

ASTM A36/A36M.

2.3 STRUCTURAL STEEL ACCESSORIES

2.3.1 Welding Electrodes and Rods

AWS D1.1/D1.1M.

2.3.2 Non-Shrink Grout

ASTM C1107/C1107M, with no ASTM C827/C827M shrinkage. Grout shall be nonmetallic.

2.4 GALVANIZING

ASTM A123/A123M or ASTM A153/A153M, as applicable, unless specified otherwise galvanize after fabrication where practicable. Hot dip galvanize all components. Minimum thickness of zinc coating shall be in accordance with the referenced standard.

2.5 FABRICATION

2.5.1 Markings

Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations. Affix embossed tags to hot-dipped galvanized members.

2.5.2 Shop Primer

Do not prime steel surfaces embedded in concrete, galvanized surfaces.

2.5.2.1 Cleaning

SSPC SP 6/NACE No.3. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

2.6 DRAINAGE HOLES

Adequate drainage holes shall be drilled to eliminate water traps. Hole diameter shall be 1/2 inch and location shall be indicated on the detail drawings. Hole size and location shall not affect the structural integrity.

PART 3 EXECUTION

3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC 325. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC 201 for Category Conventional Steel Building structural steelwork.

Structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded, shall be prepared for painting in accordance with endorsement "P" of AISC 201 and primed with the specified paint.

Splices not indicated require the approval of the Contracting Officer.

3.2 ERECTION

Provide for drainage in structural steel. After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

3.2.1 Storage

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

3.3 CONNECTIONS

Except as modified in this section, connections not detailed shall be designed in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Punch, subpunch and ream, or drill bolt and pin holes perpendicular to the surface of the member. Holes shall not be cut or enlarged by burning. Bolts, nuts, and washers shall be clean of dirt and rust, and lubricated immediately prior to installation.

3.3.1 Common Grade Bolts

ASTM A307 bolts shall be tightened to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

3.4 GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

3.5 WELDING

AWS D1.1/D1.1M. Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

The Contractor shall develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Prequalified procedures may be submitted for information only; however, procedures that are not prequalified shall be submitted for approval.

3.5.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

Removal is not required.

3.6 GALVANIZING REPAIR

Provide the galvanizing repair method as indicated or specified. Galvanize after fabrication where practicable. Repair damage to galvanized coatings using ASTM A780/A780M zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.7 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of weld inspection.

3.7.1 Welds

3.7.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. Welding inspectors shall visually inspect and mark welds, including fillet weld end returns.

3.7.2 Testing for Embrittlement

ASTM A143/A143M for steel products hot-dip galvanized after fabrication.

-- End of Section --

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SECTION 09 90 00

PAINTS AND COATINGS
05/11

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 CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100Doc	(2005) Documentation of the Threshold Limit Values and Biological Exposure Indices

ASTM INTERNATIONAL (ASTM)

ASTM D 235	(2002; R 2007) Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
ASTM D 4214	(2007) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D 523	(2008) Standard Test Method for Specular Gloss
ASTM D 6386	(2010) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

MASTER PAINTERS INSTITUTE (MPI)

MPI 101	(Oct 2009) Epoxy Anti-Corrosive Metal Primer
MPI 107	(Oct 2009) Rust Inhibitive Primer (Water-Based)
MPI 108	(Oct 2009) High Build Epoxy Coating, Low Gloss
MPI 134	(Oct 2009) Galvanized Primer (Waterbased)
MPI 163	(Oct 2009) Exterior W.B. Light Industrial Coating, Semi-Gloss, MPI Gloss Level 5
MPI 23	(Oct 2009) Surface Tolerant Metal Primer
MPI 27	(Oct 2009) Exterior / Interior Alkyd Floor Enamel, Gloss
MPI 47	(Oct 2009) Interior Alkyd, Semi-Gloss, MPI

	Gloss Level 5
MPI 77	(Oct 2009) Epoxy Gloss
MPI 79	(Oct 2009) Alkyd Anti-Corrosive Metal Primer
MPI 94	(Oct 2009) Exterior Alkyd, Semi-Gloss, MPI Gloss Level 5
MPI 95	(Oct 2009) Quick Drying Primer for Aluminum

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SP-01	(2000) Environmentally Preferable Product Specification for Architectural and Anti-Corrosive Paints

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Guide 6	(2004) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations
SSPC Guide 7	(2004; E 2004) Guide to the Disposal of Lead-Contaminated Surface Preparation Debris
SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting of Steel
SSPC PA Guide 3	(1982; E 1995) A Guide to Safety in Paint Application
SSPC SP 1	(1982; E 2004) Solvent Cleaning
SSPC SP 10/NACE No. 2	(2007) Near-White Blast Cleaning
SSPC SP 12/NACE No.5	(2002) Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating
SSPC SP 2	(1982; E 2004) Hand Tool Cleaning
SSPC SP 3	(1982; E 2004) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC VIS 1	(2002; e 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
SSPC VIS 3	(2004) Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-313	(Rev D; Am 1) Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants
29 CFR 1910.1025	Lead
29 CFR 1926.62	Lead

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

Samples of specified materials may be taken and tested for compliance with specification requirements.

In keeping with the intent of Executive Order 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition", products certified by SCS as meeting SCS SP-01 shall be given preferential consideration over registered products. Products that are registered shall be given preferential consideration over products not carrying any EPP designation.

SD-02 Shop Drawings

Piping identification

Submit color codes

SD-03 Product Data

Manufacturer's Technical Data Sheets

SD-04 Samples

Color; G

Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated.

SD-07 Certificates

Applicator's qualifications

Qualification Testing laboratory for coatings; G

SD-08 Manufacturer's Instructions

Application instructions

Mixing

Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times between coats.

Manufacturer's Material Safety Data Sheets

Submit manufacturer's Material Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

SD-10 Operation and Maintenance Data

Coatings; G

Preprinted cleaning and maintenance instructions for all coating systems shall be provided.

SD-11 Closeout Submittals

1.3 APPLICATOR'S QUALIFICATIONS

1.3.1 Contractor Qualification

Submit the name, address, telephone number, FAX number, and e-mail address of the contractor that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on industrial systems on a minimum of three similar projects within the past three years. List information by individual and include the following:

a. Name of individual and proposed position for this work.

b. Information about each previous assignment including:

Position or responsibility

Employer (if other than the Contractor)

Name of facility owner

Mailing address, telephone number, and telex number (if non-US) of facility owner

Name of individual in facility owner's organization who can be contacted as a reference

Location, size and description of structure

Dates work was carried out

Description of work carried out on structure

1.4 QUALITY ASSURANCE

1.4.1 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph "Sampling Procedures." Test each chosen product as specified in the paragraph "Testing Procedure." Products which do not conform, shall be removed from the job site and replaced with new products that conform to the referenced specification. Testing of replacement products that failed initial testing shall be at no cost to the Government.

1.4.1.1 Sampling Procedure

The Contracting Officer will select paint at random from the products that have been delivered to the job site for sample testing. The Contractor shall provide one quart samples of the selected paint materials. The samples shall be taken in the presence of the Contracting Officer, and labeled, identifying each sample. Provide labels in accordance with the paragraph "Packaging, Labeling, and Storage" of this specification.

1.4.1.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph "Qualification Testing" laboratory for coatings. The qualification testing lab report shall include the backup data and summary of the test results. The summary shall list all of the reference specification requirements and the result of each test. The summary shall clearly indicate whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If the Contractor chooses MPI to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

1.5 REGULATORY REQUIREMENTS

1.5.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify Contracting Officer of any paint specified herein which fails to conform.

1.5.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.5.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.5.4 Asbestos Content

Materials shall not contain asbestos.

1.5.5 Mercury Content

Materials shall not contain mercury or mercury compounds.

1.5.6 Silica

Abrasive blast media shall not contain free crystalline silica.

1.5.7 Human Carcinogens

Materials shall not contain ACGIH 0100Doc and ACGIH 0100Doc confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.6 PACKAGING, LABELING, AND STORAGE

Paints shall be in sealed containers that legibly show the contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints and thinners shall be stored in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F. Do not store paint or polyurethane products with materials that have a high capacity to adsorb VOC emissions. Do not store paint or polyurethane products in occupied spaces.

1.7 SAFETY AND HEALTH

Apply coating materials using safety methods and equipment in accordance with the following:

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN.

1.7.1 Safety Methods Used During Coating Application

Comply with the requirements of SSPC PA Guide 3.

1.7.2 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

a. The applicable manufacturer's Material Safety Data Sheets (MSDS) or local regulation.

b. 29 CFR 1910.1000.

c. ACGIH 0100Doc, threshold limit values.

d. The appropriate OSHA standard in 29 CFR 1910.1025 and 29 CFR 1926.62 for surface preparation on painted surfaces containing lead. Removal and disposal of coatings which contain lead is specified in Section 02 82 33.13 20 REMOVAL/CONTROL AND DISPOSAL OF PAINT WITH LEAD. Additional guidance is given in SSPC Guide 6 and SSPC Guide 7. Refer to drawings for list of hazardous materials located on this project. Contractor to coordinate paint preparation activities with this specification section.

1.8 ENVIRONMENTAL CONDITIONS

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation. Isolate area of application from rest of building when applying high-emission paints or coatings.

1.8.1 Coatings

Do not apply coating when air or substrate conditions are:

a. Less than 5 degrees F above dew point;

b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.

1.8.2 Post-Application

Vacate space for as long as possible after application. Wait a minimum of 48 hours before occupying freshly painted rooms. Maintain one of the following ventilation conditions during the curing period, or for 72 hours after application:

a. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 85 degrees F and humidity is between 30 percent and 60 percent.

b. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

1.9 SCHEDULING

Allow paint and polyurethane installations to cure prior to the installation of materials that adsorb VOCs.

1.10 COLOR SELECTION

Colors of finish coats shall be as indicated or specified. Where not indicated or specified, colors shall be selected by the Contracting Officer. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for

use only if they conform to specified requirements. Products of other manufacturers are acceptable if the colors approximate colors indicated and the product conforms to specified requirements.

Tint each coat progressively darker to enable confirmation of the number of coats.

1.11 LOCATION AND SURFACE TYPE TO BE PAINTED

1.11.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.

b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.

c. Existing coated surfaces that are damaged during performance of the work.

1.11.1.1 Exterior Painting

Includes new surfaces, existing coated surfaces, and existing uncoated surfaces, of the project and appurtenances. Also included are existing coated surfaces made bare by cleaning operations.

1.11.1.2 Interior Painting

Includes new surfaces, existing uncoated surfaces, and existing coated surfaces of the structure/enclosure and appurtenances as indicated and existing coated surfaces made bare by cleaning operations. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

a. Exposed columns, girders, beams, joists, and metal deck; and

b. Other contiguous surfaces.

1.11.2 Painting Excluded

Do not paint the following unless indicated otherwise.

a. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place.

b. Surfaces in concealed spaces. Concealed spaces are defined as enclosed spaces above suspended ceilings, furred spaces, attic spaces, crawl spaces, elevator shafts and chases.

c. Steel to be embedded in concrete.

d. Copper, stainless steel, aluminum, brass, and lead except existing coated surfaces.

e. Hardware, fittings, and other factory finished items.

1.11.3 Mechanical and Electrical Painting

Includes field coating of interior and exterior new and existing surfaces.

a. Where a space or surface is indicated to be painted, include the following items unless indicated otherwise.

(1) Exposed piping, conduit, and ductwork;

(2) Supports, hangers, air grilles, and registers;

(3) Miscellaneous metalwork and insulation coverings.

1.11.4 Definitions and Abbreviations

1.11.4.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

1.11.4.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing shall only be accomplished by MPI testing lab.

1.11.4.3 Coating

A film or thin layer applied to a base material called a substrate. A coating may be a metal, alloy, paint, or solid/liquid suspensions on various substrates (metals, plastics, wood, paper, leather, cloth, etc.). They may be applied by electrolysis, vapor deposition, vacuum, or mechanical means such as brushing, spraying, calendaring, and roller coating. A coating may be applied for aesthetic or protective purposes or both. The term "coating" as used herein includes emulsions, enamels, stains, varnishes, sealers, epoxies, and other coatings, whether used as primer, intermediate, or finish coat. The terms paint and coating are used interchangeably.

1.11.4.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

1.11.4.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five (5) levels are generically defined under the Assessment sections in the MPI Maintenance Repainting Manual.

1.11.4.6 EPP

Environmentally Preferred Products, a standard for determining environmental preferability in support of Executive Order 13101.

1.11.4.7 EXT

MPI short term designation for an exterior coating system.

1.11.4.8 INT

MPI short term designation for an interior coating system.

1.11.4.9 micron / microns

The metric measurement for 0.001 mm or one/one-thousandth of a millimeter.

1.11.4.10 mil / mils

The English measurement for 0.001 in or one/one-thousandth of an inch, equal to 25.4 microns or 0.0254 mm.

1.11.4.11 mm

The metric measurement for millimeter, 0.001 meter or one/one-thousandth of a meter.

1.11.4.12 MPI Gloss Levels

MPI system of defining gloss. Seven (7) gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units at 60 degrees	Units at 85 degrees
G1	Matte or Flat	0 to 5	10 max
G2	Velvet	0 to 10	10 to 35
G3	Eggshell	10 to 25	10 to 35
G4	Satin	20 to 35	35 min
G5	Semi-Gloss	35 to 70	
G6	Gloss	70 to 85	
G7	High Gloss		

Gloss is tested in accordance with ASTM D 523. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

1.11.4.13 MPI System Number

The MPI coating system number in each Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN).

The Division number follows the CSI Master Format.

1.11.4.14 Paint

See Coating definition.

1.11.4.15 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

1.11.4.16 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents. Comply with applicable regulations regarding toxic and hazardous materials.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect, hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

3.2 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, disintegrated coatings, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.2.1 Additional Requirements for Preparation of Surfaces With Existing Coatings

Before application of coatings, perform the following on surfaces covered by soundly-adhered coatings, defined as those which cannot be removed with a putty knife:

a. Test existing finishes for lead before sanding, scraping, or removing. If lead is present, refer to paragraph Toxic Materials.

b. Wipe previously painted surfaces to receive solvent-based coatings, except similarly rough surfaces clean with a clean, dry cloth saturated with mineral spirits, ASTM D 235. Allow surface to dry. Wiping shall immediately precede the application of the first coat of any coating, unless specified otherwise.

c. Sand existing glossy surfaces to be painted to reduce gloss. Brush, and wipe clean with a damp cloth to remove dust.

d. The requirements specified are minimum. Comply also with the application instructions of the paint manufacturer.

e. Previously painted surfaces specified to be repainted and damaged during construction shall be thoroughly cleaned of all grease, dirt, dust or other foreign matter.

f. Blistering, cracking, flaking and peeling or other deteriorated coatings shall be removed.

g. Chalk shall be removed so that when tested in accordance with ASTM D 4214, the chalk resistance rating is no less than 8.

h. Slick surfaces shall be roughened. Damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls shall be repaired with suitable material to match adjacent undamaged areas.

i. Edges of chipped paint shall be feather edged and sanded smooth.

j. Rusty metal surfaces shall be cleaned as per SSPC requirements. Solvent, mechanical, or chemical cleaning methods shall be used to provide surfaces suitable for painting.

k. New, proposed coatings shall be compatible with existing coatings.

3.2.2 Removal of Existing Coatings

Remove existing coatings from the following surfaces:

a. Surfaces containing large areas of minor defects;

b. Surfaces containing more than 20 percent peeling area; and

c. Surfaces designated by the Contracting Officer, such as surfaces where rust shows through existing coatings.

3.2.3 Substrate Repair

a. Repair substrate surface damaged during coating removal;

b. Sand edges of adjacent soundly-adhered existing coatings so they are tapered as smooth as practical to areas involved with coating removal; and

c. Clean and prime the substrate as specified.

3.3 PREPARATION OF METAL SURFACES

3.3.1 Existing and New Ferrous Surfaces

a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: Solvent clean or detergent wash in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to SSPC SP 2, SSPC SP 3, SSPC SP 6/NACE No.3, or SSPC SP 10/NACE No. 2. Brush-off blast remaining surface in accordance with SSPC SP 7/NACE No.4 to remove loose coating and other loose materials. Use inhibitor as recommended by coating manufacturer to prevent premature rusting. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with SSPC SP 6/NACE No.3 or SSPC SP 10/NACE No. 2.

c. Metal Floor Surfaces to Receive Nonslip Coating: Clean in accordance with SSPC SP 10/NACE No. 2.

3.3.2 Final Ferrous Surface Condition:

For tool cleaned surfaces, the requirements are stated in SSPC SP 2 and SSPC SP 3. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 3.

For abrasive blast cleaned surfaces, the requirements are stated in SSPC SP 7/NACE No.4, SSPC SP 6/NACE No.3, and SSPC SP 10/NACE No. 2. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 1.

3.3.3 Galvanized Surfaces

a. New or Existing Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with solvent, steam, or non-alkaline detergent solution in accordance with SSPC SP 1. If the galvanized metal has been passivated or stabilized, the coating shall be completely removed by brush-off abrasive blast. New galvanized steel to be coated shall not be "passivated" or "stabilized" If the absence of hexavalent stain inhibitors is not documented, test as described in ASTM D 6386, Appendix X2, and remove by one of the methods described therein.

b. Galvanized with Slight Coating Deterioration or with Little or No Rusting: Water jetting to SSPC SP 12/NACE No.5 WJ3 to remove loose coating from surfaces with less than 20 percent coating deterioration and no blistering, peeling, or cracking. Use inhibitor as recommended by the coating manufacturer to prevent rusting.

c. Galvanized With Severe Deteriorated Coating or Severe Rusting: Spot abrasive blast rusted areas as described for steel in SSPC SP 6/NACE No.3 to remove existing coating.

3.3.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

3.3.5 Terne-Coated Metal Surfaces

Solvent clean surfaces with mineral spirits, ASTM D 235. Wipe dry with clean, dry cloths.

3.3.6 Existing Surfaces with a Bituminous or Mastic-Type Coating

Remove chalk, mildew, and other loose material by washing with a solution of 1/2 cup trisodium phosphate, 1/4 cup household detergent, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water.

3.4 APPLICATION

3.4.1 Coating Application

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application.

Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Wear protective clothing and respirators when applying oil-based paints or using spray equipment with any paints.

Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

Thoroughly work coating materials into joints, crevices, and open spaces. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete.

Touch up damaged coatings before applying subsequent coats. Interior areas shall be broom clean and dust free before and during the application of coating material.

a. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.

b. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate

coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Each coat shall cover surface of preceding coat or surface completely, and there shall be a visually perceptible difference in shades of successive coats.

c. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

d. Thermosetting Paints: Topcoats over thermosetting paints (epoxies and urethanes) should be applied within the overcoating window recommended by the manufacturer.

e. Floors: For nonslip surfacing on level floors, as the intermediate coat is applied, cover wet surface completely with almandite garnet, Grit No. 36, with maximum passing U.S. Standard Sieve No. 40 less than 0.5 percent. When the coating is dry, use a soft bristle broom to sweep up excess grit, which may be reused, and vacuum up remaining residue before application of the topcoat. For nonslip surfacing on ramps, provide MPI 77 with non-skid additive, applied by roller in accordance with manufacturer's instructions.

3.4.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. The written permission shall include quantities and types of thinners to use.

When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

3.4.3 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

3.4.4 Coating Systems

a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

Table	
EXTERIOR	
Division 3.	Exterior Concrete Paint Table
Division 5.	Exterior Metal, Ferrous and Non-Ferrous Paint Table

Table	
INTERIOR	
Division 3.	Interior Concrete Paint Table
Division 5.	Interior Metal, Ferrous and Non-Ferrous Paint Table

b. Minimum Dry Film Thickness (DFT): Apply paints, primers, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness where specified, refers to the minimum dry film thickness.

c. Coatings for Surfaces Not Specified Otherwise: Coat surfaces which have not been specified, the same as surfaces having similar conditions of exposure.

d. Existing Surfaces Damaged During Performance of the Work, Including New Patches In Existing Surfaces: Coat surfaces with the following:

(1) One coat of primer.

(2) One coat of undercoat or intermediate coat.

(3) One topcoat to match adjacent surfaces.

e. Existing Coated Surfaces To Be Painted: Apply coatings conforming to the respective specifications listed in the Tables herein, except that pretreatments, sealers and fillers need not be provided on surfaces where existing coatings are soundly adhered and in good condition. Do not omit undercoats or primers.

3.5 COATING SYSTEMS FOR METAL

Apply coatings of Tables in Division 26 for Exterior and Interior.

a. Apply specified ferrous metal primer on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.

b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.

c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.

d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.

e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

3.6 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

3.7 PAINT TABLES

All DFT's are minimum values.

3.7.1 EXTERIOR PAINT TABLES

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
STEEL / FERROUS SURFACES		
A. New Steel that has been hand or power tool cleaned to SSPC SP 2 or SSPC SP 3		
1. Alkyd		
New; MPI EXT 5.1Q-G5 (Semigloss) / Existing; MPI REX 5.1D-G5		
Primer: MPI 23	Intermediate: MPI 94	Topcoat: MPI 94
System DFT: 5.25 mils		
B. New Steel that has been blast-cleaned to SSPC SP 6/NACE No.3:		
1. Alkyd		
New; MPI EXT 5.1D-G5 (Semigloss) / Existing; MPI REX 5.1D-G5		
Primer: MPI 79	Intermediate: MPI 94	Topcoat: MPI 94

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
System DFT: 5.25 mils		
C. Existing steel that has been spot-blasted to SSPC SP 6/NACE No.3:		
1. Surface previously coated with alkyd or latex:		
Waterborne Light Industrial Coating		
MPI REX 5.1C-G5 (Semigloss)		
Spot Primer: MPI 79	Intermediate: MPI 163	Topcoat: MPI 163
System DFT: 5 mils		
2. Surface previously coated with epoxy:		
Waterborne Light Industrial		
a. MPI REX 5.1L-G5 (Semigloss)		
Spot Primer: MPI 101	Intermediate: MPI 163	Topcoat: MPI 163
System DFT: 5 mils		

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
D. New and existing steel blast cleaned to SSPC SP 10/NACE No. 2:		
1. Waterborne Light Industrial		
MPI EXT 5.1R-G5 (Semigloss)		
Primer: MPI 101	Intermediate: MPI 108	Topcoat: MPI 163
System DFT: 8.5 mils		
E. Metal floors (non-shop-primed surfaces or non-slip deck surfaces) with non-skid additive (NSA), load at manufacturer's recommendations:		
1. Alkyd Floor Enamel		
MPI EXT 5.1S-G6 (Gloss)		
Primer: MPI 79	Intermediate: MPI 27	Topcoat: MPI 27 (plus NSA)
System DFT: 5.25 mils		
EXTERIOR GALVANIZED SURFACES		
F. New Galvanized surfaces:		

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
3. Waterborne Primer / Waterborne Light Industrial Coating		
MPI EXT 5.3J-G5 (Semigloss)		

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
Primer: MPI 134	Intermediate: MPI 163	Topcoat: MPI 163
System DFT: 4.5 mils		
G. Galvanized surfaces with slight coating deterioration; little or no rusting:		
1. Waterborne Light Industrial Coating		
MPI REX 5.3J-G5 (Semigloss)		
Primer: MPI 134	Intermediate: N/A	Topcoat: MPI 163
System DFT: 4.5 mils		

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
H. Galvanized surfaces with severely deteriorated coating or rusting:		
1. Waterborne Light Industrial Coating		
MPI REX 5.3L-G5 (Semigloss)		
Primer: MPI 101	Intermediate: MPI 108	Topcoat: MPI 163
System DFT: 8.5 mils		
EXTERIOR SURFACES, OTHER METALS (NON-FERROUS)		
I. Aluminum, aluminum alloy and other miscellaneous non-ferrous metal items not otherwise specified except hot metal surfaces, roof surfaces, and new prefinished equipment. Match surrounding finish:		

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
2. Waterborne Light Industrial Coating		
MPI EXT 5.4G-G5 (Semigloss)		
Primer: MPI 95	Intermediate: MPI 163	Topcoat: MPI 163
System DFT: 5 mils		

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
K. Surfaces adjacent to painted surfaces; Mechanical, Electrical, and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment. Match surrounding finish:		
2. Waterborne Light Industrial Coating		
MPI EXT 5.1C-G5 (Semigloss)		
Primer: MPI 79	Intermediate: MPI 163	Topcoat: MPI 163
System DFT: 5 mils		

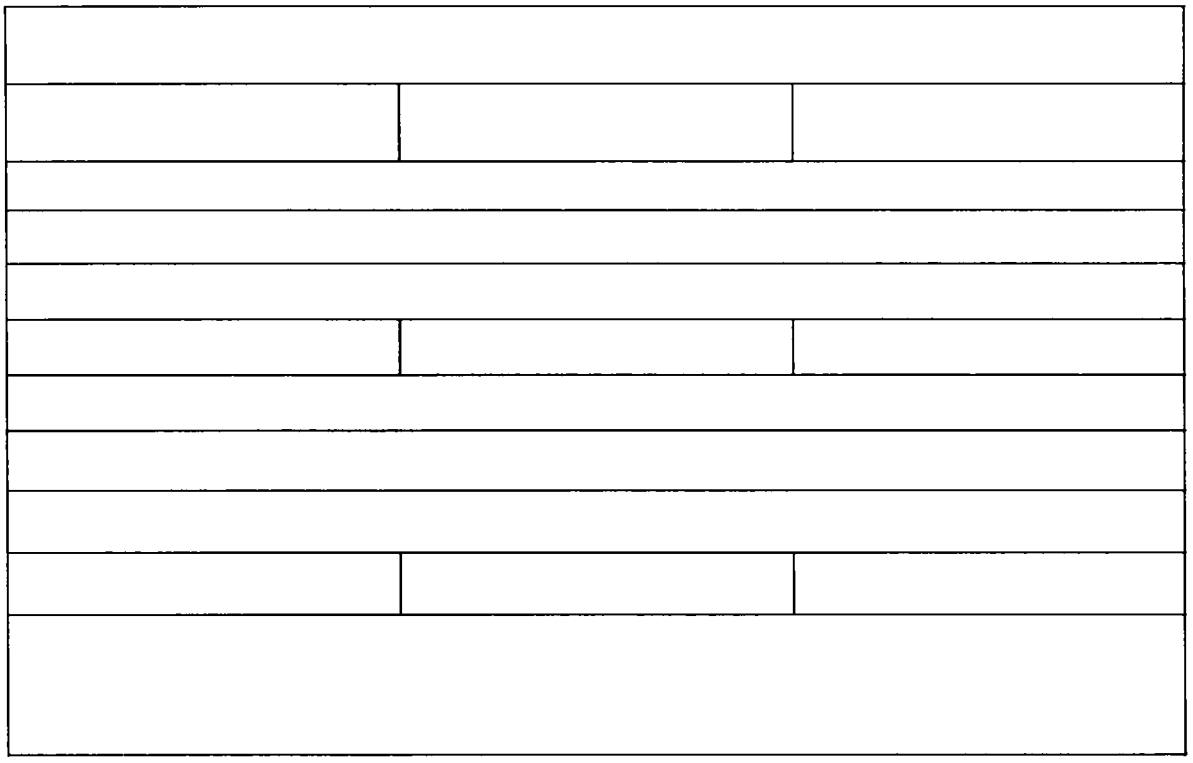
3.7.2 INTERIOR PAINT TABLES

DIVISION 5: INTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
INTERIOR STEEL / FERROUS SURFACES		
A. Metal, Mechanical, Electrical, Surfaces adjacent to painted surfaces (Match surrounding finish), and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment:		

DIVISION 5: INTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
INTERIOR STEEL / FERROUS SURFACES		
2. Alkyd		
MPI INT 5.1E-G5 (Semigloss)		
Primer: MPI 79	Intermediate: MPI 47	Topcoat: MPI 47
System DFT: 5.25 mils		
B. Metal floors (non-shop-primed surfaces or non-slip deck surfaces) with non-skid additive (NSA), load at manufacturer's recommendations:		
1. Alkyd Floor Paint		
MPI INT 5.1U-G6 (Gloss)		
Primer: MPI 79	Intermediate: MPI 27	Topcoat: MPI 27 (plus NSA)
System DFT: 5.25 mils		

DIVISION 5: INTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
INTERIOR STEEL / FERROUS SURFACES		
E. Miscellaneous non-ferrous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment. Match surrounding finish:		
2. Alkyd		

DIVISION 5: INTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE		
INTERIOR STEEL / FERROUS SURFACES		
MPI INT 5.4J-G5 (Semigloss)		
Primer: MPI 95	Intermediate: MPI 47	Topcoat: MPI 47
System DFT: 5 mils		



-- End of Section --

SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS
07/06

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 in 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 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2012) National Electrical Safety Code
IEEE C57.12.28	(2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections. This section has been incorporated into, and thus, does not apply to, and is not referenced in the following sections.

Section 26 12 19.00 40 PAD MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
Section 26 11 13.00 20 PRIMARY UNIT SUBSTATIONS
Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM
Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION

1.3 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 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.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 13.2Y/7.62 and 4.16Y/2.4 kV primary, three phase, three wire, 60 Hz, and 480Y/277 and 208Y/120 volts secondary, three phase, four wire. Where indicated switchgear control power systems shall be rated 120/240 volts secondary single phase, three wire. Final connections to the existing power distribution system shall be made by the Contractor in the locations indicated on the drawings.

1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.5.1 Shop Drawings (SD-02)

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.5.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

1.6 QUALITY ASSURANCE

1.6.1 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.

1.6.2 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 the technical section.

1.6.2.1 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.

1.7 WARRANTY

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

1.8 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.

1.9 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, 0.125 inch 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 one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

1.10 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 insulated load-break and load-interrupter switches, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch 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. PPSO710D72 or approved equal.

1.11 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.12 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given prior to acceptance or turn over of the system to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.

PART 2 PRODUCTS

2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements specified in the technical sections.

PART 3 EXECUTION

3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS specifying the associated electrical equipment.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

-- End of Section --

SECTION 26 05 13.00 98

MEDIUM-VOLTAGE CABLE
11/11

PART 1 GENERAL

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

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.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2000) Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM B8	(2011) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 48	(2009) Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 386	(2006; INT 1 2011) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE 400.2	(2004) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
IEEE 404	(2006) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE C62.11	(2005; Amd 1 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
NETA MAINT	(2011) Standard for Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C119.1	(2011) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
NEMA WC 74/ICEA S-93-639	(2006) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1072	(2006; Reprint Aug 2011) Medium-Voltage Power Cables

1.2 DEFINITIONS

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

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pulling Plan; G

SD-03 Product Data

15 kV Concentric Neutral Cable; G

5 kV Concentric Neutral Cable; G

5 kV Tape Shield Cable; G

Cable Tags; G

Fireproof Tape; G

Splices (including splice grounding and list of recommended tools

for splicing operations); G

Terminations; G

Surge Arresters; G

SD-06 Test Reports

Field Testing; G

KSC Medium Voltage Cable Test Form; G

Qualification Test Reports; G

Radiographic Tests; G

SD-07 Certificates

Factory-Conducted Tests on Each Shipping Length (Reel) of Cable; G

Splicer/Terminator Certifications; G

List of Splices/Terminations Installed by Splicer/Terminator; G

Conductor Resistance; G

Accelerated Water Absorption Test; G

Water Immersion Test; G

Ionization; G

High-Voltage; G

Partial Discharge Test; G

Qualification Test Reports; G

SD-08 Manufacturer's Instructions

Single Conductor 5 kV Shielded Cable; G

Single Conductor 15 kV Shielded Cable; G

Terminations; G

Splices (including splice grounding); G

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Verify personnel performing Medium Voltage (MV) splicing/terminations have 5 years minimum experience in cable splicing/terminations of the type used in this project. In addition, submit splicer/terminator certifications issued by the cable splice and termination manufacturer who has examined and tested a test splice/termination of each type required by this contract for each cable splicer/terminator. Ensure the certification identifies which splices/terminations it applies to. In addition require each

individual, certified or not certified, with the required 5 years medium voltage splicing/terminating who is to perform cable splicing/terminating, to perform a minimum of one splice/termination of each type in the presence of the manufacturers' representative and the Government's representative. Contractor shall supply all materials, tools, and manufacturer's services required for the demonstration splices and tape type terminations. Submit each splice/termination performed by individuals without a manufacturer's certification 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/terminations. Certification is not required for load break elbows and dead break connectors.

Once a splice/termination has been started by a splicer/terminator, ensure the same splicer/terminator completes that particular splice/termination, and that each splice/termination is started and completed in one continuous work period. The Contractor shall maintain and submit a list of splices/terminations installed by splicer/terminator. The list shall include the following for each splice/termination completed:

- Name of splicer/terminator.
- Company name.
- Date splice/termination was performed.
- Location of splice/termination. For terminations at equipment indicate switch and position number as required to completely define the location.
- Feeder number.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Shipping

Ship the cable on reels in such a manner that the cable is protected from mechanical injury. Hermetically seal every cable end of each length using heat-shrinkable molded cable end caps to exclude moisture and securely attached to the reel.

Ensure the minimum diameter of the reel drum is 14 times the overall diameter of the cable. For reels less than 60 inches in diameter, provide arbor holes sized for 2-1/2 inches spindles; for those greater than 60 inches in diameter, provide arbor holes sized for 3 inch spindles. Ensure reel sizes accommodate reel lengths specified in the purchase order, and that each reel contains only one length of cable cut to order.

Provide each reel with an arrow and appropriate wording, stenciled in plain view on each side, indicating proper rotation of reels. Plainly mark each reel on each side, and attach a tag to the cable end inside the lagging, stating 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)

Ship reels 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

Provide annealed copper core (phase) conductor material in accordance with ASTM B8.

2.1.2 Stranding

Provide Class B stranded conductors.

2.2 CABLE IDENTIFICATION

Provide cables with 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. Closely group the information on the tape at 6 foot maximum intervals to permit complete identification.

2.3 15 KV CONCENTRIC NEUTRAL CABLE

2.3.1 General; 15 kV Cable

Provide single conductor 15 kV shielded cable assemblies consisting of:

a. Conductor core described above, an extruded semiconductor shield over the conductors

b. 220 mils of ethylene-propylene-rubber (EPR) insulation

c. An extruded semiconductor insulation shield, a concentric neutral

d. A polyethylene (PE) jacket.

Ensure cable is rated for minimum 194 degrees F continuous conductor temperature and 266 degrees F emergency overload.

Provide single-conductor, ethylene-propylene-insulated, polyethylene-jacketed, shielded cable conforming to ICEA S-94-649 and AEIC CS8.

2.3.2 15 kV Cable Conductor Shielding

Provide conductors with a stress control layer consisting of extruded material applied between the conductor and the insulation to form a conductor shield (strand screen). Ensure material has proven long-term chemical compatibility with both the conductor and overlying insulation materials, and that the stress control layer meets the electrical and physical requirements of ICEA S-94-649.

2.3.3 Insulation; 15 kV Cable

Provide ozone resistant insulation material, of extruded thermosetting ethylene-propylene based polymer, capable of withstanding the continuous and emergency overload temperature ratings of the conductor.

2.3.4 Non-metallic Insulation Shield; 15 kV Cable

Provide extruded insulation shield made of an extruded thermoset material compatible with the insulation and jacket. Ensure insulation shield is applied directly over and bonded to the insulation, and complies with AEIC CS8.

2.3.5 Concentric Neutral Shield; 15 kV Cable

Provide copper wires helically applied over the insulation shield, where the minimum total cross sectional area (of the shield wires) is 1/3 of the core conductor for 350 kcmil cable. Minimum size of an individual shield wire is No. 14 AWG.

2.3.6 Jacket; 15 kV Cable

Provide polyethylene jacketed cable (PE) extruded over the concentric neutral to a minimum thickness of 80 mils.

2.4 5 KV CONCENTRIC NEUTRAL CABLE

2.4.1 General; 5 kV Cables

Provide single conductor 5 kV shielded cable assemblies consisting of:

a. Conductor core described above, an extruded semiconductor shield over the conductors

b. (2.92 millimeter) 115 mils of ethylene-propylene-rubber (EPR) insulation

c. An extruded semiconductor insulation shield, a concentric neutral

d. A polyethylene (PE) jacket.

Ensure the cable is rated for minimum (90 degrees C) 194 degrees F continuous conductor temperature and (130 degrees C) 266 degrees F emergency overload.

Provide single-conductor, ethylene-propylene-insulated, polyethylene-jacketed, shielded cable conforming to ICEA S-94-649 and AEIC CS8.

2.4.2 5 kV Cable Conductor Shielding

Provide conductors having a stress control layer consisting of extruded material applied between the conductor and the insulation to form a conductor shield (strand screen). Ensure material has proven long-term chemical compatibility with both the conductor and overlying insulation materials, and meets all electrical and physical requirements of ICEA S-94-649.

2.4.3 Insulation; 5 kV Cable

Provide insulation material which is ozone resistant, extruded thermosetting ethylene-propylene based polymer, and capable of withstanding continuous and emergency overload temperature ratings of the conductor.

2.4.4 Non-metallic Insulation Shield; 5 kV Cable

Provide extruded insulation shield made of an extruded thermostat material compatible with the insulation and jacket. Ensure insulation shield is applied directly over and bonded to the insulation, and complies with AEIC CS8.

2.4.5 Concentric Neutral Shield; 5 kV Cable

Provide copper wires helically applied over the insulation shield. Minimum total cross sectional area of the shield wires is 1/3 of the core conductor for 350 kcmil cable, and full core conductor for 4/0 cable. Minimum size of an individual shield wire is 1.6 millimeter No. 14 AWG.

2.4.6 Jacket; 5 kV Cable

Provide polyethylene jacket (PE) extruded over the concentric neutral to a minimum thickness of (2 millimeter) 80 mils.

2.5 5 KV TAPE SHIELD CABLE

2.5.1 General; 5 kV Cables

Provide single conductor 5 kV shielded cable assemblies consisting of:

a. Conductor core described above, an extruded semiconductor shield over the conductors

b. 115 mils of ethylene-propylene-rubber (EPR) insulation

c. An extruded semiconductor insulation shield, a tape shield

d. A polyethylene (PE) jacket.

Ensure the cable is rated for minimum 221 degrees F continuous conductor temperature and 284 degrees F emergency overload.

Provide single-conductor, ethylene-propylene-insulated, polyethylene-jacketed, shielded cable conforming to NEMA WC 74/ICEA S-93-639 and AEIC CS8. UL listed as Type MV-105, sunlight resistant, and for use in cable tray in accordance with UL 1072.

2.5.2 5 kV Cable Conductor Shielding

Provide conductors having a stress control layer consisting of extruded material applied between the conductor and the insulation to form a conductor shield (strand screen). Ensure material has proven long-term chemical compatibility with both the conductor and overlying insulation materials, and meets all electrical and physical requirements of NEMA WC 74/ICEA S-93-639.

2.5.3 Insulation; 5 kV Cable

Provide insulation material which is ozone resistant, extruded thermosetting ethylene-propylene based polymer, and capable of withstanding continuous and emergency overload temperature ratings of the conductor.

2.5.4 Non-metallic Insulation Shield; 5 kV Cable

Provide extruded insulation shield made of an extruded thermoset material compatible with the insulation and jacket. Ensure insulation shield is applied directly over and bonded to the insulation, and complies with AEIC CS8.

2.5.5 Tape Shield; 5 kV

Provide 5-mil minimum coated copper tape shield wrapped helically with a minimum 25 percent nominal overlap.

2.5.6 Jacket; 5 kV Cable

Provide polyethylene jacket (PE) extruded over the concentric neutral to a minimum thickness of 80 mils.

2.6 INSULATED MEDIUM VOLTAGE CONNECTORS

Provide insulated medium voltage connectors for new and modified existing dead-front construction pad mounted switchgear and pad mounted transformers.

Provide connectors in kit form, which are the product of a single manufacturer, and compatible with both the cable and equipment bushing on which the connector is applied. Connectors shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material per IEEE 386. Provide a hot line voltage indicator on each connector installed as part of this project. Provide LED type hot line voltage indicators which are the product of a single manufacturer, and compatible with the connector on which the hot line voltage indicator is applied. Provide connectors with ratings as follows:

15kV 200 Ampere Load-break Connectors: BIL impulse withstand 1.2 x 50 microsecond wave: 95kV. Short time rating: 10,000 amperes rms, symmetrical for a time duration of 0.17 seconds and 3,500 amperes rms, symmetrical for a time duration of 3.0 seconds.

15kV 600 Ampere Dead-break Connectors: BIL impulse withstand 1.2 x 50 microsecond wave: 95kV. Short time rating: 40,000 amperes rms, symmetrical for a time duration of 2.0 seconds and 27,000 amperes rms, symmetrical for a time duration of 4.0 seconds. Where piggyback mount surge arresters are specified to be installed, provide 15kV 200 ampere bushing.

5kV 200 Ampere Load-break Connectors: BIL impulse withstand 1.2 x 50 microsecond wave: 95kV. Short time rating: 10,000 amperes rms, symmetrical for a time duration of 0.17 seconds and 3,500 amperes rms, symmetrical for a time duration of 3.0 seconds.

2.7 SPLICES

Provide splices in kit form, which are the product of a single manufacturer, compatible with the cable on which the splice is applied, and

meeting the requirements in the paragraph entitled, "Splices and Terminations," of this section. Splices shall be suitable for use in the environment in which the splice is installed. Provide splices for use on 15kV and 5kV cable as follows:

a. 15kV Cable Splices: Splices for 15kV EPR concentric neutral cable shall be heat-shrink type specifically designed for NASA cable and grounding provisions which include but is not limited to the following: inner heat shrink stress control tube with external end sealant, additional heat shrink tube over inner tube and inner tube end sealant, heat shrink outer wraparound sleeve with heat sensitive indications on both the tube and tail/channel area to indicate proper torch heating, stress relief material, mastic, sealant, shielding mesh, and silicon grease.

b. 5kV Cable Splices: Splices for 5kV EPR tape shield cable shall be heat-shrink type.

2.8 TERMINATIONS

Provide Class 1 terminations per IEEE 48 in kit form, which are the product of a single manufacturer, compatible with both the cable and equipment spade terminal on which the termination is applied, and meeting the requirements in the paragraph entitled, "Splices and Terminations," of this section. Terminations shall employ copper 2-hole long barrel irreversible compression type lugs installed using the termination manufacturer's required tooling.

Provide air termination kit for new and modified existing open stud bushings from SF6 insulated vault style switch manufacturer or approved equal.

2.9 CABLE TAGS

Provide cable tags as specified herein and detailed on the drawings. Provide cable tags on each new medium voltage cable installed as part of this project, and on each existing medium voltage cable to which a new medium voltage cable is spliced as part of this project. Provide a cable tag on each individual cable in each location where the cable is accessible (e.g. manholes, pull boxes, junction boxes, termination points). Cable tags shall be polyethylene. Handwritten legends are not acceptable.

2.9.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of4500 pounds per square inch, and are 0.035-inch thick, non-corrosive non-conductive. Ensure tags are resistive to acids, alkalis, organic solvents, salt water, and are distortion resistant to300 degrees F. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ensure ties have a minimum loop tensile strength of 175 pounds. Provide cable tags with black block letters, numbers, and symbols 1-inch high on a yellow background. Ensure letters, numbers, and symbols do not fall off or change positions regardless of the cable tags orientation.

2.10 FIREPROOF TAPE

Provide fireproof tape approximately 30 mils thick by 3 inches wide, consisting of a flexible, unsupported elastomer that expands in fire to provide a thick char buildup between the flame and the cable. Ensure the

tape does not give off a smoke when subjected to flames or support combustion. Also, ensure tape does not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

2.11 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. Include in tests on each length of cable, conductor resistance; ionization; high voltage; partial discharge test. Contracting Officer or designee has 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 requested.

Submit certified qualification test reports in accordance with AEIC CS8 made in accordance with the applicable referenced standards. Ensure certified copies of test data show conformance to the requirements of referenced standards and submit for approval prior to shipment of the cable.

Prior to manufacturing, provide data regarding degradation of proposed insulating material and cable performance due to water immersion test as specified in this specification to the Contracting Officer or designee. Indicate in information AC breakdown stress in kV/mm or V/mil versus immersion time. Ensure a complete description and condition under which cable was tested accompanies the test information. Submit an accelerated water absorption test.

2.12 SURGE ARRESTERS

IEEE C62.11, rated 15kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Where surge arresters are specified, provide one per phase and ground per the manufacturer's published installation instructions.

PART 3 EXECUTION

3.1 DEMOLITION OR CABLE CUTTING

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

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

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

3.2 INSTALLATION

Install medium-voltage cables in accordance with NFPA 70.

Refer to contract provisions for safety submittals and requirements

associated with working in the vicinity of energized cables in manholes and at equipment. The use of arc-flash and shock prevention equipment and personal protective equipment is mandatory.

Notify the Contracting Officer 14 working days prior to an outage that requires testing for phasing and phase rotation of medium voltage electrical systems. The Institutional Services Contractor(ISC) will identify and tag the phasing of equipment and provide to the Contractor, in writing, the results of phasing and phase rotation tests. The Contractor is responsible for maintaining the phasing and phase rotation tests, and is responsible for maintaining the phasing, and matching the existing phase rotation and phasing when installing conductors in existing electrical systems.

Install the cables in the following locations:

Exterior:

- In underground duct banks
- In conduit above and below grade
- In manholes

Inside Buildings:

- In wall and ceiling mounted cable trays
- In rigid steel conduit

Installed cable or conductors of a primary distribution system will be rejected by the Government when placed:

- Unsecured 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
- In a manner allowing the cable to support its own weight

3.2.1 Protection During Splicing Operations

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

3.2.2 Duct Cleaning

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

3.2.2.1 PVC Duct

Ensure mandrel length is not less than 12 inches long and has a diameter 1/2 in less than the inside diameter of the duct. Pull a stiff bristled brush through each duct to remove the loosened particles. Ensure brush diameter is the same or slightly larger than the diameter of the duct.

3.2.3 Pulling Cables in Ducts and Manholes

3.2.3.1 Pulling Procedures

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. Do not perform any pull until Government reviews and approves the pulling plan.

Pull medium-voltage cables 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. Employ a sufficient number of trained personnel and equipment with two-way radio communication capability to ensure the careful and proper installation of the cable.

Set up cable reel 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. Install a flexible tube guide through the opening in a manner that prevents the cable from rubbing on the edges of any structural member (manhole frame, chimney, duct, etc.).

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

TM =0.036 X N X CM

Where: TM = maximum allowable pulling tension in pounds

N = number of conductors in the cable

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

3.2.3.2 Allowable Sidewall Pressure

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

Unreel cable from the top of the reel, carefully controlling payout. Attach cable to be pulled through a swivel to the main pulling wire by means of a pulling eye installed by the factory or approved cable splicer.

Use of a suitable cable grip is permitted only on cables less than 200 feet long and less than 2 inches in diameter.

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

3.2.3.3 Minimum Bending Radius

Minimum bending radius during cable pulling operations is 30 inches. For permanent cable bending/racking the minimum bending radius is 12 times cable diameter.

3.2.3.4 Coating of Cables

Liberally coat cables with a suitable cable-pulling lubricant as it enters the tube guide or duct. Do not use greaser and oil lubricants. Cover nonmetallic sheathed cables with wire-pulling compounds, when required, which have no deleterious effects on the cable. Use rollers, sheaves or tube guides, around which the cable is pulled, conforming to the 30 inches minimum bending radius of the cable during the pulling operations.

3.2.3.5 Pulling Speed

Pull cables into ducts at a speed not to exceed 50 feet per minute and not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle is not be permitted. Stop pulling operations immediately with any indication of binding or obstruction and do not resume until such difficulty is corrected. Provide sufficient slack for free movement of cable due to expansion or contraction.

3.2.3.6 Cable Splice Support And Sealing

Firmly support cable splices made up in manholes on cable racks as indicated. Do not pull cable splices in ducts. Overlap cable ends at the ends of a section to provide sufficient undamaged cable for splicing. Overlap cables to be spliced in manholes to the centerline of the proposed joint by not less than 2 feet.

Immediately seal cut ends of cables cut in the field to prevent entrance of moisture with heat-shrinkable molded cable end caps.

3.2.4 Splices and Terminations

Field fabricate terminations from termination kits supplied by, and in accordance with, the termination manufacturer's recommendations for the type, size, and electrical characteristics of the cable specified.

Make splices in manholes as shown on the drawings. Make cable terminations at equipment specifically indicated. Expedite splicing and terminating of cables to minimize exposure and cable deterioration.

Field fabricate cable splices from 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. Locate cable splices in manholes midway between cable racks on walls of manholes and supported with cable arms at approximately the same elevation as the enclosing duct.

Use tools recommended by the splice manufacturer including calibrated cutting equipment to ensure consistent cut depths when preparing cable ends for the application of the splice kit. Submit a list of manufacturer's recommended tools for splicing operations. Connect the cable concentric neutral/shield wires across one side of the splice by split bundling the splice neutral wiring and connecting each bundle set to a continuous No. 4 AWG solid bare copper conductor via two compression conductors. Ensure the No. 4 AWG conductor extrudes from the cable splice jacket and connects to the manholes grounding system. Make all connections within the splice utilizing long barrel-type compression connectors and appropriate compression tools with proper size dies to ensure a satisfactory mechanical and electrical joint. Ensure bare connections of concentric neutral/shield wires are either contained within the splice kit or sealed via an additional outer covering, consisting 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. Provide outer tubing conforming to ANSI C119.1. Ensure splice meets the requirements of IEEE 404 for 15kV and 5kV ratings, as applicable, and is rated by the manufacturer for use on 15kV and 5kV class feeder cable systems, as applicable. Take extra precautions to seal around the exit area of the bare copper jumpers with an additional mastic per the splice manufacturer's recommendations.

Terminate cables in approved cable terminations, rated Class 1 per IEEE 48. Dry terminations with medium voltage pennants, preformed, and hand wrapped stress cones can be used for terminating cables. Provide terminations 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 contaminants. Take extra precautions in physically protecting and supporting cables, and maintaining the insulation level of the cable.

Include in installation 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.

Install cable splices on cable racks so as the minimize the physical stress on the splice connections. Support splices at approximately the same elevation as the installed cable, except where space limitations or existing cable length limitations make this method impractical or impossible.

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

Concentric neutral conductors of medium voltage cable systems shall be bonded to all manhole ground systems at splice locations and to both the equipment enclosure and its earth ground system at all terminations.

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 1 inch into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure-sensitive glass cloth tape.

3.2.6 Cable Tag Installation

Install cable tags on each new cable installed as part of this project, in each manhole and at each termination. Install cable tags over the fireproofing and position the tags so that they are clearly visible without disturbing any other cabling or wiring.

3.3 FIELD TESTING

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

a. Provide test equipment, labor, and trained technical personnel as necessary to perform the electrical acceptance tests.

b. Obtain a KSC medium voltage cable test form from the Contracting Officer prior to commencing Field Testing. Record all tests on forms provided, and submit completed forms to the Contracting Officer.

c. Make arrangements to have tests witnessed and approved by the Contracting Officer.

d. Isolate each power-cable installation completely from extraneous electrical connections at cable splices/terminations and joints. Observe all safety precautions.

e. Ensure each power cable is first given an insulation resistance test using a meg-ohmmeter with a voltage output of at least 2,500-volts. Apply test for a long enough time to fully charge the cable (no less than one minute). Record readings as indicated on forms provided. The minimum reading is 5000 megohms at an ambient temperature of 68 degrees F. Correct readings taken at other than 68 degrees F ambient temperatures accordingly.

f. Ensure concentric neutral cable shields are bonded to the metal enclosure of all transformers, switches, and switchgear. For 5kV circuits with tape shield cable, ensure bonding and continuity of the equipment grounding conductor run with the circuit.

g. Conform testing to NETA ATS, and NETA MAINT.

Upon successful completion of the insulation resistance test, subject the cable to a Very Low Frequency (VLF) AC high potential test. Adhere general VLF testing measures, parameters, considerations, and results to the following:

a. Ensure test voltage duration is continuous duty for 30 minutes (non-interrupted)

b. Provide the test equipment to test the cable capacity in microfarads

and record on the KSC Medium Voltage AC Hi-pot test form (VLF).

c. Provide the test equipment to generate the test voltages required for the 30 minute test duration and adhere to the following table:

VLF Test Voltage for Sinusoidal Waveform

Cable Rating phase to phase	Acceptance (phase to ground test values)	Acceptance (phase to ground test values)
	(New cable)	(Existing cable spliced to new cable)
(rms voltage, KV)	(peak voltage, KV)	(peak voltage, KV)
5	14	10
15	28	22; (EPR TO EPR)
15	15	15; (EPR TO NON-EPR)

d. Ensure the sinusoidal test frequency is 0.1 Hertz.

e. Do not perform test on cable attached to equipment.

Ensure Splices/terminations are clean, dry, and tested per IEEE 48 and IEEE 400.2.

Perform and submit radiographic tests on all splices/terminations at the discretion of the Contracting Officer to determine if voids exist. Rework unacceptable cable, splices or terminations at no additional expense to the Government.

-- End of Section --

SECTION 26 05 63.00 98

COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS
02/11

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.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1584	(2002, Am 1 2004, Int 1-3 2008) Guide for Performing Arc-Flash Hazard Calculations
IEEE 242	(2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book
IEEE 399	(1997) Brown Book IEEE Recommended Practice for Power Systems Analysis
IEEE C2	(2012) National Electrical Safety Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA Z535.4	(2007; Errata 2007) American National Standard for Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code
NFPA 70E	(2012) Standard for Electrical Safety in the Workplace

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Fault Current and Arc Flash Analysis Review Submittals; G

Protective Device Coordination Study Review Submittals; G

Proposed Test Plan; G

SD-03 Product Data

Fault Current and Arc Flash Analysis; G

Protective Device Coordination Study; G

Equipment; G

System Coordinator; G

Protective Relays; G

Installation Procedures; G

SD-06 Test Reports

Field Testing; G

SD-07 Certificates

Certificates of Conformance for Devices and Equipment; G

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Submittals and Meetings

No later than 90 days after Contract Award, submit Equipment, System Coordinator, and Protective Relay data to the Contracting Officer for review and approval.

Submit the following to the Contracting Officer for review and approval prior to system installation:

a. Fault Current and Arc Flash Analysis Review Submittals

b. Protective Device Coordination Study Review Submittals

c. Proposed Test Plan

The Contractor and System Coordinator agree to attend a review meeting at a KSC location designated by the Contracting Officer and provide review submittals as follows:

a. 75 percent submittal and review meeting: Study is complete except for disposition of Government comments.

b. 100 percent submittal and review meeting: Incorporates approved Government comments.

c. Final submittal: Incorporates approved Government comments. Setting sheets and test procedures from these documents are to be used to implement protective device settings.

1.3.1.1 Proposed Test Plan

Submit a proposed test plan, consisting of complete field test procedure including tests to be performed, test equipment required, and tolerance limits, including complete testing and verification of the ground fault protection equipment, where used.

1.3.1.2 Review and Final Submittals Format

For review and final submittals, submit 5 bound copies and a PDF file formatted on Compact Disc (CD) and or electronic storage media. Also provide on a final submittal CD all power system analysis software data files necessary to restore and edit the model.

Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

a. Equipment data

Submit data consisting of manufacturer's time-current characteristic curves for individual protective devices, recommended settings of adjustable protective devices, and recommended ratings of non-adjustable protective devices.

Review protective device submittals of equipment to be provided and indicate any options or modifications required to achieve the requirements of this section. No time extensions or similar contact modifications will be granted for work arising out of the requirements for this study. The Government is not responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

b. Protective Relays

Submit data including calibration and testing procedures and instructions pertaining to the frequency of calibration, inspection, adjustment, cleaning, and lubrication.

c. Installation Procedures

Submit written description of procedures including diagrams, instructions, and precautions required to properly install, adjust, calibrate, and test the devices and equipment.

1.3.2 Final Submittals

After completion of installation and testing submit the following to the Contracting Officer for review and approval:

Field Test Results - Submit in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

1.3.3 Field Changes

If field changes are required due to discrepancies between the setting sheet documents and the available setting selections on the protective device, submit within 10 days after installation the following to the Contracting Officer for review and approval:

a. Fault Current and Arc Flash Analysis

b. Protective Device Coordination Study

1.4 QUALITY ASSURANCE

Ensure all work performed is in conformance with the following standards:

IEEE C2

IEEE 1584

NEMA Z535.4

NETA ATS

NFPA 70

NFPA 70E

1.4.1 System Coordinator

Provide documentation verifying that system coordination, recommended ratings and settings of protective devices, and design analysis are prepared (performed/reviewed/approved) by a registered professional electrical power engineer with a minimum of 3 years of current experience in the coordination of electrical power systems.

1.4.2 System Installer

Ensure all final calibration, testing, adjustment, and placing into service of the protective devices is accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of 3 years of current product experience in protective devices.

1.5 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section.

1.6 PROJECT/SITE CONDITIONS

Provide devices and equipment suitable for the following service conditions:

a. Ambient Temperature: (50 degrees C) 120 degrees F

b. Frequency: 60 Hz

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The power system covered by this specification is as shown on the drawings.

The Government will provide the short circuit values for the following connection points on the electrical system:

- Feeder 202/203 at the Orsino Substation, LBS-29 and VFI-19.
- Feeder 204/205 at the Orsino Substation.
- Feeder 101 at the Orsino Substation.
- Feeder 102 at the Orsino Substation.
- Feeder 212 at the Orsino Substation.
- Feeder 213 at the Orsino Substation, LBS-86 and SS-119.
- Feeder 215 at the Orsino Substation and SS-119.

The Government will provide the existing protective device settings for the following devices on the electrical system:

- Medium voltage primary fusing for transformers fed through feeder breakers and VFIs for the circuits listed below.
- Feeder 202/203 at the Orsino Substation.
- Feeder 202/203 VFI-19.
- Feeder 202/203 VFI-65.
- Feeder 204/205 at the Orsino Substation.
- Feeder 204/205 VFI-18.
- Feeder 204/205 VFI-63.
- Feeder 212 at the Orsino Substation.
- SS-117 and SS-118 primary protection.
- Feeders 213 and 215 at the Orsino Substation.
- SS-119A and SS-119B, all circuits.

2.2 ARC FLASH LABELS

Provide weatherproof detailed arc flash warning labels for all electrical equipment covered in the coordination study, and as required by NFPA 70 and NFPA 70E, including, medium voltage switches, transformers, switchgear main breakers, switchgear bus-tie breaker, switchgear feeder breakers, switchgear cable compartments, switchboards, panel boards, motor control centers, enclosed breakers, safety switches automatic transfer switches, motor starters, control panels, and other equipment modified or installed by the project. All electrical equipment shall be assumed to require examination, adjustment, servicing, or maintenance while energized. Prepare arc-flash labels based on analyses performed without consideration for the arc-flash mitigating effects of specified zone-selective interlocking systems.

2.2.1 Label Format

Label format is to be NFPA 70E detailed format type. Conform in detail with samples provided at the time of award. Format includes different colors and formatting per NEMA Z535.4 for different hazard levels and the following information:

a. Flash hazard boundary

b. Incident energy

c. Hazard category and PPE

d. Shock voltage

e. Minimum insulated glove rating

f. Limited approach boundary distance

g. Restricted approach boundary distance

h. Prohibited approach boundary distance

2.2.2 Label Content

Ensure arc flash label content is based on the operational scenario, fault location, and fault type (arcing or bolted) that results in the highest incident energy.

2.3 COORDINATED POWER SYSTEM PROTECTION

Prepare and submit analyses to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. Include a fault current and arc flash analysis, equipment evaluation report, and a protective device coordination study. Submit Certificates of Conformance verifying that the studies have been prepared (performed/reviewed/approved) by a registered professional engineer with demonstrated experience in power system coordination over at least the past 3 years. Provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

Prepare and submit short circuit studies, coordination studies, and arc-flash hazard analysis in accordance with NETA ATS and as specified herein.

2.3.1 Scope of Analyses

Ensure the short circuit, coordination, and arc-flash hazard analyses cover the complete power system as shown on the drawings. Perform analyses without considering the arc-flash mitigating effects of specified zone-selective interlocking systems. Include largest existing devices downstream from new devices in coordination studies. Coordination study and relay settings sheets shall be provided for and include the following (Government will provide settings for use in Contractor study for all spare VFI positions):

- Feeder 202/203 at the Orsino Substation; pre-coordination with the Government is required prior to making any changes on settings for this

protective device.

- Feeder 202/203 VFI-80, all relay protected positions.
- Feeder 202/203 VFI-32, all relay protected positions.
- Feeder 202/203 VFI-19, all relay protected positions.
- Feeder 202/203 VFI-70, all relay protected positions.
- Feeder 202/203 VFI-65, all relay protected positions.
- Feeder 202/203 VFI-65 supplied M7-355 Substation 227B, all protective devices. Include the largest existing MCC-E-1-P load in the analysis.
- M7-355 Substation B supplied Switchboard B1 and Panel B2, all protective devices. Include the largest existing MCC-EE load in Switchboard B1 analysis.
- Feeder 204/205 at the Orsino Substation pre-coordination with the Government is required prior to making any changes on settings for this protective device.
- Feeder 204/205 VFI-14, all relay protected positions.
- Feeder 204/205 VFI-31, all relay protected positions.
- Feeder 204/205 VFI-18, all relay protected positions.
- Feeder 204/205 VFI-69, all relay protected positions.
- Feeder 204/205 VFI-63, all relay protected positions.
- Feeder 204/205 VFI-63 supplied M7-355 Substation 227A, all protective devices. Include existing MCC-A main breaker, largest MCC-A feeder, and the fire pump in the analysis.
- Feeder 212 at the Orsino Substation pre-coordination with the Government is required prior to making any changes on settings for this protective device.
- Feeder 212 VFI-212, all relay protected positions.
- Feeder 213 at the Orsino Substation pre-coordination with the Government is required prior to making any changes on settings for this protective device.
- Feeder 215 at the Orsino Substation pre-coordination with the Government is required prior to making any changes on settings for this protective device.
- New primary unit substation SS-119A and SS-119B, all protective devices.

2.3.2 Determination of Facts

Perform field inspections to determine and document the time-current characteristics, features, and nameplate data for each existing protective device. Utilize the fault current availability provided by the Government as a basis for fault current studies.

2.3.3 Single Line Diagram

Prepare a single line diagram to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Ensure each bus, device or transformation point has a unique identifier. If a fault-impedance diagram is provided, show impedance data. Show the location of switches, breakers, and circuit interrupting devices on the diagram together with available fault data, and the device interrupting rating.

2.3.4 Fault Current Analysis

2.3.4.1 Method

Perform the fault current analysis in accordance with methods described in IEEE 242 and IEEE 399. Single line drawings based on existing hardware will be provided to the Contractor for reference. Utilize specialized computer aided engineering software (SKM or ETAP) designed for fault current analysis, including the following capabilities:

a. Single-ended substation source operation.

b. Double-ended substation source operation.

Perform analysis and provide separate study report generated for each operational scenario.

2.3.4.2 Data

Utilize actual hardware data in fault calculations. Ensure bus characteristics and transformer impedance are those proposed. Document all data in the report.

2.3.4.3 Fault Current Availability

Provide three-phase line-to-line fault, line-to-line-to-ground fault, and line-to-ground bolted fault current values at each voltage transformation point and at each power distribution bus. Show the maximum and minimum values of fault available at each location in tabular form on the diagram or in the report.

2.3.5 Coordination Study

Ensure the study demonstrates that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. Include a description of the coordination of the protective devices in this project. Provide a written narrative describing:

a. Which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings.

b. Situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap).

c. Coordination between upstream and downstream devices; and relay settings.

d. Provide recommendations to improve or enhance system reliability by reducing the incident energy level, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction).

Provide composite coordination plots on log-log graph paper.

a. Provide separate plots for phase and ground faults.

b. Include applicable cable and transformer damage curves on phase fault plots.

c. Limit the number of protective device curves on any plot to 5.

2.3.6 Study Report

Include the following in the report:

a. A cover sheet and table of contents. Provide separate sections with all applicable content, for all operating scenarios.

b. A narrative describing:

(1) The analyses performed.

(2) The basis and methods used.

(3) The desired method of coordinated protection of the power system.

c. Descriptive and technical data for existing devices and new protective devices proposed, including manufacturers published data, nameplate data, time-current curves, and definition of the fixed or adjustable features of the existing or new protective devices.

d. Document utility data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings; and existing power system data including time-current characteristic curves and protective device ratings and settings.

e. Provide time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment, including recommended ratings and settings of all protective devices in tabulated form.

f. Provide all calculations performed for the analyses, including computer analysis programs utilized, the name of the software package, developer, and version number. Include all information input to (define) nodes such as cable data, conduit type, circuit length, transformer impedance, bus impedance, generator impedances, etc. For all nodes include phase fault short circuit levels and X/R ratios, ground fault short circuit levels and X/R ratios, load flow levels, arc flash energy (for both bolted and arcing short circuit levels), and motor starting studying results. Indicate which study options have been chosen which the software utilizes to generate the Short Circuit Analysis and Arc Flash Hazard Analysis results; use preferred method below when available. Options included are, but not limited to the following:

(1) Standard used for arc-flash calculations: (IEEE 1584 - preferred method).

(2) 240 volt exceptions (report Cat 0 if XFMR less than 125kVA - preferred method).

(3) Maximum arcing time: (2 sec - preferred - fully dependent on task performed). For certain tasks, such as working in manholes, elevated work areas, or underneath equipment, it may not be possible for trained personnel to distance themselves from the Arc Flash within 2 seconds.

(4) Motor fault contributions: (5 cycles preferred - motors with 50 hp or greater are to be evaluated).

(5) Levels Mis-coordination checked (5 levels-preferred).

(6) Mis-coordination Ratio: (80 percent - preferred - ensure Cleared Fault Threshold matches Mis-coordination Ratio).

(7) Flash Boundary Calculation Adjustments above 1kV, Trip Time less than =0.1s: (1.5 cal/square meter - preferred).

(8) Properly categorize all equipment types in Arc Flash Evaluation: (Ensure switchgear, panel boards have proper gap distance).

(9) Utility information as shown on the drawings and provided by the Government.

(10) Short Circuit Study Utilized: (Comprehensive-preferred).

(11) Fault types analyzed: (Three Phase, Single Line to Ground, Line to Line, Line to Line to Ground, All -preferred).

g. Single line diagram(s).

h. Protective device setting sheets, as separate pages, suitable for use by installing technicians, separate from other report analysis and data. Include recommended changes to existing protective device settings and settings for all new protective devices. Provide all information to field install the settings, including settings or features not used or turned off.

i. Tabulated Arc Flash data for all equipment requiring an arc flash warning label and all modified equipment also requiring an arc flash label.

j. Equipment Evaluation Report (EER) showing the AIC/SCCR ratings for all equipment evaluated and the required rating for the application where the equipment is installed. Ensure the EER identifies underrated and marginally rated equipment. Underrated equipment is defined as equipment with actual AIC/SCCR ratings that do not meet the required AIC/SCCR rating for the application/installation. Marginally rated equipment is defined as equipment within 90 percent to 100 percent of the required rated AIC/SCCR for the application/installation.

PART 3 EXECUTION

3.1 INSTALLATION

Install and test protective devices settings in accordance with the manufacturer's published instructions and in accordance with the protective device coordination study protective device setting sheets and test plan.

Affix detailed arc flash warning labels to all electrical equipment as required by NFPA 70 and NFPA 70E.

3.2 FIELD TESTING

3.2.1 General

NETA ATS and Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein. Submit Performance Test Reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls. Submit Certificates of Conformance for Devices and Equipment to the Contracting Officer, certifying that all devices or equipment meet the requirements of the contract documents.

3.2.2 Safety

Provide and use safety devices such as arc flash personal protective equipment, electrically insulating rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. Replace any devices or equipment which are damaged due to improper test procedures or handling.

3.2.3 Molded-Case Circuit Breakers

Visually inspect circuit breakers. Verify current ratings and adjustable settings incorporated in accordance with the coordination study.

3.2.4 Power Circuit Breakers

3.2.4.1 General

Visually inspect the circuit breaker and implement settings in accordance with the coordination study.

3.2.4.2 Current Injection Tests

Test with approved settings installed in accordance with NETA ATS and the Test Plan; document results in the field test reports.

a. Determine long time pick-up value and delay by primary current injection.

b. Determine short time pick-up value and delay by primary current injection.

c. Determine instantaneous pick-up value by primary current injection.

d. Determine ground-fault pick-up value and delay by primary current

injection.

e. Test trip unit functions by secondary current injection or in accordance with the manufacturer's requirements.

3.2.5 Protective Relays

3.2.5.1 General

Visually inspect protective relays. Implement relay settings in accordance with the coordination study.

3.2.5.2 Current Injection Tests

Test with approved settings installed in accordance with NETA ATS and the Test Plan; document results in the field test reports.

a. Determine long time pick-up value and delay by secondary current injection.

b. Determine short time pick-up value and delay by secondary current injection.

c. Determine instantaneous pick-up value by secondary current injection.

d. Determine ground fault pick-up value and delay by secondary current injection.

-- End of Section --

SECTION 26 05 71.00 40

LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES
05/11

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 A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.09	(1999; AMD 1 2005; Corr 1 2007; R 2007; Errata 2007; Amendment B 2011) Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.13	(2008; INT 1 2009) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.16	(2009) Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC 3200 V and below) Power Circuit Breakers
IEEE C37.17	(1997) Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
IEEE C37.90	(2005) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.13	(2008) Standard Requirements for Instrument Transformers
IEEE C63.2	(2009) Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz - Specifications
IEEE C63.4	(2009) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

IPC D330	(1992) Design Guide Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 107	(1987; R 1993) Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus (inactive)
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 3	(2006) Molded Case Circuit Breakers and Their Application
NEMA FU 1	(2002; R 2007) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2011) Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2006; Reprint Feb 2011) Surge Protective Devices
UL 20	(2010) General-Use Snap Switches
UL 489	(2009; Reprint Jun 2011) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 50	(2007) Enclosures for Electrical Equipment, Non-environmental Considerations

1.2 SUBMITTALS

Where equipment specified by this section is installed in switchgear, switchboards, motor control centers or other similar equipment, coordinate and integrate drawing submittals with those of the other related

specification sections.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit Connection Diagrams and Fabrication Drawings for the following items in accordance with paragraph entitled "General Requirements" of this section.

All Shop Drawings shall be computer aided design (CAD) generated. With each submittal provide a CD with a complete copy of the drawings in PDF format.

Submit Shop Drawings for approval prior to equipment manufacturing.

Submit "As-Built" Shop Drawings after installation, inspection and testing is complete which document all field changes made. Provide Digital media compact disc (CD) with all submittals including .DWG or .DXF CAD source files as well as PDF format files for all drawings.

Submit Installation drawings for the following items in accordance with the paragraph entitled "Installation" of this section.

Control Devices; G
Protective Relays; G
Electrical Power Monitoring Systems; G
Surge Protective Devices; G

SD-03 Product Data

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

Instrument Transformers; G
Enclosures; G
Circuit Breakers (including trip unit data and complete register list); G
Fuses; G
Control Devices; G
Time Switches; G
Protective Relays; G
Surge Protective Devices; G
Electrical Power Monitoring Systems; G
Indicating Lights; G

SD-06 Test Reports

Submit test reports for the following tests in accordance with the paragraph entitled "Field Testing" of this section.

Factory tests; G
Field testing; G

Submit test forms showing compliance with NETA ATS inspections and tests for approval prior to testing.

Submit completed test forms showing the results of all inspections and tests in accordance with NETA ATS inspections and tests after inspections and testing is complete.

SD-08 Manufacturer's Instructions

Submit manufacturer's instructions for the following items, including special provisions required to install equipment components and system packages. Provide detail on resistance impedances, hazards and safety precautions within the special notices.

Control Devices; G
Protective Relays; G
Circuit Breakers (including trip units); G
Electrical Power Monitoring Systems; G
Surge Protective Devices; G

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for the following equipment:

Circuit Breakers (including trip units); G
Time Switches; G
Protective Relays; G
Electrical Power Monitoring Systems; G
Surge Protective Devices; G

1.3 GENERAL REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to work specified in this section.

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

For devices and equipment integral to substations SS-119A and SS-119B, the requirements of Section 26 11 13.00 98 PRIMARY UNIT SUBSTATION, take precedence over this specification section.

Provide a power system study as specified in Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION. Set protective devices in accordance with the approved study submittal.

Submit Connection Diagrams showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, interconnection of the substation control and monitor system with KCCS, and internal tubing, wiring, and other devices.

Submit Fabrication Drawings for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

Provide products with continuous-current rating, interrupting rating,

clearing time, and melting time, indicated herein and on the drawings. No change from the continuous-current rating, interrupting rating, clearing time, and melting time indicated herein and on the drawings shall be made unless written permission has first been secured from the Contracting Officer.

PART 2 PRODUCTS

2.1 INSTRUMENT TRANSFORMERS

Comply with the interference requirements measured in accordance with IEEE C63.2, IEEE C63.4, and NEMA 107 for Instrument transformers.

2.1.1 Current Transformers

Provide current transformers that conform to IEEE C57.13 for installation in metal-clad switchgear. Use standard multi-ratio 5-A secondary transformer.

Provide wound, bushing, bar and window type transformers as required.

Provide transformers that have single or double secondary winding as required.

Provide transformers that are complete with secondary short-circuiting device.

For low voltage window-type current transformers, provide indoor dry type construction with secondary current ratings as indicated with B-1 burden, specified frequency, and minimum 10C100 accuracy.

For medium voltage window-type current transformers, provide indoor dry type construction with secondary current ratings, burden, frequency, and accuracy as indicated on the drawings.

2.1.2 Potential Transformers

For potential transformers, provide fixed mount potential transformers as indicated or required for metering and relaying applications. Unless otherwise indicated, use three (3) standard 120-volt, 60-hertz grounded secondary transformers for 3-phase applications.

Provide transformers that have single, tapped or double secondary as required.

Provide burden, frequency and accuracy as indicated on the drawings.

For low voltage switchgear bus tap power supply connections provide a fully enclosed, dead-front type fused switch mounted in the metering compartment containing one fuse per phase.

Provide secondary fusing and pull-out type fuse block. Size fuses as recommended by the manufacturer.

2.2 ENCLOSURES

Provide enclosures for equipment in accordance with NEMA 250.

Contain equipment installed in clean, dry indoor locations in a NEMA Type

12 industrial use, sheet-steel enclosure, constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Contain equipment installed in damp or wet locations in a NEMA Type 4X 316 stainless steel watertight, corrosion-resistant sheet-steel enclosure, constructed to prevent entrance of water when tested in accordance with NEMA ICS 6 for Type 4X enclosures.

Fabricate sheet-steel enclosures from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with UL 50.

Fabricate steel enclosures from corrosion-resistant, chromium-nickel steel sheet conforming to ASTM A167 Type 300 series with ASM No. 4 general-purpose polished finish, with box dimensions and thickness of sheet steel in accordance with UL 50.

2.3 CIRCUIT BREAKERS

Provide circuit breakers that conform to UL 489, and NEMA AB 3.

2.3.1 Power Circuit Breakers

Provide air-break type power circuit breakers enclosed in ventilated housings for those rated below 600 volts with current (frame and trip), voltage, and interrupting ratings as indicated. Provide 100 percent rated drawout type circuit breakers.

Comply with IEEE C37.16 and IEEE C37.13 for power circuit breakers.

Mount draw-out breakers on a mobile frame with primary and secondary disconnecting devices to allow complete removal of the unit for inspection and maintenance. Provide a mechanism with an electrically and remotely operated racking mechanism that moves the breaker between the connected, test, and disconnect positions by means of a remote operator. Provide interlocks to prevent the complete withdrawal of the circuit breaker from its compartment when the stored-energy mechanism is in the fully charged position. Design circuit breakers to prevent the release of stored energy unless the mechanism is fully charged. Provide provisions to manually charge, open and trip electrically operated circuit breakers.

Equip power circuit breakers with static trip (solid-state) units with long-time/short-time and instantaneous elements, and ground fault protection. Provide breakers that are electrically and mechanically trip-free in any position of the closing stroke. Provide silver-plated main contacts and sintered tungsten alloy arcing contacts. Accomplish tripping by a shunt-trip device. Provide electrical closing operation.

Trip units shall be digital solid-state type for low voltage power circuit breakers in accordance with IEEE C37.17; Square D Micrologic 5.0P or approved equal. Trip unit electronics module shall be interchangeable between breaker frame sizes without replacing current sensors or flux trip devices already installed. Units shall be powered from current sensors and a separate battery back-up source. Batteries shall only be used to power indicator lights and display after the unit trips. Trip units shall be adjustable. Trip settings shall not rely on rheostats, dip switches, jumpers or pins to maintain their present adjustments, and instantaneous trip settings shall be defeatable. Provide a sealable cover over the adjustments to prevent tampering. Units shall not rely solely on any

volatile or nonvolatile electronic memory to maintain their settings. Provide units complete with the capability, options, accessories, devices, cabling, wiring, and appurtenances, setup, programming, testing, and certification necessary for the implementation of the zone-selective interlocking systems described in Section 26 23 00.00 98 LOW VOLTAGE SWITCHGEAR paragraph entitled "Zone-Selective Interlocking Systems."

Provide communication interface to allow the trip units to communicate using the communication system described in Section 26 23 00.00 98 LOW VOLTAGE SWITCHGEAR paragraph entitled "Switchgear Monitoring and Control System." The digital solid state trip units shall be capable of clearly communicating all data to KCCS via Modbus TCP/IP communication protocol using a maximum of one hardware conversion and no software conversions. Breaker status data shall include, but shall not be limited to, the following: breaker status, current, time of trip, operational history, cause of trip, current date and time, power (KW), energy (KWH), peak demand, self-diagnostic information and set points. Breaker remote control functions shall include, but shall not be limited to, the following: breaker open, close, and trip operations for electrically operated breakers, date/time energy clear, energy (KWH) clear and remote set date/time and trip reset.

Provide submittals of the KCCS communication drawings. Provide two licensed copies of all software and all hardware, including connection cables, necessary to modify and download programs to the digital solid state trip units.

Provide Citect programming to display the breaker status data described in this section on KCCS. Similar, Citect screens for existing trip units will be provided as a guide for the new screens. New screens shall match the "look and feel" of existing screens. If Square D Micro logic 5.0 trip units are provided, no new Citect trip unit screens will be required. If other trip units are provided, the Contractor shall develop all new KCCS Citect interfaces as described in Section 26 23 00.00 98 LOW VOLTAGE SWITCHGEAR paragraph entitled "Switchgear Monitoring and Control System."

Trip units shall be equipped with test jacks on circuit breaker face for service functional testing of each trip unit function using a full function test kit for secondary injection. Provide one full function test kit to the Contracting Officer as part of this project. Test kit shall be a product of the trip unit manufacturer.

Upon a circuit breaker trip operation, it shall not be possible to close the circuit breaker until a manual reset operation occurs locally at the breaker trip unit or a lockout relay activated by the circuit breaker trip unit.

Supply alarms, auxiliary switches, truck auxiliary switches, interlocks, and similar devices as required and indicated.

Provide breakers with a removable operating handle, provision for padlocking, and position indicator.

Provide all maintenance items for breakers including lifting device, racking equipment and manual spring charging equipment as required.

Submit certification of factory testing of Power Circuit Breakers in accordance with IEEE C37.09.

2.3.2 Molded-Case Circuit Breakers

For circuit breakers on frame sizes larger than 250 amperes, provide solid-state tripping mechanism with adjustable long-time, short-time, instantaneous, and ground fault trip settings. Such trip settings shall be accessible and adjustable from the front of the breaker.

For circuit breakers on frames size of 250 amperes, provide thermal-magnetic tripping mechanism with fixed inverse-time-delay thermal overload protection and instantaneous magnetic short-circuit protection. Locate the thermal-magnetic tripping mechanism elements in each pole of the breaker.

Size breaker as required for the continuous current rating of the circuit. Provide interrupting capacity indicated. Provide breaker class as required.

Provide interrupting capacity as indicated, of the panel and lighting branch circuit breakers, to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Where not indicated, provide circuit breaker interrupting capacities with a minimum of 10,000 amperes and that conform to NEMA AB 3. Series ratings of breakers is not permitted.

Provide the common-trip type multi-pole circuit breakers having a single operating handle and a two-position on/off indication. Provide circuit breakers with temperature compensation for operation in an ambient temperature of 104 degrees F. Provide circuit breakers that have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective type tripping (time delay, magnetic, thermal, or ground fault).

Provide phenolic composition breaker body capable of having such accessories as handle-extension, handle-locking, and padlocking devices.

Provide circuit breakers used for meter circuit disconnects that meet the applicable requirements of NFPA 70 and that are of the motor-circuit protector type.

For circuit breakers used for service disconnection, provide an enclosed circuit-breaker type with external handle for manual operation. Provide sheet metal enclosures with a hinged cover suitable for surface mounting.

2.3.3 Enclosed Molded-Case Circuit Breakers

For enclosed circuit breakers, provide thermal-magnetic molded-case circuit breakers in surface-mounted, non-ventilated enclosures conforming to the appropriate articles of NEMA 250 and UL 489.

Provide enclosures for units per the paragraph entitled "Equipment and Enclosures." Provide copper ground bus and, where indicated, a solid neutral.

2.4 FUSES

Provide a complete set of fuses for all switches and switchgear. Provide fuses that have a voltage rating of not less than the circuit voltage.

Make no change in continuous-current rating, interrupting rating, and clearing or melting time of fuses unless written permission has first been

secured.

Provide rejection type, high interrupting, current limiting, nonrenewable cartridge type fuses with time-delay dual elements, except where otherwise indicated. Conform to NEMA FU 1 for fuses.

Label fuses showing UL class, interrupting rating, and time-delay characteristics, when applicable. Additionally, clearly list fuse information on equipment drawings.

Provide dead-front pull-out type fuse holders when field-mounted in a cabinet or box. Do not use fuse holders made of such materials as ebony asbestos, Bakelite, or pressed fiber.

2.5 CONTROL DEVICES

2.5.1 Magnetic Contactors

Provide magnetic contactors in accordance with NEMA ICS 1 and NEMA ICS 2 as required for the control of low-voltage, 60-hertz, tungsten-lamp loads, fluorescent-lamp loads, resistance-heating loads, and the secondary windings of low-voltage transformers.

Provide core-and-coil assembly that operates satisfactorily with coil voltage between 85 and 110 percent of its voltage rating.

Provide contactor that is designed with a normally open holding circuit auxiliary contact for control circuits, with a rating in accordance with NEMA ICS 1 and NEMA ICS 2.

Furnish solderless pressure wire terminal connectors, or make available for line-and-load connections to contactors in accordance with NEMA ICS 1 and NEMA ICS 2.

Provide magnetic contactors with a rating in accordance with NEMA ICS 1and NEMA ICS 2.

2.5.2 Control-Circuit Transformers

Provide control-circuit transformers within the enclosure of switchgear, magnetic contactors, and motor controllers when the line voltage is in excess of 120 volts. Provide encapsulated dry type, single-phase, 60-hertz transformer, with copper windings and a 120-volt (or 120/240-volt where indicated) isolated secondary winding.

Do not provide a transformer with a rated primary voltage less than the rated voltage of the controller, or a rated secondary current less than the continuous-duty current of the control circuit.

Provide voltage regulation of the transformer such that, with rated primary voltage and frequency, the secondary voltage is not less than 95 percent nor more than 105 percent of rated secondary voltage.

Provide source of supply for control-circuit transformers at the load side of the main disconnecting device. Protect secondary winding of the transformer and control-circuit wiring against overloads and short circuits, with circuit breakers where indicated and, if not indicated, with fuses selected in accordance with NEMA ICS 6. Ground secondary winding of the control-circuit transformer in accordance with NEMA ICS 6.

2.5.3 Magnetic Control Relays

Provide magnetic control relays for energizing and de-energizing the coils of magnetic contactors or other magnetically operated devices, in response to variations in the conditions of electric control devices in accordance with NEMA ICS 1, and NEMA ICS 2.

Provide core-and-coil assembly that operates satisfactorily with coil voltages between 85 and 110 percent of their voltage rating.

Provide relays that are designed to accommodate normally open and normally closed contacts.

Provide 120-volt, 60-hertz, Class AIB magnetic control relays with a continuous contact rating of 10 amperes, and with current-making and -breaking ability in accordance with NEMA ICS 1 and NEMA ICS 2, two normally open and two normally closed.

2.5.4 Pushbuttons and Switches

2.5.4.1 Pushbuttons

For pushbuttons for low-voltage ac full-voltage magnetic controllers, provide heavy-duty oiltight NEMA 250, Type 4, momentary-contact devices rated 600 volts, with pilot light, and with the number of buttons and the marking of identification plates as shown. Furnish pushbutton color code in accordance with NEMA ICS 6.

Provide pushbuttons that are designed with normally open, circuit-closing contacts; normally closed circuit-opening contacts; and two-circuit normally open and normally closed circuit-closing and -opening contacts. Provide pushbutton-contact ratings in accordance with NEMA ICS 1 and NEMA ICS 2 with contact designation A600.

Identify pushbuttons in remote control stations with identification plates affixed to front cover in a prominent location. Carry the identification of the system being controlled on the identification plate.

2.5.4.2 Selector Switches

Provide heavy-duty oiltight maintained-contact selector switches for low-voltage control circuits, with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Identify selector switches in remote control stations with engraved identification plates affixed to front cover in a prominent location. Carry the identification of the system being controlled on the identification plate.

2.5.4.3 Miscellaneous Switches

Provide float, limit, door, pressure, proximity, and other types of switches in accordance with IPC D330 and of the types and classes indicated.

2.5.4.4 Test Switches

Provide test switches as indicated on the drawings. Test switches shall be ABB Type FT-1 or equal with clear covers, and shall be mounted on the door

of the instrument compartment or as indicated.

2.6 TIME SWITCHES

Provide time switches for the control of tungsten-lamp loads, fluorescent-lamp loads, resistive-heating loads, motors, and magnetically operated devices, consisting of a motor-driven time dial and switch assembly in a NEMA 250, Type 1 general-purpose enclosure.

Provide motor drives consisting of 120-volt, single-phase, 60-hertz, heavy-duty, self-starting synchronous motors, directly connected to the time dial through a geartrain operating mechanism. Provide a spring-wound stored-energy source of reserve power that will automatically operate the mechanism for a period of not less than 12 hours in case of electric power failure. Provide spring that automatically rewinds electrically in not more than 3 hours of time after electric power is restored.

Include a heavy-duty general-purpose precision snap-action switch in accordance with UL 20 for switch mechanism, with provision for a manual "OFF" and "ON" operation of the switch.

Provide time switches for the control of 120/240-volt, 2- and 3-wire, single-phase, 60-hertz circuits and 120/208-volt, three-phase, 4-wire, 60-hertz circuits, with a continuous-current tungsten-lamp load rating of 35 amperes.

Provide astronomic type time dials which automatically change settings each day, in accordance with the seasonal time changes in sunrise and sunset. Provide astronomic type dials that have adjustable on and off trippers, for repetitive switching operations at solar time each day and each day in the year and that make one revolution in a 24-hour period of time. Provide time dials that are designed to operate in the "ON" position at sunset and be fully adjustable upward in 15-minute intervals of time throughout each day, and that indicate the day and month of the year. Calibrate dial in 15-minute intervals over a 24-hour period of time around its circumference. Make provision to defeat the switching operation over weekends or up to 6 preselected calendar days each week.

2.7 PROTECTIVE RELAYS

2.7.1 Multi-Function Voltage Relays

For undervoltage relays conform to IEEE C37.90.

Provide three-phase solid-state multi-function type voltage relays, Basler Electric or equal, with definite time characteristics and adjustable and calibrated pick-up settings for protection against negative sequence voltage (Device 47), undervoltage (Device 27), and overvoltage (Device 59). Provide thumb wheel setting switches for pick-up and timing adjustments and equip relays with electrically separate contact circuits for all protective functions that are suitable for operation on dc or ac control circuits.

Provide relays that are of draw-out construction with built-in testing facilities and that are suitable for operation on 120-volt ac instrument circuits.

Provide a semi-flush mount case with matching cover to the hinged instrument panel.

2.7.2 Synchronization Check Relays

For synchronization check relays (Device 25) conform to IEEE C37.90.

Provide solid-state electronic relay, Basler Electric or equal, with the ability to user select synchronization check function for the following conditions:

Live Line - Dead Bus
Live Line - Live Bus
Dead Line - Dead Bus
Dead Line - Live Bus

Provide three-phase solid state relay designed to accept 120 Volts AC inputs. Dead line and live line settings shall be adjustable. Synchronization angle shall be adjustable from 1 to 99 degrees with an adjustable time delay of 1 to 99 seconds. Provide thumb wheel setting switches for pick-up and timing adjustments and equip relays with electrically separate contact circuits for all protective functions that are suitable for operation on dc or ac control circuits.

Provide relays that are of draw-out construction with built-in testing facilities, and that are suitable for operation on 120-volt ac instrument circuits.

Provide semi-flush mount case with matching cover to the hinged instrument panel.

2.7.3 Timing Relays

Provide timing relays with calibrated timing head, precision-wound potted coil, and a snap-action switch assembly. The calibrated timing head shall re-circulate air under controlled pressure through a variable orifice to provide a linearly adjustable timing. The precision-would potted coil shall be totally sealed without any external leads. The snap-action switch assembly shall be double-pole, double-throw with copper blades and silver-cadmium oxide contacts to insure positive wiping action.

2.7.4 Lockout Relays

Provide high speed lockout relays with manual rotary cam reset and latching relay clearing contact. Provide contact deck with contacts having a rating adequate for the duty performed, but shall not be less than 600 volts, 20 amperes continuous. Door mounted control switch shall have mechanical targets with spring return type of operation and pistol grip handle. All switches shall be equipped with engraved plastic escutcheons identifying its function.

2.8 ELECTRICAL POWER MONITORING SYSTEMS

For compatibility, metering equipment shall be NASA KSC Standard, Schneider Electric Square D CM4250 with ECC21 Ethernet communications card, IOC input/output card, and CMDLC backlit LCD display, and no other. Metering equipment shall be UL recognized, CSA certified and also meet IEEE C37.90.

a. Meter Monitoring Functions: Provide meter designed for use on a 3-phase, 3- or 4-wire, systems with 3 current transformers and 2 or 3 voltage transformers as indicated. The meter shall provide direct

reading metered or calculated values and shall auto range between units, kilo-units, and mega-units for all metered values.

b. Case: Display case shall be semi-flush mounted to a hinged panel door. Power supply and other metering components may be fixed mounted within an auxiliary compartment.

c. Meter Enclosure: Where indicated, provide an enclosure in accordance with the paragraph entitled "Equipment Enclosures" and include a back-panel for mounting power supply, terminal strip, and similar components and a hinged interior panel for mounting the display case. Provide a warning label on the hinged panel indicating energized line voltage components are behind the hinged panel.

d. Test Blocks: Provide four pole current and four pole potential test blocks, General Electric Type PK or Westinghouse Type FT in line after the power monitor for additional metering or testing.

e. Meter Fusing: Provide a fully enclosed pullout, dead-front type fuse block containing one fuse per phase to protect the voltage input to the watt-hour meter. Size fuses as recommended by the meter manufacturer.

f. Provide short-circuiting type terminal strips for connecting meter to current transformer circuits.

2.9 FACTORY TESTING

Perform factory tests on control and low voltage protective devices in accordance with the manufacturer's recommendations.

Conduct short-circuit tests in accordance with Section 2 of NEMA ICS 1.

Factory witness testing, at Government's option, shall take place at vendor's facility for circuit breakers, trip units, and KCCS communication.

Provide documentation on successful completion of factory tests for the above equipment prior to final activation at KSC.

2.10 INDICATING LIGHTS

Provide transformer, push-to-test LED type, rated for 120 volts ac. Lights shall be capable of being relamped from the front.

2.11 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices which comply with UL 1449 in the locations indicated on the drawings. Provide surge protectors in a NEMA Type enclosure per NEMA ICS 6. Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS -
Each phase to neutral (L-N)
Neutral to ground (N-G)
Phase to ground (L-G)

Surge protective devices at the service entrance shall have a minimum surge current rating of 80,000 amperes per mode minimum and downstream protectors shall be rated 40,000 amperes per mode minimum. The maximum line to neutral (L-N) Suppressed Voltage Rating (SVR) shall be:

500V for 120V, single phase system
500V for 120/240V, single phase system
500V for 208Y/120V, three phase system
900V for 480Y/277V, three phase system

The minimum MCOV (Maximum Continuous Operating Voltage) rating shall be:

150V for 120V, single phase system
300/150V for 120/240V, single phase system
300/150V for 208Y/120V, three phase system
600/320V for 480Y/277V, three phase system

EMI/RFI filtering shall be provided for each mode with the capability to attenuate high frequency noise. Minimum attenuation shall be 20db.

2.12 FINISH

Protect metallic materials against corrosion. Provide equipment with the standard finish by the manufacturer for indoor installations.

PART 3 EXECUTION

3.1 INSTALLATION

Install Control devices and protective devices that are not factory installed in equipment, in accordance with the manufacturer's recommendations and field adjusted and operation tested. Conform to NFPA 70, NEMA ICS 1 and NEMA ICS 2 requirements for installation of control and protective devices.

3.1.1 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible.

3.2 FIELD TESTING

Demonstrate to operate as indicated control and protective devices not factory installed in equipment.

Ratio and verify tap settings of instrumentation, potential, and current transformers.

Perform all applicable inspections and electrical tests, including optional tests, in accordance with NETA ATS and Section 26 08 00 APPARATUS INSPECTION AND TESTING for all meter, over-current protective device, and relays including but not limited to the following:

a. Circuit Breakers, Air, Low-Voltage Power

b. Circuit Breakers, Air, Insulated Case/Molded Case - Do not perform primary current injection tests.

c. Protective Relays, Electromechanical and Solid-State

d. Protective Relays, Microprocessor based

e. Instrument Transformers

f. Metering Devices

g. Low Voltage Ground Fault Protection Systems

h. Surge Arresters, Low Voltage

Do not energize control and protective devices until recorded test data has been approved. Provide final test reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

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SECTION 26 08 00

APPARATUS INSPECTION AND TESTING
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.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance tests and inspections procedures; G

Acceptance tests and inspections reports; G

SD-07 Certificates

Qualifications of organization, and lead engineering technician; G

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

Contractor shall engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization shall be independent of the supplier, manufacturer, and installer of the equipment. The organization shall be a first tier subcontractor. No work required by this section of the specification shall be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization shall have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization shall have a calibration program, and test instruments used shall be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and

telephone numbers for reference. Testing, inspection, calibration, and adjustments shall be performed by an engineering technician, certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution equipment, systems, and devices.

1.3.2 Acceptance Tests and Inspections Reports

Submit certified copies of inspection reports and test reports. Reports shall include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.

1.3.3 Acceptance Tests and Inspections Procedures

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization shall perform acceptance tests and inspections. Test methods, procedures, and test values shall be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are required unless otherwise specified. Equipment shall be placed in service only after completion of required tests and evaluation of the test results have been completed. Contractor shall supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Contracting Officer shall be notified at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

Section 26 05 63.00 98	COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSES (KSC)
Section 26 05 13.00 98	MEDIUM VOLTAGE CABLE - Perform testing in accordance with requirements of this section.
Section 26 05 71.00 40	LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES
Section 26 11 13.00 98	PRIMARY UNIT SUBSTATIONS
Section 26 12 19.00 40	PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
Section 26 13 00.00 98	SF6 INSULATED SWITCHGEAR

Section 26 20 00	INTERIOR DISTRIBUTION SYSTEM
Section 26 23 00	SWITCHBOARDS
Section 26 23 00.00 98	LOW-VOLTAGE SWITCHGEAR
Section 33 71 02.00 20	UNDERGROUND ELECTRICAL DISTRIBUTION

3.2 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

3.3 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization shall be present when equipment tested by the organization is initially energized and placed in service.

-- End of Section --

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SECTION 26 11 13.00 98

PRIMARY UNIT SUBSTATION
04/07

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 WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A276	(2010) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A345	(2009) Standard Specification for Flat-Rolled Electrical Steels for Magnetic Applications
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A572/A572M	(2007) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A666	(2010) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D 877	(2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D 92	(2005a; R 2010) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D 97	(2011) Pour Point of Petroleum Products
ASTM E84	(2012) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-104-696	(2001) Standard for Indoor-Outdoor Optical Fiber Cable

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 32	(1972; R 1997) Standard Requirements, Terminology, and Test Procedures for Neutral Grounding Devices
IEEE 802.3	(2008; AT 2009; AV 2009; BC 2009; Corr 1 2009; INT 1 2010; BA 2010; AZ 2010; BG 2011; BD 2011) Standard Information Technology--Telecommunications and Information Exchange Between Systems--Specific Requirements Part 3: CSMA/CD Access Method and Physical Layer Specifications
IEEE C2	(2012) National Electrical Safety Code
IEEE C37.04	(1999; Amd A 2003; Errata 2005; R 2006; Amd B 2008; INT 2010) Standard for Rating Structure for AC High-Voltage Circuit Breakers
IEEE C37.121	(1989; R 2006) American National Standard for Switchgear-Unit Substations - Requirements
IEEE C37.20.2	(1999; Corr 2000; R 2005) Standard for Metal-Clad Switchgear
IEEE C37.20.3	(2001; R 2006) Standard for Metal-Enclosed Interrupter Switchgear
IEEE C37.20.7	(2007) IEEE Guide for Testing Metal-Enclosed Switchgear Rated up to 38 kV for Internal Arching Faults
IEEE C57.12.00	(2010) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.10	(2010; Errata 2012) Standard for Transformers 230 kV and Below 833/958 through 8333/10,417 kVA, Single-Phase, and 750/862 through 60,000/80,000/ 100,000 kVA, Three-Phase Without Load Tap Changing; and 3750/4687 through 60,000/80,000/100,000 kVA With Load Tap Changing - Safety Requirements

IEEE C57.12.28	(2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2010) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(2008) Standard Requirements for Instrument Transformers
IEEE C57.96	(1999; R 2005) Guide for Loading Dry-Type Distribution and Power Transformers
IEEE C57.98	(1993; Errata 1998; R 1999) Guide for Transformer Impulse Tests

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

IPC-CC-830B	(2002; 2008 Amd 1) Qualification and Performance of Electrical Insulating Compound for Printed Wiring Assemblies

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering
ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA C37.06	(2000) AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568-C.3	(2008; Corrections 2008) Optical Fiber Cabling Components Standard

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-90/027F	(1993) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms
EPA 712-C-98-075	(1996) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"

UNDERWRITERS LABORATORIES (UL)

UL 1666	(2007; Reprint May 2011) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
UL 467	(2007) Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS and Section 26 08 00 APPARATUS INSPECTION AND TESTING apply to this section, with the 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 Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES in sufficient detail to demonstrate full compliance with the specification:

SD-02 Shop Drawings

All Shop Drawings shall be computer aided design (CAD) generated. With each submittal provide a CD with a complete copy of the drawings in PDF format.

Submit Shop Drawings for approval prior to equipment manufacturing.

Submit Connection Diagrams in accordance with paragraph entitled, " Primary Unit Substation Drawings," of this section.

Submit Fabrication Drawings in accordance with paragraph entitled, "Primary Unit Substation Drawings," of this section.

Submit Installation Drawings for the secondary unit substation in accordance with the paragraph entitled, "Installation," of this section.

Primary unit substation drawings; G

Weatherproof prefabricated housing drawings; G

KCCS integration design drawings; G

Communications interconnection diagrams; G

DC power supply drawings; G

Transformer drawings; G

Submit "As-Built" Shop Drawings after installation, inspection and testing is complete which document all field changes made. Provide Digital media compact disc (CD) with all submittals including .DWG or .DXF CAD source files as well as PDF format files for all drawings.

SD-03 Product Data

Primary unit substation; G

Weatherproof prefabricated housing; G

Circuit breaker; G

Breaker lifter; G

Auxiliary ground and test device; G

Insulating kits for cable terminations; G

Transformer; G

Transformer accessories; G

Protective relays, SEL-351A, SEL-387-0, SEL-351S; G

Communication processor and equipment, SEL-3530, SEL-2800M, SEL-2812MT, and SEL-9220; G

System GPS clock, SEL-2407; G

DC power supply; G

Unmanaged Ethernet switch; G

Control, transfer and selector switches; G

Lockout Relays; G

Instrument transformers; G

Space heaters; G

Pilot and indicating lights; G

Lightning arresters; G

Electrical Power Monitoring System; G

Laptop computer (including all software installed thereon on original manufacturer's media, and list of software); G

Submittal shall include manufacturer's information for each component, device and accessory provided with the equipment.

Submittal Equipment Foundation Data for Primary Unit Substation equipment in accordance with paragraph entitled, "General Requirements," of this section.

SD-04 Samples

Color chips and colors for prefabricated housing; G

SD-05 Design Data

Capacity calculations for battery charger and batteries; G

Capacity Calculations for each AC Control Power Transformer; G

SD-06 Test Reports

Submit report of results of acceptance checks and tests specified by paragraph entitled, "Source Quality Control"; G

Submit report of results of acceptance checks and tests specified by paragraph entitled, "Field Quality Control"; G

Submit report of results of communication processor configuration tests specified by paragraph entitled, "Communication Processor Configuration Tests"; G

SD-07 Certificates

Tested Transformer Losses; G

Citect SCADA integrator qualifications; G

SD-08 Manufacturer's Instructions

Primary unit substation; G

Transformer; G

Protective relays; G

Communication processor and equipment; G

DC power supply; G

SD-09 Manufacturer's Field Reports

Switchgear design tests; G

Switchgear production tests; G

Transformer design tests; G

Transformer routine and other tests; G

Substation paint qualification test; G

Weatherproof prefabricated housing paint qualification test; G

Communication processor and equipment configuration tests; G

Circuit breaker power factor tests; G

Integral assembly test; G

SD-10 Operation and Maintenance Data

Primary unit substations, Data Package 5; G

Transformer, Data Package 5; G

Protective relays, Data Package 5; G

Communication processor and equipment, Data Package 5; G

DC power supply, Data Package 5; G

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Calibration schedule; G

Formal request for settings; G

Equipment test schedule; G

1.4 SERVICE CONDITIONS

1.4.1 General Requirements

Items provided under this section shall be specifically suitable for the following service conditions:

a. Ambient Temperature: (50 degrees C) 120 degrees F

b. Frequency: 60 Hz

c. Humidity Control

d. Hurricane Force Winds

e. Salt Fog Corrosive Atmosphere

1.4.2 Humidity Control

Provide thermostatically and humidistatically controlled space heaters inside each section/cubicle of the substation as required to preclude the buildup of condensation within the substation.

1.4.3 Hurricane Force Winds

Substation housing and associated substructure shall be of sufficient construction to withstand a Basic Wind Speed of 130 mph (3 sec. gust) without physical damage due to wind loading or wind driven rain water infiltration.

1.5 QUALITY ASSURANCE

1.5.1 Battery and AC Control Power Transformer Calculations

Submit capacity calculations for battery charger and batteries. Calculation shall verify that battery capacity exceeds station DC power requirements.

Submit capacity calculations for each AC control power transformer. Calculation shall verify that control power transformer capacity exceeds the station AC power requirements.

Each individual DC power supply system, A-Side or B-Side, shall be capable of powering all substation loads, both A-Side and B-Side.

1.5.2 Transformer Efficiency and Factory Tests

Submit transformer efficiency calculations from the manufacturer indicating conformance with the paragraph entitled, "Specified Transformer Efficiency."

Provide manufacturer certification that the insulating oil contains no PCB's and affix a label to that effect on the transformer tank and on each oil drum containing the insulating oil.

Ship no transformer to the site until all factory tests and their results are approved by the Contracting Officer and the equipment is inspected and approved by the Contracting Officer unless he has given the manufacturer a written waiver.

1.5.3 Primary Unit Substation Drawings

Drawings shall include, but are not limited to the following for primary unit substation and transformer equipment:

a. Connection Diagrams for Incoming Section, Power Transformer, Outgoing Section, DC power supply, and all ancillary equipment provided. Provide Connection Diagrams that indicate the relations and connections of the following items by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

b. Fabrication Drawing for Incoming Section, Power Transformer, Outgoing Section, DC power supply, and all ancillary equipment provided. Provide Fabrication Drawings that consist of manufacturers original fabrication and assembly details to be performed at the factory for the Project.

c. Provide Equipment Foundation Drawings for power Incoming Section, Power Transformer, Outgoing Section, DC power supply, and all ancillary equipment provided that includes plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal

and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

d. An outline drawing with front, top, and side views.

e. Ampere ratings of bus bars.

f. Maximum short-circuit bracing.

g. Nameplate data.

h. Transformer forced air equipment.

i. Circuit breaker type(s), interrupting ratings, protective relays, current transformers, and potential transformers.

j. Bus-tie and related provisions.

k. DC power supply.

l. Neutral grounding resistor.

m. Elementary diagrams and wiring diagrams with terminals identified and indicating prewired interconnections between items of equipment and the interconnection between the items.

n. One-line and three-line diagrams, including circuit breakers, protective relays, current transformers, potential transformers, meters, and fuses.

o. Logic schematics and control interconnection diagrams detailing all the interconnections between protective relays, instrument transformers, metering, space heating, and circuit breaker operating mechanisms.

p. Communications interconnection diagrams detailing all the interconnections between the communication processor and equipment, protective relays, power meters, switches, and gateways. The diagrams shall include cable types, port assignments, and communication port settings where applicable.

1.5.4 Calibration Schedule

Provide a calibration schedule including the anticipated dates when equipment requiring coordination and protection will be installed, the anticipated date when the Contractor will submit a formal request for settings, and the anticipated date when the manufacturer's technical representative will perform settings and calibrate equipment.

1.5.5 Power System Analysis and Protective Relay Settings

a. Provide power system analysis, arc-flash studies, and protective relay settings for all equipment specified in this section shall be in accordance with Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS.

b. Protective relay settings, based on the Contractor's final approved power system analysis and recommended relay settings, will be provided by the Contracting Officer. Submit a formal request for settings 30 days in advance of the field acceptance tests.

c. The equipment requiring protection and coordination shall be installed prior to making this request.

d. Communication processor settings will be provided by the Contractor and downloaded prior to the factory acceptance tests. Settings shall include configuration settings for KCCS and the existing SEL-5040 report server. A shop drawing detailing the settings shall be submitted and approved by the Contracting Officer prior to downloading.

1.5.6 Final Substation Shop Drawings

After the substation has been manufactured and acceptance tests have been completed, the substation manufacturer shall submit a Final Substation Shop Drawings as-built set of substation drawings documenting any changes to the Contracting Officer for approval. Provide two CDs containing the complete set of the as-built drawings in CAD source file and pdf format.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

In addition to requirements of Data Package 5, include the following on the actual primary unit substations provided:

a. An instruction manual with pertinent items and information highlighted.

b. An outline drawing, including front view and sectional views with items and devices identified.

c. Prices for spare parts and supply list.

d. Routine and field acceptance test reports.

e. Information on metering.

f. Fuse data including time-current-curves.

g. Actual nameplate diagram.

h. Date of purchase.

1.7 DEFINITIONS

The Kennedy Complex Control Systems (KCCS) is a combination of hardware and software components that are used to monitor and control power, HVAC, water and waste, and pneumatic utilities across the Kennedy Space Center.

Citect SCADA is an industrial control Supervisory Control and Data Acquisition (SCADA) software application that is used to monitor and control the I/O devices connected to the KCCS network. The Citect SCADA application provides the Human Machine Interface (HMI) to display, trend, alarm and control, and/or monitor the I/O points connected to or through the I/O devices. Information is transferred to and from the Citect SCADA server over a dedicated Ethernet controls network using Modbus TCP/IP as the preferred transportation protocol.

1.8 MANUFACTURER QUALIFICATIONS

Material and equipment to be provided under this specification shall be the standard catalog product of a manufacturer regularly engaged in the manufacture of primary unit substation assemblies and their component parts and equipment. Equipment shall be of the latest standard design and shall have been in repetitive manufacture for at least 50 units.

1.9 Citect SCADA INTEGRATOR QUALIFICATIONS

Submit documentation of Citect SCADA integrator qualifications demonstrating experience with Citect SCADA use in power systems. Submittal shall include sample Citect SCADA graphical process visualization and user interface screens with power systems related elements prepared by the proposed integrator.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be primary unit substations and related accessories are specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 PRIMARY UNIT SUBSTATIONS

IEEE C37.121, arrangement as indicated, consisting of an incoming section, a transformer, an outgoing section with bus-tie, auxiliary sections, and DC power supply. Switchgear shall be listed and labeled by the manufacturer as suitable for use as service equipment. The incoming and outgoing sections of the substation shall be of indoor construction, installed inside a prefabricated custom walk-in style weather-tight corrosion-resistant housing. Two separately housed single-ended arrangement substations, each with a bus-tie, shall be connected together as shown on the drawings, to form a double-ended arrangement. The housing shall be designed for outdoor service with ventilation openings and gasketing provided to ensure a weather-tight assembly under rain, snow, sleet, corrosive atmospheres, and hurricane conditions. The housing shall include hinged external rear doors to provide unfettered access to the cable terminations in the rear of each incoming and outgoing section without requiring the removal of any bolts. There shall be no other barriers between the cable terminations and the external rear doors. External doors shall have handles/latching mechanisms with provisions for padlocking. The transformer and associated DC power supply shall receive the same paint finish as that specified for the housing.

2.2.1 Incoming Section

The incoming section shall consist of 15kV metal-clad switchgear for connecting the incoming circuit through a circuit breaker to the transformer. Connection between circuit breaker and transformer shall be via cables as indicated on the drawings.

Mount incoming section within the enclosure housing the outgoing section as indicated on the drawings.

2.2.1.1 Metal-Clad Switchgear

Switchgear shall conform to IEEE C37.20.2 for metal-clad medium voltage

vacuum circuit breaker type, insulated for 15kV for use on 13.2kV system. The switchgear shall also meet the requirements of IEEE C37.20.7, Accessibility Type 2 (arc-resistant functionality at the front, rear, and sides of the switchgear), Suffix B (arc-resistant functionality maintained in low-voltage compartments), Suffix C (arc-resistant functionality in compartments adjacent to the compartment in which the arc occurs), arc-resistant switchgear. The steel unit, 14 gage minimum, forming part of the switchgear structure shall be self-contained and shall enclose separate compartments for the circuit breaker, incoming and outgoing cable terminations, main bus, and instrument compartments. Equip circuit breaker compartment with drawout contacts, rails, disconnecting mechanism, and a cell interlock to prevent moving the removable element into or out of the "connected" position while the circuit breaker is closed. Provide front steel hinged doors with multi-point latching system for circuit breaker compartment. Provide laminated plastic nameplates for each relay, switch, meter, device, and cubicle to identify its function. Provide permanent labels for wiring and terminals corresponding to the designations on approved shop drawings. Mount nameplates on each circuit breaker compartment door using stainless steel screws.

a. Phase buses and connections: Mount bus structure on insulated supports of high-impact, non-tracking, high-quality insulating material and brace bus to withstand the mechanical forces exerted during short-circuit conditions when connected directly to a source having a maximum rating of 20 kA rms symmetrical available. Bus bars shall be rated 1200A, shall be insulated and shall be high conductivity copper having silver plated joints. Bus bar connections shall utilize silicon bronze hardware, made with a calibrated torque wrench, and shall be insulated. Equip circuit breaker line-and load-side studs with copper NEMA 2-hole pattern cable pads suitable for the quantity and size of incoming and outgoing cables shown on the drawings. Provide cable supports for the incoming and outgoing cables and heat- or cold- shrink insulating kits for all cable termination locations. Wire secondary circuits including heater circuits, to terminal blocks. Terminal blocks shall be readily accessible for making external connections as required.

b. Ground bus: Provide a copper ground bus sized for full short-circuit capacity of the system. Secure ground bus to each vertical structure and extend ground bus the entire length of switchgear. Include provisions for making the station ground connections.

c. DC bus: Provide an insulated copper bus or wire extending the entire length of switchgear. Bus shall be rated 100 amperes at 125 volts dc. Provide pull-out fuse block to circuit breaker open and close circuits.

d. AC control power bus: Provide an insulated copper bus extending the entire length of switchgear. Bus shall be rated 150 amperes minimum at 600 volts ac. Provide pull-out fuse block or circuit breakers to space heater or other auxiliary equipment.

e. Circuit breaker compartment shall have provisions for mounting up to four sets of ANSI rated current transformers, two on line-side and two on load-side of circuit breaker.

f. PTs: Provide 3-phase draw-out PTs as indicated with primary fuses and secondary fuses.

g. Provide one set of three lightning arresters, one per phase, on the

line-side of the incoming cable termination position of the incoming section. Mount these lightning arresters in the incoming cable termination sub-compartment of the incoming section. Each lighting arrester shall be heavy duty distribution class, of polymer construction, with the following protective and insulation characteristics:

Protective Characteristics									
Rated Voltage (kV)	MCOV (kV rms)	0.5 usec. 10kA Max. IR (kV)	500A Switching Surge Max. IR (kV)	8/20 Max. Discharge Voltage (kV Crest)					
				1.5kA	3kA	5kA	10kA	20kA	40kA
15	12.7	54.2	35.0	38.4	41.0	43.4	48.0	54.6	64.2

Insulation Characteristics					
Rated Voltage (kV)	Creep (in.)	Strike (in.)	Minimum 1.2 x 50 msec. Withstand (kV Crest)	Minimum Power Frequency (kV rms)	
				Wet (10 sec.)	Dry (1 sec.)
15	26.0	9.7	125	65	45

Switchgear shall be metal-enclosed in accordance with the paragraph "Corrosion Protection," and shall be installed inside a walk-in housing in accordance with paragraph "Housing." Incoming section shall be front and rear aligned with itself and the outgoing section.

2.2.1.2 Circuit Breaker

Circuit breaker shall be a vacuum type, electrically operated, three-pole circuit interrupting device rated as indicated at maximum voltage of 15kV and 95kV BIL. Breaker shall be sized for 1200A and be designed for service on a 13.2kV system with a short-circuit capacity of not less than 20 kA rms symmetrical. Rating shall be based on IEEE C37.04 and NEMA C37.06. Breaker opening speed shall not exceed 3-cycles (50 ms), and breaker closing speed shall be less than 4.8-cycles (80 ms). Circuit breaker shall be drawout-mounted with position indicator, operation counter, auxiliary switches, truck switches, mechanism operated contacts, latch check switches, and primary and secondary disconnect devices. Circuit breaker shall be operated by an electrically charged, mechanically and electrically trip-free, stored-energy operating mechanism. Provide manually operated trip and close controls. Provide for manual charging of the mechanism and for slow closing of the contacts for inspection or adjustment. Circuit breaker control voltage shall be 125 volts dc.

a. Contacts: Silver-plated, multifinger, positive pressure, self-aligning type for main drawout contacts.

b. Drawout circuit breaker shall be provided with three-position operation. The connected position and the test/disconnect position shall be clearly identified by an indicator on the circuit breaker front panel. In addition, breaker truck switches shall be wired in series or parallel with each mechanism operated contact used in control

sequences such that control sequences consider breaker position.

1. Connected position: Contacts are fully engaged. Circuit breaker shall be tripped before it can be racked into or out of this position.

2. Test/disconnect position: Position shall allow for complete testing and operation of the circuit breaker without energizing the primary circuit.

3. Withdrawn (removed) positions: Places circuit breaker completely out of compartment, ready for removal.

c. Each circuit breaker shall be equipped with color-coded 125 volt dc LED pilot type indicating lights as follows:

1. Breaker Open - Green.

2. Breaker Closed - Red.

3. Control Power On - Red.

4. Automatic Mode - Blue.

5. Manual Mode - White.

6. Auto Lockout - Amber.

2.2.1.3 Compartment Details

Compartments shall be completely wired with cable terminals, cable lugs, control bus, control power switch, fuse and terminal blocks. Terminal blocks shall be readily accessible for the external connections of metal-clad switchgear. Access to all compartments shall be via hinged doors.

Low voltage wiring for controls, metering, relaying and accessories shall be run to terminal blocks.

All switchgear components, including but not limited to fuse blocks, pushbuttons, selector switches, indicating lights and terminal blocks, shall have a unique designation by section/cubicle. A label with minimum 1/4-inch high lettering with the device designation shall identify the device. Wiring between sections/cubicles shall identify the end devices by "section/cubicle number and device designation."

Terminal blocks shall have engraved plastic terminal strips with screw type terminals having letter designations and numbered terminal points. Terminal blocks in each section/cubicle used for the same wiring as the adjacent sections/cubicles shall have the same letter designation preceded by the section/cubicle number. Terminal blocks associated with current transformers shall be short-circuiting type. Terminal blocks with sliding links will not be allowed. Terminal blocks for multi-ratio current transformers shall be wired with all taps and ground, one terminal block per current transformer. CT Tap jumpers shall not be located on the same side as the leads from the CT. Wiring shall be SIS Class insulation, sized #14 AWG for control, #12 AWG for potential leads, and #10 AWG for current leads. Terminate all conductors with compression ring terminal lugs. Male/female spade or forked connectors shall not be used. Final conductor

leads for terminations on the space heaters shall be a minimum of 150 degrees high temperature wiring.

Wire marking for controls, metering, relaying, and accessories conductors shall be at both ends. Wire markers shall be white plastic tubing heat stamped with black block type letters. All wire markers shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached, as well as the terminal number to which the wire is directly attached (near end/far end marking).

An identification plate engraved with circuit and function designations shall identify each compartment of the substation assembly.

Removable elements of the same type and rating in the substation assembly shall be physically and electrically interchangeable in corresponding compartments.

2.2.2 Transformer Primary Terminal Chamber

Transformer primary terminal chamber shall be a 304 stainless steel compartment for enclosing the transformer primary bushings, and line-side cables and terminations. Transformer primary terminal chamber shall have a removable panel(s), providing access for inspection, operation, and maintenance activities in connection with the items enclosed therein, shall have insulated supports for transformer line-side cables to minimize torsional stress on transformer primary bushings, and shall have provisions for making ground connections. Cable supports shall be suitable for the quantity and size line-side cables shown on the drawings.

2.2.3 Transformer Section

IEEE C57.12.00. Less-flammable liquid-insulated, two winding, 60 hertz, (55 degrees C rise above a 30 degrees C) 131 degrees F above an 86 degrees F average ambient at base MVA rating, (65 degrees C rise above a 30 degrees C) 149 degrees F rise above an 86 degrees F average ambient at 112 percent of base MVA rating, self-cooled type (KNAN) with provisions for future forced air type (KNAF) cooling, and neutral grounding resistor (NGR).

2.2.3.1 Tank

Provide transformer tank with walls, bottom, and cover fabricated from hot-rolled 304 stainless steel plate with cooling tubes or radiators vertically mounted to the side walls of the tank.

Provide transformer tank that is welded construction with rectangular base designed for rolling in the direction of the centerline of the bushing segments.

Provide lifting, moving, and jacking facilities conforming to IEEE C57.12.10.

Provide tank that has a handhole in the cover. Provide circular handholes that are not less than 6 inches diameter. Provide rectangular handholes that are not less than 4-1/2 inches wide and that have an area of not less than 65 square inches.

Provide transformer base that is designed to provide natural draft ventilation under the transformer tank when the transformer is placed on a flat concrete foundation. Undercoat the bottom of the transformer tank with a protective sealing material.

Weld cooling tubes into headers which in turn are welded into the transformer tank well.

2.2.3.2 Bushings

Terminate primary and secondary windings of the transformer in sidewall bushings enclosed within weathertight terminal chambers. Connection between terminal chambers and transformer shall be via throats or flanges that are an integral part of the transformer.

a. Primary Bushings

Provide two 15kV 600 amp dead-front dead-break bushings per phase for terminating line-side cables.

b. Secondary Bushings

Provide phase and neutral 5kV spade type cable terminal bushings with NEMA 2-hole spacing and arrangement suitable for cable quantities indicated on the drawings based on a 2-hole lug per cable. Provide insulating boots to completely cover un-insulated transformer cable terminals, and cable lugs connections.

2.2.3.3 Cores and Coils

Provide cores that are built up with laminated, nonaging, high-permeability, grain-oriented, cold-rolled, silicon sheet steel. Provide laminations that are coated with an insulating film or finish to minimize eddy-current losses. Provide sheet steel that conforms to ASTM A345.

Provide high- and low-voltage coil sections that consist of insulated copper conductors would around the core. Provide coil sections that counteract forces incurred under short-circuit conditions and provide with oil ducts to dissipate the heat generated in the windings. Provide coil sections that are electrically connected together and to the respective terminal bushings of the transformer.

Provide primary winding of the transformer that is equipped with four 2.5 percent full-capacity taps, two above and two below normal voltage, brought out to an externally operated manual tap changer. Provide tap changer handle that is capable of being padlocked in each tap position and is operable when the transformer is deenergized.

2.2.3.4 Cooling Provisions

Provide radiators that are detachable all-welded 304 stainless steel construction, with top and bottom connections to the transformer tank wall. Provide tank wall top and bottom connections to radiators that are equipped with valves that permit removal of radiator without draining oil from the transformer tank.

Provide thermally operated control device that consists of a hot-spot temperature relay with thermal element mounted in a well and a bushing type current transformer. Add energy from the current transformer to the top oil temperature of the transformer to indicate the simulated hot-spot condition in one phase of the transformer winding.

Connect manually operated bypass switch in parallel with the automatic control contacts. Provide fan motors that are 230-volt, single-phase, 60-hertz, without centrifugal switch and are individually fused and thermally protected.

2.2.3.5 Transformer Ratings

a. Transformer shall be rated 7.5/8.4 MVA at (55/65 degrees C) 131/149 degrees F for cooling class KNAN, 9.4/10.5 MVA at (55/65 degrees C) 131/149 degrees F for cooling class KNAF, 95kV BIL primary, 60kV BIL secondary.

b. Transformer voltage ratings: 13.2kV - 4.16 Y/2.4kV.

c. Tested impedance shall be between 6.0125 and 6.5 percent at (75 degrees C) 167 degrees F.

d. Audible sound levels shall not exceed 68 dB maximum.

e. Transformer shall have the following accessories:

1. Diagrammatic stainless steel or laser-etched anodized aluminum nameplate.

2. Ground pads. The transformer shall have an insulated low-voltage neutral bushing with copper cable pad for connecting the grounding resistor cable.

3. Liquid-level indicator with low level alarm dry contacts for remote monitoring.

4. Pressure-vacuum gauge with pressure and vacuum alarm dry contacts for remote monitoring.

5. Dial type liquid temperature indicator with (60 degrees C) 140 degrees F warning dry contact and (90 degrees C) 194 degrees F alarm dry contact for remote monitoring.

6. Drain and filter valves.

7. Pressure relief device with alarm dry contact for remote monitoring.

8. Rapid pressure rise relay with a seal-in relay panel and alarm dry contact for remote monitoring.

9. Winding temperature indicator with alarm dry contact for remote monitoring.

10. Automatically controlled fans for forced-air-cooling.

11. Nitrogen fill valve to be located above the transformers liquid level.

12. External Wiring Connection

Group fan controls and wiring connections in a NEMA 4X Type 316 stainless steel weatherproof cabinet located on the side of the transformer at a height not greater than 60 inches above the

concrete foundation. Group together all externally powered wiring as possible and connect to a terminal block which is marked with a laminated plastic nameplate having 3/16-inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

Provide terminal strips for all external connection wiring that includes space heaters, alarm devices, fans, and instrumentation circuits.

2.2.3.6 Specified Transformer Efficiency

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformers prepared for this project. No-load losses (NLL) shall be referenced at (20 degrees C) 68 degrees F. Load losses (LL) shall be referenced at (55 degrees C) 131 degrees F and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than 99.50 percent.

2.2.3.7 Insulating Liquid

Insulating liquid shall be less-flammable type conforming to NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than (300 degrees C) 572 degrees F tested per ASTM D 92 and a dielectric strength not less than 33kV tested per with ASTM D 877. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate. The fluid shall be a biodegradable electrical insulating and cooling liquid classified by UL and approved by FM as "less flammable" fluids. The fluid shall meet the following fluid properties:

a. Pour point: ASTM D 97, less than (-15 degrees C) 5 degrees F.

b. Aquatic biodegradation: EPA 712-C-98-075, 100 percent.

c. Trout toxicity: OECD Test 203, zero mortality of EPA 600/4-90/027F, pass.

2.2.3.8 Neutral Grounding Resistor (NGR)

The neutral grounding resistor assembly shall comply with IEEE 32 and shall be factory-mounted on top of the associated transformer. The assembly shall meet the following:

a. The resistor element shall be stainless steel and rated 400A for a 10-second duty, 2.4kV L-N, and (760 degrees C) 1400 degrees F.

b. The resistor shall be installed in an aluminized screened or expanded 304 stainless steel enclosure of the personnel safety type and shall be provided with any necessary supports and mounting hardware. The enclosure, including screening and support framing, shall have two finish coats applied over a prepared substrate. The color of the finish coats shall be the same as the color of the associated transformer.

c. A stress-relief terminator shall be provided and arranged to permit the proper termination of the No. 4/0 AWG, 5kV shielded transformer neutral

cable entering the enclosure as recommended by the manufacturer. If the terminal bushing is external to the enclosure, the bushing and terminal provisions shall be enclosed by a solid metal cable box equipped with conduit fittings correctly sized for the conduit required. An approved type and size of terminal lug shall also be provided and arranged for the field termination of the No. 4/0 AWG bare copper grounding cable entering the enclosure from the bottom.

d. One current transformer conforming to the requirements of paragraph Instrument Transformers shall be provided and housed in the resistor enclosure. The current transformer shall have the ratio shown and be connected as indicated to the associated overcurrent relay, device 51G, located in the outgoing section. The terminals of the current transformer shall be wired with not less than No. 10 AWG conductors to the proper terminals of device 51G through a short-circuiting type of terminal block and test block located in the outgoing section.

2.2.4 Transformer Secondary Terminal Chamber

Transformer secondary terminal chamber shall be a 304 stainless steel compartment for enclosing the transformer secondary bushings, and load-side cables and terminations. Transformer secondary terminal chamber shall have a removable panel(s), providing access for inspection, operation, and maintenance activities in connection with the items enclosed therein, shall have insulated bushing and cable supports for transformer load-side bushings and cables, respectively, to minimize the torsional stress on transformer secondary bushings, and shall have provisions for making ground connections. Bushing and cable supports shall be suitable for the quantity and size load-side cables shown on the drawings.

2.2.5 Outgoing Section

Outgoing section shall consist of multiple metal-clad switchgear sections for connecting the transformer through to the outgoing feeder cables and bus-tie as indicated on the drawings. Connection between transformer and outgoing section main bus shall be via cables as indicated on the drawings. Bus-tie between adjacent substations outgoing sections shall be via cables as indicated on the drawings.

2.2.5.1 Metal-Clad Switchgear

Switchgear shall conform to IEEE C37.20.2 for metal-clad medium voltage vacuum circuit breaker type, insulated for 5kV for use on 4.16kV system. The switchgear shall also meet the requirements of IEEE C37.20.7, Accessibility Type 2BC, for arc resistant switchgear with suitable construction at the front, back and sides and between adjacent cells. Each steel, 14 gage minimum, unit forming part of the switchgear structure shall be self-contained and shall enclose separate compartment for the circuit breakers (two-high construction) instrument compartments, full height center and rear compartment for the line-side buses and outgoing cable connection compartments. For two-high breaker units, provide a removable metal barrier to separate the two cable circuits. Equip individual circuit-breaker compartments with drawout contacts, rails, disconnecting mechanism, and a cell interlock to prevent moving the removable element into or out of the "connected" position while the circuit breaker is closed. Provide front steel hinged doors with multi-point latching system for each breaker compartment. Design the structure to allow for future additions. Provide laminated plastic nameplates for each relay, switch, meter, device, and cubicle to identify its function. Provide permanent

labels for wiring and terminals corresponding to the designations on approved shop drawings. Mount nameplates on each circuit breaker compartment door using stainless steel screws.

a. Phase buses and connections: Mount bus structure on insulated supports of high-impact, non-tracking, high-quality insulating material and brace bus to withstand the mechanical forces exerted during short-circuit conditions when connected directly to a source having maximum 40 kA rms symmetrical available. Bus bars shall be rated 2000A, shall be insulated and shall be high conductivity copper having silver plated joints. Bus bar connections shall utilize silicon bronze hardware, be made with a calibrated torque wrench, and shall be insulated. Make bus bar connections from main buses to the circuit breaker line-side studs. Equip circuit breaker load-side studs with copper NEMA 2-hole pattern cable pads suitable for the quantity and size of outgoing cables shown on the drawings. Provide cable supports for outgoing cables and heat- or cold- shrink insulating kits for all cable termination locations. Wire secondary circuits, including heater circuits, to terminal blocks. Terminal blocks shall be readily accessible for making external connections as required.

b. Ground bus: Provide a copper ground bus sized for full short-circuit capacity of the system. Secure ground bus to each vertical structure and extend ground bus the entire length of switchgear. Include provisions for making the station ground connections.

c. DC bus: Provide an insulated copper bus or wire extending the entire length of switchgear. Bus shall be rated 100 amperes at 125 volts dc. Provide pull-out fuse block to each circuit breaker open and close circuits.

d. Main bonding jumper: Provide removable main bonding jumper bus bar of suitable size, between the neutral terminals and ground bus.

e. AC control power bus: Provide an insulated copper bus or wire extending the entire length of switchgear. Bus shall be rated 150 amperes minimum at 600 volts ac. Provide pull-out fuse block or circuit breakers to equipment requiring AC power for proper operation.

f. Each circuit breaker compartment shall have provision for mounting up to four sets of ANSI rated current transformers, two on line side and two on load side of each circuit breaker. Provide current transformers as indicated on the drawings and Section 26 05 71.00 40 OVERCURRENT PROTECTIVE DEVICES.

g. PTs: Provide 3-phase, wye-connected (3 transformer), draw-out PTs with drawer mounted primary fuses and pull-out fuse block mounted secondary fuses as indicated.

h. CPT: Provide 25kVA, 4.16kV single-phase primary to 120/240 V ac single-phase secondary transformer to serve the primary unit substation ac loads. Transformer shall be designed for continuous operation at rated kVA 24 hours a day, 365 days a year with normal life expectancy as defined in IEEE C57.96. Dry-type, two-winding type, (115 degrees C) 239 degrees F rise above (40 degrees C) 104 degrees F maximum ambient, with copper windings, designed for mounting in switchgear cubicle or drawer. Provide drawout-mounted, current limiting transformer primary fuses rated for the specified transformer size and the available short-circuit current. Provide 125A, 2-pole, 10kAIC rated

thermal-magnetic molded-case transformer secondary main circuit breaker and distribution panelboard to individually supply all substation loads indicated or required.

i. Provide one set of three lightning arresters, one per phase, on the load-side of each outgoing feeder cable termination position of the outgoing section. Mount these lightning arresters in the feeder cable termination sub-compartment of the outgoing section. Each lightning arrester shall be heavy duty distribution class, of polymer construction, with the following protective and insulation characteristics:

Protective Characteristics									
Rated Voltage (kV)	MCOV (kV rms)	0.5 usec. 10kA Max. IR (kV)	500A Switching Surge Max. IR (kV)	8/20 Max. Discharge Voltage (kV Crest)					
				1.5kA	3kA	5kA	10kA	20kA	40kA
6	5.1	25.0	16.0	19.0	20.0	21.0	22.0	26.0	30.5

Insulation Characteristics					
Rated Voltage (kV)	Creep (in.)	Strike (in.)	Minimum 1.2 x 50 msec. Withstand (kV Crest)	Minimum Power Frequency (kV rms)	
				Wet (10 sec.)	Dry (1 sec.)
6	15.4	6.7	75	45	35

Switchgear shall be metal-enclosed with an overall skin enclosure in accordance with the paragraph "Corrosion Protection," and shall be installed inside a separate walk-in housing in accordance with the paragraph "Housing." Outgoing section shall be front and rear aligned with itself and the incoming section.

2.2.5.2 Circuit Breaker

Each circuit breaker shall be a vacuum type, electrically operated, three-pole, circuit interrupting device rated as indicated at maximum voltage of 5kV and 60kV BIL. Breaker shall be sized for 2000A or 1200A, as indicated on the drawings. Breakers rated 2000A, used for main and tie breakers, shall be designed for service on a 4.16kV system with a short-circuit capacity of not less than 25kA rms symmetrical. Breakers rated 1200A, used for feeder breakers, shall be designed for service on a 4.16kV system with a short-circuit capacity of not less than 40kA rms symmetrical. Rating shall be based on IEEE C37.04 and NEMA C37.06. Breaker opening and closing speeds shall not exceed 3-cycles (50 ms) and 3.6-cycles (60 ms), respectively. Breaker frame size shall be as indicated. Circuit breaker shall be drawout-mounted with position indicator, operation counter, auxiliary switches, mechanism operated contacts, truck switches, latch check switches, primary and secondary disconnect devices, and pilot lights. Circuit breaker shall be operated by an electrically charged, mechanically and electrically trip-free, stored-energy operating mechanism. Provide manually operated trip and close controls. Provide for manual charging of the mechanism and for slow

closing of the contacts for inspection or adjustment. Circuit breaker control voltage shall be 125 volts dc.

a. Contacts: Silver-plated, multifinger, positive pressure, self-aligning type for main drawout contacts.

b. Each drawout breaker shall be provided with three-position operation. The connected position and the test/disconnect position shall be clearly identified by an indicator on the circuit breaker front panel. In addition, breaker truck switches shall be wired in series or parallel with each mechanism operated contact used in control sequences such that control sequences consider breaker position.

    1. Connected position: Contacts are fully engaged. Circuit breaker shall be tripped before it can be racked into or out of this position.

    2. Test/disconnect position: Position shall allow for complete testing and operation of the circuit breaker without energizing the primary circuit.

    3. Withdrawn (removed) positions: Places circuit breaker completely out of compartment, ready for removal.

c. Each circuit breaker shall be equipped with color-coded 125 volt dc LED pilot type indicating lights as follows:

    1. Breaker Open - Green.

    2. Breaker Closed - Red.

    3. Control Power On - Red.

    4. Automatic Mode - Blue.

    5. Manual Mode - White.

    6. Auto Lockout - Amber.

2.2.5.3 Space Only Compartments

Provide fully equipped with busing, control switch, indicating lights, overcurrent protection devices, and drawout breaker mounting and connecting straps to accommodate future circuit breakers. Provide compartments with doors.

2.2.5.4 Compartment Details

Compartments shall be completely wired with cable terminals, cable clamps, control bus, control power switch, fuse and terminal blocks. Terminal blocks shall be readily accessible for the external connections of metal-clad switchgear. Access to all compartments shall be via hinged doors.

Low voltage wiring for controls, metering, relaying, and accessories shall be run to terminal blocks.

All switchgear components, including but not limited to fuse blocks, pushbuttons, selector switches, indicating lights and terminal blocks,

shall have a unique designation by section/cubicle (i.e., A1, B1, A2, B2, this would be Bus A Device 1, Bus B Device 1, etc.). A label with minimum 1/4-inch high lettering with the device designation shall identify the device. Wiring between sections/cubicles shall identify the end devices by "section/cubicle number and device designation."

Terminal blocks shall have engraved plastic terminal strips with screw type terminals having letter designations and numbered terminal points. Terminal blocks in each section/cubicle used for the same wiring as the adjacent sections/cubicles shall have the same letter designation preceded by the section/cubicle number. Terminal blocks associated with current transformers shall be short-circuiting type. Terminal blocks with sliding links will not be allowed. Terminal blocks for multi-ratio current transformers shall be wired with all taps and ground, one terminal block per current transformer. CT Tap jumpers shall not be located on the same side as the leads from the CT. Wiring shall be SIS Class insulation, sized #14 AWG for control, #12 AWG for potential leads and #10 AWG for current leads. Terminate all conductors with compression ring terminal lugs. Male/female spade or forked connectors shall not be used. Final conductor leads for terminations on the space heaters shall be a minimum of 150 degrees high temperature wiring.

Wire marking for controls, metering, relaying and accessories conductors shall be at both ends. Wire markers shall be white plastic tubing heat stamped with black block type letters. All wire markers shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached, as well as the terminal number to which the wire is directly attached (near end/far end marking).

An identification plate engraved with circuit and function designations shall identify each compartment of the substation assembly.

Removable elements of the same type and rating in the substation assembly shall be physically and electrically interchangeable in corresponding compartments.

2.2.5.5 Auxiliary Section(s)

Auxiliary section(s) shall house the auxiliary power distribution system, control power distribution system, switchgear monitoring and control system, and relay management system. Each auxiliary section shall have a hinged front panel, main bus spanning the entire width of the section, main bus bar connections, and full capacity ground bus spanning the width of the section, and shall be equipped with barriers, terminal blocks, cabling/wiring, and cable/wire management as required.

a. DC Power Distribution System: Provide for the distribution of 125 volts dc from the station DC power supply to the substation loads. Each dc power supply shall be capable of supplying the entire double-ended arrangement substation load, both A-side and B-side substation sections. Provide a dc control power transfer scheme to transfer the entire dc control power load to the dc power supply remaining energized when the other of the two systems indicated is de-energized for maintenance.

b. Switchgear Monitoring and Control System: See the paragraph entitled "Switchgear Monitoring and Control System."

c. Relay Management System: See the paragraph entitled "Relay Management

System."

2.2.6 Breaker Lifter

Provide a portable lifter rated for lifting and lowering 15kV and 5 kV circuit breakers from two-high cubicles. Portable lifter shall have swivel casters in front for ease of movement.

2.2.7 Auxiliary Ground and Test Device

Provide electrically operated auxiliary ground and test device which can be installed into any breaker compartment, 15kV and 5kV, during maintenance. This device shall permit the solid grounding of the equipment and provide six test terminals on the front of the device for testing by qualified personnel. These terminals shall provide access to all three phases on both sides of the selected breaker compartment for phasing and other tests.

2.2.8 Mimic Bus

Provide mimic bus using 3/32-inch red plastic laminate. Mimic bus shall show breakers and bus. Fasten to switchgear using stainless steel screws.

2.2.9 Switchgear Monitoring and Control System

Provide a complete switchgear monitoring and control system that includes, but is not limited to, a protective relay based control system that monitors and controls remote devices, human machine interface (HMI), electrical power monitoring system, protective relays, device communications interface hardware, intercommunication wiring, software, startup and training services, and ongoing technical support. This system shall comply with the applicable portions of IEEE 802.3. Provide two licensed copies of all software and all hardware necessary to modify and download the operating programs to any equipment.

Main and tie-bus circuit breakers shall be electrically operated with capability to be both operated locally and remotely via KCCS. Main-Tie-Main (M-T-M) circuit breakers shall be electrically interlocked so that only two of the three breakers may be closed for any extended length of time by operation of the respective breaker closing.

Secondary main circuit breakers shall include under voltage and phase sequence relays with adjustable time delay.

Main and tie-bus circuit breakers shall be equipped with independent three-phase sync check relays, hardwired to main and tie-bus circuit breaker control schemes for fail safe operation.

All automatic transfer control functions shall be accomplished via the protective relay based control system. Circuit breakers shall remain in the last state if protective relay based control system is taken off-line.

All timing and control for automatic transfer shall be performed via the Schweitzer Engineering Laboratories model number SEL-351S three-relay main-tie-main (M-T-M) based control system. Auxiliary relays shall only be used where circuit breaker control circuit exceeds the rating of the relay system output contacts or to function as contact multipliers. Auxiliary relays shall only be used to directly connect one circuit breaker control circuit. Use of auxiliary relays to provide relay logic or timing functions is not permitted. Relays shall be industrial grade, octal based,

single tier with screw terminals, pilot light, retainer clip, vibration resistant 10 amp rated output contacts.

The switchgear transfer control shall be designed to auto transfer load on loss of power on either of the two sources and provide automatic re-transfer on source return after an adjustable time period. The re-transfer operation shall be selectable either open or closed transition locally or by the KCCS remote operator.

The local controls shall allow the user to enable/disable the automatic transfer function and initiate the selection of the desired unit substation modes of operation. Modes of operation are 'Automatic' or 'Manual' with re-transfer options for either 'Open' or 'Closed' transition.

Selection of 'Closed' transition also disables electrical interlock functions, specifically, circuit breakers can be configured such that all three (M-T-M) can be closed simultaneously for a limited duration. This protective function is intended to ensure the three circuit breakers are not closed for an extended duration.

The automatic transfer scheme shall follow the SEL Quickset Design Template Guide LDC0003-01. Programming of the relays and the processor shall be performed by Schweitzer Engineering Services.

2.2.9.1 Electrical Power Monitoring System

Where indicated, provide metering equipment to monitor energy usage on the circuit indicated. For compatibility, metering equipment shall be NASA KSC Standard, Schneider Electric Square D CM4250 with ECC21 Ethernet communications card, IOC input/output card, and CMDLC backlit LCD display, and no other. Provide metering appurtenances, including cables, as required for complete and proper operation. Metering equipment shall conform to Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Install metering equipment in accordance with the metering equipment manufacturer's published installation instructions. Mount metering equipment in strict accordance with the orientation recommendations of the metering equipment manufacturer. Mount LCD display on the front panel of the compartment containing the circuit being monitored.

2.2.9.2 Communications

a. Protective relay based control system shall provide for the exchange of data via Ethernet communications with the following:

   1. KCCS.
   2. Electrical Power Monitoring System (Modbus TCP/IP).

Provide industrial unmanaged Ethernet switch, N-TRON 309FX-ST or equal. Provide industrial media adapters as required. Ethernet communications that do not extend outside of switchgear shall employ 4-pair #23 AWG CAT6 UTP Type CM indoor/outdoor rated fully water blocked and sunlight resistant cable. Ethernet communications extending outside of switchgear shall employ 62.5/125 um multimode (OM1) indoor/outdoor all dielectric riser (OFNR) rated backbone fiber optic cable (FOC) conforming to ICEA S-104-696, TIA-568-C.3, UL 1666, and NFPA 70.

b. Provide the following discrete input monitoring points:

1. Secondary voltage monitors for secondary switchgear incoming line and outgoing bus.
2. Main circuit breaker status open/close/trip. Provide for both the primary main and the secondary main.
3. Tie-bus circuit breaker status open/close/trip.
4. Feeder circuit breaker status open/close/trip.
5. Automatic/Manual transfer mode status.
6. Transformers:
   i) Fans on/off operating status
   ii) Over temperature alarm
   iii) Pressure alarm
   iv) Vacuum alarm
7. Normal configuration.
8. DC power system status indication.
9. AC Auxiliary power status.

c. Provide the following discrete output control points:

1. Main circuit breaker open/close. Provide for secondary main only.
2. Tie-bus circuit breaker open/close.
3. Automatic/Manual transfer control function.
4. Feeder breaker open/close.

2.2.9.3 Sequence of Operation

The automatic transfer scheme shall follow the SEL QuickSet Design Template Guide LDC0003-01.

The Main-Tie-Main (M-T-M) transfer scheme shall be implemented by multifunction protective control relays and shall enable Automatic Operation and Manual Operation as described below, either selectable locally by protective/control relay front panel operator interface pushbuttons or remotely via KCCS. The M-T-M circuit breakers shall remain in their last state when the transfer mode is changed from Automatic to Manual. Overcurrent and under-voltage protection shall not be disabled in either mode.

Normal (operating) configuration is characterized by both main circuit breakers closed, the tie circuit open, and by Automatic Operating Mode and closed transition retransfer selected.

Any circuit breaker trip shall activate a separate lockout relay that electrically blocks any subsequent close operation, automatic or manual, for that breaker. If a main or tie breaker trips, block close circuits shall ensure that the faulted section cannot be re-energized from another source until the lockout relay is reset.

2.2.9.3.1 Automatic Operation

Automatic operation transfers shall occur only when the automatic scheme is enabled. Automatic Transfer shall be enabled or disabled either locally by protective/control relay front panel operator interface pushbuttons or remotely via KCCS.

Automatic Transfer operation shall be predicated on:

a. Both power sources are operational within user-defined specification and

b. The Main breakers are closed and racked in and

c. The Tie breaker is racked in and

d. No current breaker failure condition is detected and

e. Protective/Control relay communications are operating nominally

Automatic Transfer operation shall be disabled if:

a. The M-T-M circuit breakers' protective/control relays' Automatic Transfer statuses are inconsistent or

b. A current breaker failure condition is detected or

c. A non-manual trip or a trip associated with a current automatic transfer is detected or

d. Either main breakers' bus lockout signal is asserted

Automatic Transfer will be initiated if:

a. Voltage on one or more phases of one power source falls below a user-defined level for a user-defined time and

b. The decreased voltage level is not attributable to an overcurrent condition and

c. The main breaker associated with the bus sustaining the voltage decrease is closed and

d. The main breaker associated with the other power source is closed and

e. The tie breaker is open and racked in and

f. The Automatic Transfer Mode is enabled

The Tie Breaker will close if:

a. The main breaker associated with the bus sustaining the voltage decrease is open and

b. The decreased line to line bus voltage is below the user-defined dead source voltage set point and

c. The user-defined transfer time has expired

Automatic retransfer of load from the tie breaker back to the respective main breaker shall be capable of being enabled and disabled by the operator whenever the Automatic Transfer is enabled. If automatic retransfer is disabled, load remains connected through the tie breaker after an automatic transfer and must be manually transferred back to the respective main breaker. If automatic retransfer is enabled, load is automatically retransferred back to the respective main breaker after the respective power source has been restored within user-defined specification. Automatic Retransfer shall be enabled or disabled either locally by protective/control relay front panel operator interface pushbuttons or

remotely via KCCS.

Automatic Retransfer operation shall be predicated on all of the following:

a. Automatic Transfer is enabled and

b. The tie breaker is closed and

c. Protective/Control relay communications are operating nominally

Automatic Retransfer will be initiated if:

a. Automatic Retransfer is enabled and

b. The respective main breaker has tripped on Automatic Transfer or by live source seeking logic described below and

c. The voltage level of the source previously transferred from has been restored at or above a user-defined level for a user-defined time and

d. The tie breaker is closed and

e. The tie breaker relay has detected no bus faults and

f. The load bus voltage is in synchronism with the source or the load bus voltage level is below the user-defined dead bus level

The Tie Breaker shall open when the user-defined retransfer time has expired.

The transfer scheme shall incorporate logic that affords automatic recovery from a non-concurrent loss of both power sources in that the scheme will ensure the load is transferred to whichever power source is restored first, and that "backfeed" to the unrestored power source is prevented.

2.2.9.3.2 Manual Operation

The control scheme shall accommodate manual breaker operations either locally by protective/control relay front panel operator interface pushbuttons or remotely via KCCS. The local manual CLOSE operation shall be implemented by pressing the {CLOSE} pushbutton on the protection/control relay front panel thereby initiating a user-defined time delay to allow the operator to move away from the breaker prior to the breaker closing. Similarly, the breakers can be opened by pressing the {TRIP} pushbutton which initiates a user-defined time delay allowing operator repositioning.

A manually initiated main-tie-main transfer scheme shall provide for manual transfer of load to the tie breaker via closed or open transition.

Closed transition transfer to the Tie Breaker is enabled if:

a. The main breakers have not tripped due to a fault condition and either

b. Both power sources are operational within user-defined specification and in synchronism or

c. One power source is operational within user-defined specification

and the other power source voltage level is below the user-defined dead bus level

The tie breaker shall close and the main breaker that is selected to trip shall open.

Open transition transfer to the Tie Breaker is enabled if:

a. The main breaker selected to be tripped has opened and

b. The main breakers have not tripped due to a fault condition and

c. One power source is operational within user-defined specification and the other power source voltage level is below the user-defined dead bus level

The tie breaker shall close.

Closed transition transfer to the Main Breaker is enabled if:

a. Both the power source and load bus voltages are operational within user-defined specification and in synchronism or

b. The power source is operational within user-defined specification and the load bus voltage is below the user-defined dead bus level

The selected main breaker shall close and the tie breaker shall open.

Open transition transfer to the Main Breaker is enabled if the power source is operational within user-defined specification.

2.2.10 Protective Relays

2.2.10.1 Multi-Function Relays

Protective relays shall be Schweitzer Engineering Laboratories model number SEL-387-0 for transformer primary breakers and SEL-351S for transformer secondary and bus tie breakers, and SEL-351A for feeder breakers. All relay com ports shall be set at 19,200 baud rate, and all relays shall have the following options:

a. Relay shall have corrosion limiting finishes on all surfaces including circuit boards. Circuit board coating shall conform to specification IPC-CC-830B.

b. Relay shall have connectorized terminals. CT connector shall be the shorting type.

c. The relay shall include a front mounted integral display and have the capability to display custom messages.

d. The relay shall be connected to the real-time automation controller via a serial data port.

2.2.11 Relay Management System

The protective relays will be connected to the existing KSC Relay Management System through a local SEL-3530 real-time automation controller This system provides the user the ability to fully program the

relay, including making setting changes, either locally or remotely and has the ability to verify and compare relay settings in the relay with the settings stored in the system database. The system is capable of viewing real-time power system parameters (including kW, kVAR, Voltage, Current, PF), collect relay status information (including relay health), read event reports from the relay (including faults, high, or low voltage, high current levels), and analyze event reports graphically, either locally or remotely. The system shall have a minimum communication baud rate of 19,200.

Integration of the protective relays into the existing RMS shall be performed by Schweitzer Engineering Services. The server for the RMS is located in the KSC Launch Control Center (LCC) and is loaded with SEL-5010, SEL-5020, SEL-5030, SEL-5040, and SEL-5601 application software programs. All of these programs shall be updated to incorporate the relays installed under this project.

2.2.11.1 Communication Processor and Equipment

The Communication Processor shall be a Schweitzer Engineering Laboratories SEL-3530 with SEL-2800M, SEL-2812MT, and SEL-9220 fiber optic adapters.

2.2.11.2 Communication Integration

Integration of the relays and real-time automation controller with the existing KSC Relay Management System, and the KCCS (CITECT) system shall be performed by Schweitzer Engineering Services in coordination with the Contractor's specialist and the CITECT integrator. This integration shall include, but not be limited to setting up each port on the SEL-3530 and programming each SEL-3530 to efficiently provide SCADA type data and control to KCCS. "Efficiently" implies that data will be transmitted and received such that the response time to the KCCS workstation will be less than 4 seconds. This document will provide the minimum required data point list for the relays.

The relays shall be able to communicate with the KSC Relay Management System, and the KCCS via an Ethernet connection using MODBUS via TCP/IP (Citect standard Modnet driver). The communication shall occur via SEL-3530. The manufacturer shall provide, in writing, after communication integration is complete, that the communications system provided under this project will communicate efficiently with the Citect software. If problems are encountered, Citect is located at 30000 Mill Creek Avenue, Alpharetta, GA 30022. Phone is 770-521-7511, facsimile is 770-521-7512. Sales email is sales-americas@citect.com, service email is support-americas@citect.com.

Provide Engineering and Technical Support for on-site modifications to the existing user interface screens used by the ISC power coordinators as part of the Kennedy Complex Control System (KCCS). The Contractor shall provide technical support to develop additional screens and/or modifications to existing screens required to incorporate the new relays into the KCCS system. The additional screens will allow the ISC power coordinator to monitor and control each circuit breaker via Citect "Genies" and "Super-Genies." The Government will perform the final integration of the new screens, Genies, and Super-Genies into the existing KCCS file server. The existing KCCS system shall be modified to incorporate all the changes associated with the installation of the new relays. The modifications to the project shall include but not be limited to, adding/deleting variable tags, alarm tags and trend tags, modifying/building "genies and super genies," and modifying/creating user interface screens. All modifications

to the Citect project shall comply with the KCCS Software Architecture Standard. The following minimum information and control shall be available to the user through the developed genies:

a. Individual phase and ground currents.

b. Phase-to-phase and phase-to-neutral voltage.

c. Alarm on circuit breaker trip, cause of trip and magnitude of the fault current (trip records).

d. Circuit breaker status including open, close, tripped, truck position and connected, test, or disconnected if available.

e. Time-stamped trip data including magnitude and cause of trip.

f. Remote circuit breaker open and close commands.

Coordinate all communication network interface equipment and software (if necessary) with the Citect integrator to ensure that the communication solution provided is efficient and compatible with the existing KCCS architecture. Provide manufacturer's cut sheets and interconnection drawings for additional equipment not specified herein but necessary to insure the relay data communication will be TCP/IP Modbus. Acceptance of additional equipment shall be subject to the approval of the Contracting Officer.

The communication system shall be capable of retrieving breaker status of all breakers. A Government sample KCCS Citect project containing a library of Citect symbols, genies, and super genies has already been developed and will be provided to the Contractor to assist with the development of the new operator screens. This library includes the Citect interface for the SEL-351A relay.

Three KCCS integration design reviews will be scheduled by the Contractor to ensure that all of the parties involved in developing any new Citect interfaces (screens, genies, super genies, and alarm data exchange methods) are properly coordinated. The first meeting will be a kickoff meeting where the Government will provide a sample KCCS Citect project to assist in the development of new interfaces. At the second meeting, the Contractor will provide a sample of all the new types of Citect interfaces that are being developed. At the third meeting, the Contractor will provide a fully working sample of the entire project. The first meeting shall be scheduled within 75 days of the contract award. The sample project and the screens developed will be used to perform the factory testing as described in this section.

Final installation and acceptance testing of the developed Citect project shall be performed by the Contractor's Citect SCADA integrator using the laptop computer to be turned over to the Government. The tests shall be performed on site on active equipment after the relays have been installed and fully integrated into the SEL-3530.

Upon the completion of the contract, the Contractor shall provide to the Government a complete set of Communication Interconnection Diagrams depicting the system as installed.

2.2.11.3 System GPS Clock

Provide a relay system GPS clock source, Schweitzer Engineering Laboratories type SEL-2407, capable of providing an unmodulated IRIG-B timing signal to the real-time automation controller. The GPS controlled clock shall be suitable for 125 VDC operating voltage complete with a GPS antenna, suitable for pipe mounting with coaxial cable, and applicable connectors.

2.2.12 Control Devices

2.2.12.1 Test Switches

Provide test switches between all instrument transformer circuits and protective relays/meters, and in all hardwired interlock circuits, to allow full protective and metering device testing or replacement without physically disconnecting instrument transformer and control circuits. Test switches shall be ABB Type FT-1 with clear covers or approved equivalent and shall be mounted on the door of the instrument compartment.

2.2.12.2 Control, Transfer and Selector Switches

Shall be rotary cam operated for remote operation devices with individual stages, a dust-tight cover and contacts with a positive wiping action. Contacts shall be silver-to-silver or an approved substitute which provides equal or superior performance. Contacts shall have a rating adequate for the duty performed, but shall not be less than 600 volts, 20 amperes continuous. Circuit breaker control switches shall have a red and green target. Red, amber, and green indicator lamps shall also be provided and wired as shown. Circuit breaker control switches shall have a combination of maintained action and spring return type of operation. Circuit breaker control switches shall have pistol grip handles. All switches shall be equipped with engraved plastic escutcheons identifying its function and position.

2.2.12.3 Instrument Transformers

Instrument transformers shall conform to IEEE C57.13, as applicable.

a. Current transformers: Transformers shall be multi-ratio relay accuracy, as indicated, 60 Hz, and coordinated to the rating of the associated switchgear, relays, meters, and instruments. CTs for relaying shall have -ratings as indicated on the drawings as a minimum. CTs shall have a thermal rating factor of 2.0.

b. Potential transformers: Transformers shall be drawout type, 60 Hz, with voltage ratings and ratios coordinated to the ratings of the associated switchgear, relays, meters, and instruments. Potential transformers shall be with two fuses in the primary. Fuses shall be current limiting and sized as recommended by the potential transformer manufacturer. Transformers shall meet ANSI metering accuracy classifications of 0.3 W, X, Y.

2.2.12.4 Pilot and Indicating Lights

Provide push-to-test transformer LED type, rated for 120 volt ac. Lights shall be capable of being relamped from the front.

2.2.12.5 Lockout Relays

Provide high speed lockout relays with manual rotary cam reset and latching relay clearing contact. Provide contact deck with contacts having a rating adequate for the duty performed, but shall not be less than 600 volts, 20 amperes continuous. Door mounted control switch shall have mechanical targets with spring return type of operation and pistol grip handle. All switches shall be equipped with engraved plastic escutcheons identifying its function.

2.2.13 Insulated Barriers

Where insulated barriers are required by reference standards, provide barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness.

2.2.14 Space Heaters

Provide 120-volt ac space heater(s) in each switchgear section. Each space heater shall be of sufficient capacity to control moisture condensation in the compartments. Heaters shall be sized to provide approximately 4 watts per square foot of outer surface area. Provide heaters that have a power density that does not exceed 4 watts per square inch of heater element surface. Provide heaters that are rated at 240-volts for connection to 120-volts. Locate heaters at the lowest portion of each space to be heated. Cover terminals. Use thermostats to regulate the temperature.

Heaters shall be controlled by a thermostat and humidistat located inside the same compartment as the heater being controlled. Thermostats shall be industrial type, high limit, to maintain compartments within the range of 60 to 90 degrees F. Humidistats shall have a range of 30 percent to 60 percent relative humidity. Energize electric heaters in switchgear assemblies while the equipment is in storage or in place prior to being placed in service.

Install operable heaters at the time of shipment for use immediately upon arrival at the site, during storage, or before installation. Prominently mark connection locations on drawings and shipping covers. Provide temporary leads capable of plugging into a standard 120 volt, 20 amp receptacle for storage operation. Make connections easily accessible without having to remove shipping protection.

2.2.15 Corrosion Protection

Frames, channels, panels, and doors of primary unit substation shall be corrosion resistant and shall be fabricated of 304 stainless steel. Base shall include any part of switchgear that is within 3 inches of concrete pad. Paint unit substation, including bases with manufacturer's high perform coating system per IEEE C57.12.29. Prepare stainless steel surfaces per coating manufacturer's instructions. Paint color shall match the adjacent IACP M7-407 building exterior finish color.

2.2.15.1 Stainless Steel

Stainless steel sheet, strip, plate, and flat bars shall conform to ASTM A666, Type 304. Stainless steel bars and shapes shall conform to ASTM A276, Type 304.

2.2.16 Weatherproof Prefabricated Housing

2.2.16.1 Construction

Housing shall be weatherproof, prefabricated, with exterior walls and roof constructed from self-framing interlocking panels to house and protect the internal equipment installed in configuration shown on the drawings. Structural grid base and floor shall be designed for applicable floor loading allowing the structure to be lifted and transported with (as applicable) the interior equipment installed.

Basic design loads, as well as auxiliary and collateral loads include live load and wind load, in addition to the dead load.

Housing shall provide for an aisle along the front of the switchgear of adequate width and height to allow the removal and insertion of circuit breakers.

2.2.16.2 Materials

Structural steel frame fabricated from steel channel, wide flange and angle sections forming a self-supporting grid to support floor.

a. Steel Grade: ASTM A572/A572M (C10 and larger) or ASTM A36/A36M (C8 and smaller).

b. One (1) set of removable lift lugs. (Due to shipping considerations, these items are shipped loose with the building).

c. All welding to be in accordance with AWS D1.1/D1.1M Structural Welding Code.

d. All bolts for field assembly of primary structural members (where required) shall be high strength bolts conforming to ASTM A307 and be a minimum of 1/2-inch diameter.

Floor Plate - 5/16-inch, stainless steel.

Base Structure - galvanized steel with epoxy paint finish.

Exterior Walls - 12 gauge interlocking stainless steel panels with Series 300 stainless steel (18-8) fasteners.

Insulated Roof Panels - 12 gauge interlocking stainless steel insulated panels (2 inch thick rigid insulation between stainless steel sheets) with Series 300 stainless steel (18-8) fasteners. Insulation shall be polyurethane, polyisocyanurate, or manufacturer's standard with a maximum flame spread of 25 and a smoke developed rating of 450 per ASTM E84. Penetrations of, or through insulated roof panels are not permitted.

2.2.16.3 Plenum Duct Assemblies

Plenum duct assemblies shall provide a path for arc propagation from the switchgear to the exterior housing wall. The plenum duct shall be designed and assembled to meet the on-site installation requirement based on supplied equipment.

2.2.16.4 Doors and Hardware

Provide the following Personnel Doors and Hardware.

a. Single Exterior Personnel Door, 3ft x 7ft x 1-3/4in, 18 Gauge Stainless Steel, swing as indicated, with 3 inch Factory Stainless Steel Frame. Each shall include the following:

- Stainless Steel Hinges
- Stainless Steel TOUCH Type Panic Hardware - Lockwood/Magnokrom N1500-5XOT53 x 32D w/Cylinder Lock Exterior Trim
- Closer w/Stopping Arm
- Crash Chain
- Aluminum Threshold
- Weatherstripping
- Stainless Steel Drip Edge
- Removable Transom above Door (MRT)
- Sign "Danger Electrical Equipment / Authorized Personnel Only"

b. Double Exterior Personnel Doors, Pair 3ft x 8ft x 1-3/4in, 18 Gauge Stainless Steel, swing as indicated, with 3 inch Factory Stainless Steel Frame. Each shall include the following:

- Stainless Steel Hinges
- Stainless Steel TOUCH Type Panic Hardware - Lockwood/Magnokrom N1500-5XOT53 x 32D w/Cylinder Lock Exterior Trim (Active Door)
- Surface Bolts (In-active Door)
- Closer w/Stopping Arm (Active Door)
- Crash Chain
- Aluminum Threshold
- Weatherstripping
- Stainless Steel Drip Edge
- Stainless Steel Astragal
- Removable Transom above Door (MRT)
- Sign "Danger Electrical Equipment / Authorized Personnel Only"

Provide the following Equipment Doors and Hardware.

a. Equipment Doors, Louvered (stamped louvers in doors), 12 Gauge Stainless Steel, size and swing as indicated and/or as required. Each shall include the following:

- Stainless Steel Hinges
- Hold Open Device
- Padlocking Handle
- Adjustable Cam w/2 Notches Hub for Unthreaded Shank Pawl Equipment Door Locking
- Equipment Door Access Brackets
- Adjustable Rod Guide
- 60-inch Closer Rods
- Full Gasketing
- Drip Shield
- Sign (as appropriate) "Daner High Voltage / Keep Out" or "Danger Electrical Equipment / Authorized Personnel Only"

2.2.16.5 Finishes/Colors

Finish system as follows:

a. Exterior Wall and Roof Surfaces: Type 304 Stainless Steel with High Performance Coating

- Prepare surface per coating manufacturer's instructions/recommendations.
- Shop Applied High Performance Primer and Finish coats per requirements of IEEE C57.12.29.
- Provide one (1) quart touch-up paint shipped inside structure.
- Color shall match adjacent IACP M7-407 building.

b. Interior Wall and Ceiling Surfaces: Type 304 Stainless Steel with High Performance Coating

- Prepare surface per coating manufacturer's instructions/recommendations.
- Shop Applied High Performance Primer and Finish coats per requirements of IEEE C57.12.29.
- Provide one (1) quart touch-up paint shipped inside structure.
- Color to be "White."

c. Floor and Base: Type 304 Stainless Steel with High Performance Coating

- Prepare surface per coating manufacturer's instructions/recommendations.
- Shop Applied High Performance Primer and Finish coats per requirements of IEEE C57.12.29.
- Provide one (1) quart touch-up paint shipped inside structure.
- Color to be ANSI 61 "Gray."

d. Floor Underside:

- Clean and prepare all surfaces per SSPS standards as recommended by coating manufacturer.
- Undercoat - Transcoat 101™, 10 mils DFT
- VOC - 0.0
- Federal Specification TT-C-520B
- Asbestos Free
- Flame Spread Rating = 0

2.2.16.6 Electrical Utilities

Provide in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS for all electrical utility systems.

Conduit

a. Indoor, Dry Locations - Exposed EMT conduit (set screw fittings) as required by NEC.

b. Outdoor, Underground, and Wet Locations - Exposed PVC coated galvanized rigid steel conduit as required by NEC, 3/4-inch diameter minimum, ANSI C80.1.

Panelboards, Interior

a. Provide in auxiliary switchgear compartment. Power all lighting, receptacle and equipment circuits from this panelboard.

Wire

a. Power Wiring - Use Type THHN/THWN-2 in indoor dry locations and Type RHW-2/USE-2 in outdoor, underground, and wet locations, #12 AWG Stranded Minimum

- Temperature Rating 600V 90 degrees C Dry and 75 degrees C Wet
- Insulation - Flame Resistant PVC
- Meets UL "VW-1" Flame Test Requirements
- Standard Color Coding:

Single Phase Circuits	Three Phase Circuits	DC Circuits
A-Black	A-Black	Pos(+)-Red
B-Red	B-Red	Neg(-)-Black
	C-Blue	
N-White	N-White	
G-Green	G-Green	Ground-Green

Provide color identification within each enclosure where tap, splice, or termination is made. For conductors No. 2 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 1 AWG and larger diameter, color coding shall be by plastic coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink sleeves.

Interior Lighting and GFCI Receptacles

a. Provide a minimum average maintained illumination on the floor of 300 lux 30 footcandles. Lighting shall be accomplished using vaportight fluorescent luminaires employing F32T8 fluorescent lamps and (-18 degrees C) 0-degrees F ballasts.

b. Provide a timer switch for controlling lighting located adjacent to the main access door.

c. Provide one exterior and two interior 20A, 120V ac, NEMA 5-20R, industrial grade ground fault circuit interrupter (GFCI) type duplex receptacles. The interior receptacles shall be located, on each, at each end of the housing for servicing the switchgear.

d. Combination Emergency Light/Exit Sign (Green)

- AC Input Voltage 120/277 Volts
- Lamp LED/Color Green
- Wall or Ceiling Mount
- Power Circuit - 120V, 1 Phase 20A

Item(s) shall be powered every 4-6 weeks during storage to prevent battery failure and meet manufacturer's warranty requirements.

Exterior Lighting

a. Exterior Light, Wallpack 4000K LED Type III (SR3) 3250 lumens (min.).

- Internal Photo Cell (1 per system)
- Listings - UL 1598 Listed for Wet Location
- Power Circuit - 120V, 1 Phase 20A

Grounding

a. Ground Pads - 4 Hole Stainless Steel Welded

b. Ground Lug - #4/0

c. Copper Bar Ground Loop

Copper Bar 2-inch x 1/4-inch
Mounting Anchors
3-inches Below Ceiling Mounted on Wall

d. Ground Drops from Ground Loop to Ground Lugs @ Base or Equipment Ground Bus

Ground Circuit 4/0 Bare Copper Cable

e. Ground Drops from Ground Loop to Small Equipment

M Ground Circuit (Sized as Required $\leq$ #8) Copper Wire)

Ventilation

a. Exhaust Fan Assembly 16-inch diameter - 117 CFM w/Aluminum Damper and Thermostat

b. Power Circuit - 120 VAC, 1-Phase, 20A

c. Intake Louver Assembly - 24-inch x 24-inch w/Damper and Aluminum Mesh Filter

2.2.16.7 Lifting and Transporting Housing

During lift and transport, the housing shall be supported at all times at the lift lug locations.

2.2.17 DC Power Supply

Provide control power batteries and charger, suitable for the requirements of the primary unit substation, in a NEMA type 3R ventilated 304 stainless steel enclosure. Batteries shall be 1.75 volts per cell, 60 cells, lead acid, sealed, totally absorbed electrolyte type.

a. Sealed batteries: Provide batteries with leakproof, spillproof electrolyte utilizing highly absorbent material to separate the positive and negative plates. Battery jars shall be hermetically sealed with welded seams. Batteries shall be maintenance-free and shall not require water to be added. Capacity shall be calculated by switchgear manufacturer and approved by Contracting Officer before acceptance.

b. Battery charger shall be full-wave rectifier type, utilizing silicon semiconductor devices. Charger shall maintain a float charge of 2.15 volts per cell and an equalizing charge of 2.33 volts per cell. An

equalizing charge timer shall be provided which operates automatically after an AC power failure of 5 seconds or more. Timer shall also be capable of being actuated manually. Adjustable float and equalizing voltage potentiometers shall be provided. Charger voltage shall be maintained within plus or minus 1/2 percent from no load to full load with AC line variations of plus or minus 10 percent and frequency variations of plus or minus 5 percent. DC voltmeter and ammeter with a minimum (90 mm) 3 1/2-inch scale and 2 percent accuracy of full scale shall be provided. Output current shall be limited to 115 percent of rated output current. AC and DC magnetic circuit breakers shall be provided. Circuit breakers shall not be overloaded or actuated under any external circuit condition, including recharge of a fully discharged battery and short circuit of the output terminals. Charger shall be capable of continuous operation at rated current at an ambient temperature of (40 degrees C) 104 degrees F. Output DC current capacity shall match the requirements of the batteries provided.

c. Secure battery rack such that it cannot overturn or be disrupted by lateral forces accompanying a seismic disturbance. Provide steel, three-step racks, painted with two coats of acid resistant paint for mounting batteries. Provide lead-plated copper inter-rack connectors and cell numbers with each rack.

2.3 SOURCE QUALITY CONTROL

2.3.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

1. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.

4. Dated calibration labels shall be visible on all test equipment.

5. Calibrating standard shall be of higher accuracy than that of the instrument tested.

6. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

(a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.3.2 Switchgear Design Tests

IEEE C37.20.2 or IEEE C37.20.3 as applicable. Submit documentation showing the results of design tests on a product of the same series and rating as that provided by this specification. Required tests shall be as follows:

a. Design Test

1. Dielectric test.

2. Rated continuous current test.

3. Short-time current withstand tests.

4. Short-circuit current withstand tests.

5. Mechanical endurance tests.

6. Flame-resistance tests.

7. Rod entry tests.

8. Rain test for outdoor switchgear.

2.3.3 Switchgear Production Tests

IEEE C37.20.2 or IEEE C37.20.3 as applicable. Submit reports which include results of production tests performed on the actual equipment for this project. Required tests shall be as follows:

a. Production Test

1. Dielectric test.

2. Mechanical operation tests.

3. Grounding of instrument transformer case test.

4. Electrical operation and control-wiring tests.

5. Impulse withstand test.

2.3.4 Transformer Design Tests

In accordance with IEEE C57.12.00 and IEEE C57.12.90. Additionally, IEEE C57.12.80, section 5.1.2 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results) in the same submittal package as the catalog data and drawings for the specified transformer. Design tests shall have been performed prior to the award of this contract.

a. Tests shall be certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise

test means a unit-substation transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same MVA, the same cooling type (ONAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a unit-substation transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer (if specified). Design lightning impulse tests shall include both the primary and secondary windings of that transformer.

1. IEEE C57.12.90 paragraph entitled, "Lightning Impulse Test Procedures" and IEEE C57.98.

2. State test voltage levels.

3. Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" for the lifting and moving devices test means a transformer in the same weight range as the transformer specified.

e. Pressure: "Basically the same design" for the pressure test means a unit-substation transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

2.3.5 Transformer Routine and Other Tests

In accordance with IEEE C57.12.00 and IEEE C57.12.90. Routine and other tests shall be performed by the manufacturer on each of the actual transformers prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence shall be as follows:

a. High-Voltage Tests

b. Insulation-Resistance Test

c. Temperature-Rise Tests

d. Oil Power Factor

e. Sound Tests

f. Bushing Tests

g. Short-Circuit Tests

h. Cold resistance measurements (provide reference temperature).

i. Phase relation.

j. Ratio.

k. Insulation power-factor by manufacturer recommended test method.

1. No-load losses (NLL) and excitation current.

m. Load losses (LL) and impedance voltage.

n. Dielectric.

1. Impulse: Per IEEE C57.12.90 paragraph 10.3 entitled, "Lightning Impulse Test Procedures" and IEEE C57.98. Test the primary winding only.

(a) State test voltage levels.

(b) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test reports.

2. Applied voltage.

3. Induced voltage.

o. Leak.

2.3.6 Neutral Grounding Resistor Tests

Manufacturer's standard tests in accordance with IEEE 32.

2.3.7 Substation Paint Qualification Test

Submit reports showing that the paint qualification test has been performed according to IEEE C37.20.2 or IEEE C57.12.28 as applicable, to ensure the adequacy of finishes to inhibit the buildup of rust on ferrous metal materials used for enclosures.

2.3.8 Integral Assembly Test

Substation shall be tested as an integral assembly at the switchgear manufacturer's test facility. Test shall include verification of connections between substation sections and switchgear sections/cubicles, including but not limited to, main bus, ground bus, control power, and control wiring. This test shall conform to IEEE C37.20.2. Once acceptance of test results is received, ship unit substation.

2.3.9 Communication Processor Configuration Tests

Submit reports indicating that the communication processor has been correctly configured to interface with each of the protective relays, KCCS, and the SEL-5040 report server.

2.4 SPARE PARTS AND ANCILLARY EQUIPMENT

2.4.1 Spare Protective Relays

The Contractor shall provide one spare SEL-351A protective relay and one spare SEL-351S protective relay for the project.

2.4.2 Spare Communication Processor

The Contractor shall provide one spare communication processor for the project. The communication processor shall be the same as specified in paragraph above entitled, "Communication Processors and Equipment."

2.4.3 Laptop Computer

Provide a laptop computer for programming and interrogating the switchgear monitoring and control system, protective relays, relay management system, and associated communications. Provide laptop complete with the performance characteristics, features, hardware, cables, software and appurtenances necessary to complete the programming and interrogating of the switchgear monitoring and control system, protective relays, relay management system, and associated communications. Provide laptop with the latest processor and the latest operating system commercially available at the time of the bid and supported by the software to be installed thereon. Provide laptop with a minimum 17-inch screen. Provide laptop with a hard disc drive capacity of at least four times that required by the software to be installed thereon, but not less than 1 TB. Provide the software required for programming and interrogating the switchgear monitoring and control system, protective relays, relay management system, and associated communications, and load this software on this laptop computer. Register the software loaded on this laptop computer to the Government and assign all rights of use to the Government, and provide this software to the Government on original manufacturer's media (e.g., CD or DVD). The Contractor shall prepare an itemized list of software installed on this computer with associated Serial Numbers, Authorization Numbers, User Names, and Passwords identified. Coordinate User Names and Passwords with the Contracting Officer prior to bringing this laptop computer onto the project site. All programming and interrogating of switchgear monitoring and control system, protective relays, relay management system, and associated communications, specified to be completed as part of this project, shall be accomplished using this specific laptop computer. This laptop computer shall become the property of the Government at the conclusion of this project. Deliver this laptop computer, and all software installed thereon on original manufacturer's media, and the list of software, to the Government during the protective relay training session.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

Submit Installation Drawings for the primary unit substation. Provide drawings that include complete details of equipment layout and design. Include a scaled and dimensioned plan drawing showing all electrical underground installation (e.g., duct banks, conduits, grounding) that meets the design requirements indicated on the drawings, but is coordinated for the actual equipment provided.

3.2 GROUNDING

Grounding shall conform to NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Connect ground conductors to the upper end of the ground rods by exothermic welds. Provide compression connectors at

equipment ends of ground conductors.

3.2.2 Substation Grounding

Provide counterpoise ground system consisting of 4/0 AWG bare stranded copper conductor direct buried with a minimum of 24 inches earth cover and interconnecting ground rods as shown on the drawings. Substation transformer neutral connections shall not be smaller than No. 2/0 AWG.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld. Exothermic welds shall be installed as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM paragraph entitled "Grounding and Bonding."

3.2.4 Ground Cable Crossing Expansion Joints in Structures and Pavements

Protect from damage by means of approved devices or methods of installation to allow the necessary slack in the cable across the joint to permit movement. Provide stranded or other approved flexible copper cable across such separations.

3.2.5 Grounding and Bonding Equipment

Grounding and bonding equipment shall conform to UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect unit substations furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Medium-Voltage Switchgear

Medium-voltage switchgear installation shall conform to IEEE C37.20.2.

3.3.2 Meters and Instrument Transformers

Meters and instrument transformers installations shall conform to ANSI C12.1.

3.3.3 Galvanizing Repair

Repair damage to galvanized coatings caused by handling, transporting, cutting, welding, or bolting. Make repairs in accordance with ASTM A780/A780M, zinc rich paint. Do not heat surfaces that repair paint has been applied to.

3.4 FOUNDATION FOR SUBSTATION

Foundation for substation shall be as detailed on the drawings. Mount substation on foundation.

3.5 FACTORY TESTING

Factory tests on the substation shall be performed in accordance with IEEE C37.20.2. All tests shall be witnessed by the Contracting Officer or his designee unless waived, in writing, and no equipment shall be shipped until it has been approved for shipment by the Contracting Officer.

Factory test results shall be signed off by the Contracting Officer or his designee unless waived in writing.

Factory tests shall also demonstrate substation ability to communicate with the existing KCCS. The following minimum functionality shall be demonstrated:

a. Correct graphics for symbols, colors, and animation of the user screens as defined during the software development reviews.

b. Alarms and trends.

c. Display of all the information referenced in the communication section.

d. Open and close commands for the breakers.

e. The communication network provided with the switchgear does not generate any "hardware alarms" within the existing Citect SCADA system.

Provide documentation on successful completion of factory tests for the above equipment prior to shipping the unit substation to KSC.

3.6 FIELD QUALITY CONTROL

3.6.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, in accordance with NETA ATS, Section 26 08 00 APPARATUS INSPECTION AND TESTING, and additional requirements as indicated below. Perform and record results for all NETA ATS visual and mechanical inspections, standard tests, and optional tests unless otherwise indicated. The results of the acceptance checks and tests shall be neatly cataloged and bound, and shall be submitted to the Contracting Officer or their designee prior to Final Acceptance. Perform tests on all equipment.

3.6.1.1 Medium-Voltage Circuit Breakers (Vacuum)

Perform all acceptance tests as per Section 7.6.3 of NETA ATS with the following additions/deletions:

a. Perform power factor tests on each pole with the breaker open and each phase with the breaker closed.

b. The requirement to perform time-travel analysis is waived.

3.6.1.2 Transformers (Liquid-Filled)

a. Visual and mechanical inspection

1. Verify space heater operation. Check for damaged or cracked insulators and leaks.

2. Verify operation of all alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay.

3. Verify tightness of accessible bolted electrical connection by calibrated torque-wrench method. Thermographic survey is required.

4. Verify correct liquid level in transformer tank.

5. Perform specific inspections and mechanical tests as recommended by manufacturer.

b. Electrical tests

1. Perform insulation power-factor/dissipation-factor tests on windings.

2. Sample insulating liquid. Sample shall be tested for:

(a) Dielectric breakdown voltage.

(b) Acid neutralization number.

(c) Specific gravity.

(d) Interfacial tension.

(e) Color.

(f) Visual condition.

(g) Parts per million water.

(h) Measure dissipation factor or power factor.

3. Perform dissolved gas analysis (DGA).

4. Test for presence of PCB.

5. Verify that tap-changer is set at specified ratio.

6. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3.6.1.3 Switchgear Assemblies

Perform all acceptance tests per Section 7.1 of NETA ATS with the exception of the primary current injection test. The requirement to perform the primary current injection test is waived.

3.6.1.4 Instrument Transformers

Perform all acceptance tests per Section 7.10 of NETA ATS with the following additions:

a. Verify all current transformer ratio taps for each CT.

b. Verify phase, polarity, and all connections from each CT ratio tap to the switchgear termination points.

3.6.1.5 Protective Relays

a. Visual inspection

1. Inspect connections on the rear of the relay. Ensure cables/wires are secure and tight.

2. Ensure relay is properly mounted to panel door.

b. Electrical tests

1. Install relay settings obtained from the Contracting Officer. Using current and voltage injection, verify relay operates per installed settings and manufacturer's curves. A minimum of three trip points per element shall be used to verify the selected curves.

2. Verify that each of the relay contacts performs its intended function in the control scheme including breaker trip tests, close inhibit tests, 86 lockout tests, and alarm functions if required.

3.6.1.6 DC Power Supplies

a. Visual and mechanical inspection

1. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

2. Measure electrolyte specific gravity and temperature and visually check fill level.

3. Verify adequacy of battery support racks, mounting, anchorage, and clearances.

b. Electrical tests

1. Set charger float and equalizing voltage levels.

2. Verify all charger functions and alarms.

3. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.

4. Perform a capacity load test.

3.6.1.7 Metering and Instrumentation

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify tightness of electrical connections.

b. Electrical tests

1. Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

2. Calibrate watthour meters according to manufacturer's published data.

3. Verify all instrument multipliers.

4. Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.6.1.8 Grounding System

a. Visual and mechanical inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

1. 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.

3.6.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device, by simulating a fault and shall be opened and closed by the protective device by using KCCS. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times for checks, settings, and tests.

3.6.3 Manufacturer's Certification

A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations for the transformer, switchgear, and switchgear protective relays.

3.6.4 Training

Provide the services of manufacturer representatives to train the owner's personnel in operation of the switchgear and programming of the protective relays. The manufacturer representatives shall be factory-trained and shall have a thorough knowledge of the switchgear, all protective devices, metering, hardware and system programming. The training session on the IEDs and all controls shall include:

a. One Day - Unit substation on-site training - Unit Substation Manufacturer

   1. Full operation demonstrations of all functions.

   2. Circuit breaker electrical and mechanical operations.

   3. Explanations and instructions for all protective devices.

b. Two Days - Protective relay on-site training - Protective Relay Manufacturer

   1. Classroom on-site training for programming the protective relays and relay management system.

c. Three days of classroom on-site training for the SEL-3530 communication processor training performed by Schweitzer Engineering Laboratories for 10 engineers.

-- End of Section --

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SECTION 26 12 19.00 40

PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM D 877	(2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D 92	(2005a; R 2010) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D 97	(2011) Pour Point of Petroleum Products
ASTM D1535	(2012) Specifying Color by the Munsell System

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(2006; INT 1 2011) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE C2	(2012) National Electrical Safety Code
IEEE C37.47	(2000) Standard for High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches
IEEE C57.12.00	(2010) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment

	- Enclosure Integrity for Coastal Environments
IEEE C57.12.34	(2009) Standard for Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 5 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2010) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.98	(1993; Errata 1998; R 1999) Guide for Transformer Impulse Tests
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-90/027F	(1993) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms
EPA 712-C-98-075	(1996) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment

UNDERWRITERS LABORATORIES (UL)

UL 467 (2007) Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Stds Dictionary.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pad-Mounted Transformer Drawings; G

SD-03 Product Data

Pad-Mounted Transformers; G

Submittal shall include manufacturer's information for each component, device, and accessory provided with the transformer.

SD-06 Test Reports

Acceptance Checks And Tests; G

SD-07 Certificates

Transformer Efficiencies; G

Submit certification from the manufacturer indicating conformance with the paragraph entitled "Specified Transformer Efficiencies."

SD-09 Manufacturer's Field Reports

Pad-mounted transformer Design Tests; G

Pad-mounted transformer Routine And Other Tests; G

SD-10 Operation and Maintenance Data

Transformer(s), Data Package 5; G

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

Transformer Test Schedule; G

Submit report of test results as specified by paragraph entitled "Field Quality Control."

1.5 QUALITY ASSURANCE

1.5.1 Pad-Mounted Transformer Drawings

Drawings shall indicate, but not be limited to the following:

a. An outline drawing, with front, top, and side views.

b. ANSI nameplate data.

c. Elementary diagrams and wiring diagrams with terminals identified of watthour meter and current transformers.

d. One-line diagram, including switch(es), current transformers, meters, and fuses.

e. Manufacturer's published time-current curves (on full size logarithmic paper) of the transformer high side fuses.

1.5.2 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.

1.5.3 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.

1.5.3.1 Material and Equipment Manufacturing Date

Do not use products manufactured more than 6 months prior to date of delivery to site, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

In addition to requirements of Data Package 5, include the following on the

actual transformer(s) provided:

a. An instruction manual with pertinent items and information highlighted

b. An outline drawing, front, top, and side views

c. Prices for spare parts and supply list

d. Routine and field acceptance test reports

e. Fuse curves for primary fuses

f. Information on watthour demand meter, CTs, and fuse block

g. Actual nameplate diagram

h. Date of purchase

1.7 WARRANTY

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

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be pad-mounted transformers and related accessories are specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 THREE-PHASE PAD-MOUNTED TRANSFORMERS

IEEE C57.12.34, IEEE C57.12.29 and as specified herein.

2.2.1 Compartments

Separate the high- and low-voltage compartments with steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

2.2.1.1 High Voltage, Dead-Front

High-voltage compartment shall contain the incoming line, insulated high-voltage load-break connectors, bushing well inserts, six high-voltage bushing wells configured for loop feed application, load-break switch handle(s), access to oil-immersed fuses, dead-front surge arresters, tap changer handle, connector parking stands with insulated standoff bushings, protective caps, drain valve with sampler device, and ground pad.

a. Bushing well inserts: IEEE 386, 200 amperes, 15 kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise. Provide feed-thru inserts as indicated.

b. Load-break switch: Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition

loop feed and sectionalizing. Each switch shall be rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handles in the high-voltage compartment. Operation of switches shall be as follows:

ARRANGEMENT NO.	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION LINE A SW. OPEN	LINE A SW. CLOSE	LINE B SW OPEN	LINE B SW CLOSE	XFMR. SW OPEN	XFMR. SW CLOSE
1	Line A connected to Line B and both lines connected to transformer		X		X		X
2	Transformer connected to Line A only		X	X			X
3	Transformer connected to Line B only	X			X		X
4	Transformer open and loop closed		X		X	X	
5	Transformer open and loop open	X		X		X	

c. Provide bayonet type, oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. Bayonet fuse links shall sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing which closes when the fuse holder is removed and an external drip shield. Conspicuously display warning within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the open position and the tank pressure has been released.

1. Bayonet fuse assembly: 150 kV BIL.

2. Oil-immersed current-limiting fuses: IEEE C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.

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

e. Protective caps: IEEE 386, 200 amperes, 15 kV Class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushing well inserts and insulated standoff bushings.

f. Drain valve with sampler device.

2.2.1.2 Low Voltage

Low-voltage compartment shall contain low-voltage bushings with NEMA spade terminals, bushing supports, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, ground pad, and accessories. Provide insulated low-voltage bushing supports connected to the ends of the spade terminals to minimize the torsional stress on the bushings due to cable weight/tension. Spade type cable terminals with NEMA 2-hole spacing and arrangement suitable for cable quantities indicated on the drawing based on a 2-hole lug per cable. Provide insulting boots to completely cover un-insulated transformer cable terminals, and cable lugs connections. Accessories shall include the following:

a. Fill plug.

b. Pressure relief device.

c. Liquid level gage.

d. Pressure-vacuum gage.

e. Dial type thermometer with maximum temperature indicator.

2.2.2 Compartment Construction

Separate the high- and low-voltage compartments with steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

2.2.3 Transformer

a. Less-flammable liquid-insulated, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

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

c. Transformer voltage ratings: 13.2kV - 480Y/277V.

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

e. Tested impedance for units provided shall be between 5.75 and 5.9125 percent.

f. Audible sound levels shall not exceed 60 dB.

g. Transformer shall include lifting lugs and provisions for jacking under base. The transformer base construction shall be suitable for using rollers or skidding in any direction. Provide transformer top with an

access handhole. Transformer shall have its kVA rating conspicuously displayed on its enclosure. The transformer shall have an insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.

2.2.3.1 Specified Transformer Efficiencies

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformers prepared for this project. No-load losses (NLL) shall be referenced at 20 degrees C. Load losses (LL) shall be referenced at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than 99.42 percent or maximum calculated efficiency based on the impedence range specified. The specified transformer efficiency value is based on requirements contained within 10 CFR 431, Subpart K.

2.2.4 Insulating Liquid

Less-flammable transformer liquids: NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D 92 and a dielectric strength not less than 33 kV tested per ASTM D 877. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

a. The fluid shall be a biodegradable electrical insulating and cooling liquid classified by UL and approved by FM as "less flammable" fluids. The fluid shall meet the following fluid properties:

   1. Pour point: ASTM D 97, less than -15 degree C

   2. Aquatic biodegradation: EPA 712-C-98-075, 100%

   3. Trout toxicity: OECD Test 203, zero mortality of EPA 600/4-90/027F, pass

2.2.4.1 Liquid-Filled Transformer Nameplates

Provide distribution transformers with nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.2.5 Corrosion Protection

Entire transformer assembly, including tank, radiator, base, and enclosure shall be fabricated of stainless steel conforming to ASTM A167, Type 304 or 304L. Form enclosure of stainless steel sheets. Paint entire transformer assembly Munsell 7GY3.29/1.5 green. Paint coating system shall comply with IEEE C57.12.29. The Munsell color notation is specified in ASTM D1535.

2.3 WARNING SIGNS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.29, such as for pad-mounted transformers, 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 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two

lines of nominal 2 inch 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. PPSO710D72 or approved equal.

2.4 GROUNDING AND BONDING

UL 467. Provide grounding and bonding as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.5 CAST-IN-PLACE CONCRETE

Concrete associated with electrical work for other than encasement of underground ducts shall be 4000 psi minimum 28-day compressive strength unless specified otherwise. All concrete shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

Concrete shall be composed of fine aggregate, coarse aggregate, portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture. Fine aggregate shall be of hard, dense, durable, clean, and uncoated sand. The coarse aggregate shall be reasonably well graded from 3/16 inch to 1 inch. The fine and coarse aggregates shall be free from injurious amounts of dirt, vegetable matter, soft fragments or other deleterious substances. Water shall be fresh, clean, and free from salts, alkali, organic matter, and other impurities. Concrete associated with electrical work for other than encasement of underground ducts shall be 4000 psi minimum 28-day compressive strength unless specified otherwise. Slump shall not exceed 4 inches. Retempering of concrete will not be permitted. Exposed, unformed concrete surfaces shall be given a smooth, wood float finish. Concrete shall be cured for a period of not less than 7 days, and concrete made with high early strength portland cement shall be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer. Air entrain concrete exposed to weather using an air-entraining admixture conforming to ASTM C260/C260M. Air content shall be between 4 and 6 percent.

2.6 SOURCE QUALITY CONTROL

2.6.1 Transformer Test Schedule

The Government reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

1. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.

4. Dated calibration labels shall be visible on all test equipment.

5. Calibrating standard shall be of higher accuracy than that of the instrument tested.

6. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

   (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

   (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.6.2 Design Tests

IEEE C57.12.00, and IEEE C57.12.90. Section 5.1.2 in IEEE C57.12.80 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for each of the specified transformer(s). Perform design tests prior to the award of this contract.

a. Tests shall be certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (ONAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests shall include the primary windings only of that transformer.

   1. IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

   2. State test voltage levels.

   3. Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with IEEE C57.12.34.

e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

f. Short circuit: "Basically the same design" for the short circuit test means a pad-mounted transformer with the same kVA as the transformer specified.

2.6.3 Routine and Other Tests

IEEE C57.12.00. Routine and other tests shall be performed by the manufacturer on each of the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence shall be as follows:

a. Cold resistance measurements (provide reference temperature)

b. Phase relation

c. Ratio

d. No-load losses (NLL) and excitation current

e. Load losses (LL) and impedance voltage

f. Dielectric

1. Impulse

2. Applied voltage

3. Induced voltage

g. Leak

h. Dissolved gas analysis (DGA)

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Pad-Mounted Transformer Grounding

Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is

required to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Meters and Current Transformers

ANSI C12.1.

3.4 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.5 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

3.6 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount transformer on concrete slab as detailed on the drawings.

3.6.1 Cast-In-Place Concrete

Cast-in-place concrete work shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.6.2 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.7 FIELD QUALITY CONTROL

3.7.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, in accordance with NETA ATS, Section 26 08 00 APPARATUS INSPECTION AND TESTING, and additional requirements as indicated below. Perform and record results for all NETA ATS visual and mechanical inspections, standard

tests, and optional tests unless otherwise indicated. The results of the acceptance checks and tests shall be neatly cataloged and bound, and shall be submitted to the Contracting Officer or their designee prior to Final Acceptance.

3.7.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection

1. Verify that the tap-changer is set at specified ratio.

2. Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

3. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter and by verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

4. Verify correct equipment grounding. Ensure 15 kV cable shields are bonded to the tank ground pad.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

2. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3.7.1.2 Grounding System

a. Visual and mechanical inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

1. 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. Equip the instrument with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

2. 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.

3.7.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show

by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times of checking and testing.

-- End of Section --

SECTION 26 13 00.00 98

SF6 INSULATED 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 C37.72	(1987) Standard for Manually-Operated Dead-Front Pad Mounted Switchgear with Load Interrupting Switches and Separable Connections for Alternating-Current Systems

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(1999; R 2009) 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	(2012) National Electrical Safety Code
IEEE C37.60	(2003) Standard Requirements for Overhead, Pad-mounted Dry-Vault and Submersible Automatic Circuit Reclosers and Fault Interrupters for Alternating Systems Up To 38kV
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE Std 386	(2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

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	(2011; Errata 2 2012) National Electrical Code
NFPA 70B	(2006; Errata 2007) Electrical Equipment Maintenance

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS and Section 26 08 00 APPARATUS INSPECTION AND TESTING 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 Contractor Quality Control approval. 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

Switchgear Drawings; G

Submittal shall include the following for each switch: outline drawing, ratings, nameplate diagram, single-line diagram, connection diagram, and time-current coordination curves. Outline drawing shall include dimensioned plan and elevation views drawn to scale and weights. Connection diagram shall include point-to-point wiring for switch auxiliary power supplies (where required), metering and controls (where specified), and overcurrent protection current transmitters and potential transmitters. 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

Electronic Overcurrent Controls Instructions; G

SF6 Insulated Pad-mounted Switchgear; G

SF6 Insulated Vault-Style Switchgear; 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; G

Electrical Power Monitoring System; G

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

Switchgear design and production tests reports for switches shall be submitted and shall be in accordance with IEEE 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 Acceptance Checks and Tests; G

SD-10 Operation and Maintenance Data

SF6 Insulated Pad-mounted Switchgear Operation and Maintenance Manual; G

SF6 Insulated Pad-mounted Switchgear Installation Manual; G

SF6 Insulated Pad-mounted Switchgear; G

Accessories; G

Vacuum Interrupters; G

Electronic Trip Units; G

Electronic Overcurrent Controls Instructions; G

SF6 Insulated Vault-style Switchgear Operation and Maintenance Manual; G

SF6 Insulated Vault-style Switchgear Installation Manual; G

SF6 Insulated Vault-style Switchgear; G

Submittal shall include wiring diagrams, maintenance and testing schedules, and recommended spare parts list. Once equipment is approved and at least 30 days prior to field testing, request trip unit settings from the Contracting Officer.

1.5 QUALITY ASSURANCE

1.5.1 Switchgear Drawings

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

a. Outline drawing showing dimensioned plan and elevation views drawn to scale and weights.

b. Ratings.

c. Nameplate diagram.

d. Single-line diagram for switch.

e. Connection diagram showing point-to-point wiring for switch auxiliary power supplies (where required), metering and controls (where specified), and overcurrent protection current transmitters and potential transmitters.

f. Time-current coordination curves for all available trip settings, plotted on standard log-log coordination paper.

1.5.2 Paint Coating System

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

1.5.3 Electronic Overcurrent Controls Instructions

Provide instruction manuals covering the set-up and adjustment of electronic overcurrent controls.

1.6 MAINTENANCE

Provide safety precautions, preventive maintenance plan and schedule, troubleshooting guides and diagnostic techniques, parts identification, warranty information, testing and performance data and contractor information for the following:

SF6 Insulated Vault-Style Switchgear Operation and Maintenance

SF6 Insulated Pad-Mounted Switchgear Operation and Maintenance

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:

Load Interrupting Ways

Rated Maximum Voltage, kV	15.5
Rated Withstand Impulse Voltage, kV BIL	110
AC 1 Min. Withstand kV	34
DC 15 Min. Withstand kV	53
Fault close Current, kA Asym (3 times)	25
1 Sec. Rating sym., kA	16
Continuous and Load Interrupting Current, A	630
Short-Time Current, kA rms Sym	12
Short-Circuit interrupting Current, kA rms Sym.	12
Momentary Current kA Asym.	25

Fault Interrupting Ways

Rated Maximum Voltage, kV	15.5
Rated Withstand Impulse Voltage, kV BIL	110
AC 1 Min. Withstand, kV	34
DC 15 Min. Withstand, kV	53
Continuous and Load Interrupting Current, A	630
Interrupting Current, kA Asym.	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.

2.1.2 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 3 inches of concrete pad. Paint switchgear enclosure including base No. 70 light gray. Paint coating system shall comply with the manufacturer's standard equipment finish for highly corrosive areas and 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 for single-phase 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.

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 each switched and protected way.

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.

2.1.6 Electrical Power Monitoring System

Where indicated, provide metering equipment to monitor energy usage on the position indicated in accordance with Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTION and the following:

a. Two fixed mount (2) metering potential transformers, ABB Type VIL-95 or equal, with integral 15 kV primary fuse clip and fuses. 15 kV cable terminations shall be suitable for quantities and sizes of cables indicated.

b. Concrete pad mounted NEMA 4X Type 316 stainless steel sectionalizing cabinet enclosure for potential transformers. Provide stainless steel standoff such that current transformers are not directly mounted to concrete surfaces.

c. Three (3) 300:5 Amp metering window current transformers.

d. For compatibility, metering equipment shall be NASA KSC Standard, Schneider Electric Square D CM4250 with ECC21 Ethernet communications card, IOC input/output card, and CMDLC backlit LCD display, and no other. Metering equipment shall conform to Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Install metering equipment in accordance with the metering equipment manufacturer's published installation instructions. Mount metering equipment in strict accordance with the orientation recommendations of the metering equipment manufacturer. Metering equipment shall be factory installed in NEMA 4X Type 316 stainless steel enclosure with back panel, hinged mounting panel, test switch, shorting CT terminal strips, and 3-pole fuse block. Mount LCD display internal to enclosure.

2.2 SF6 INSULATED VAULT-STYLE SWITCHGEAR

2.2.1 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
Rated Withstand Impulse Voltage, kV BIL	110
AC 1 Min. Withstand, kV	35
DC 15 Min. Withstand, kV	53
Continuous and Load Interrupting Current, A	630
Momentary Current, kA Asym	40
Fault close Current, kA Asym (3 times)	40
1 Sec. Rating sym., kA	25

Switched ways shall be rated for the required continuous and load interrupting current.

2.2.2 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 switched ways. Vault type switches shall be in accordance with ANSI C37.71. 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. Cable entrances shall be by means of open stud bushings as indicated. Switch configuration shall be as indicated.

2.2.3 Load Interrupting Switched Ways

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

2.2.4 Equipment Finish

Each switch tank and enclosure shall have the manufacturer's standard finish for highly corrosive areas. The finish shall meet the requirements of IEEE C57.12.29 and must be No. 70 light gray.

2.3 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.

2.4 SOURCE QUALITY CONTROL

2.4.1 Switchgear Acceptance Checks and 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.

2.4.2 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 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, and 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 the 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.

2.4.3 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:

a. Filling valve with gauge.

b. Lifting eyes.

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

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

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

f. Provide a welded flange ready to accept a future gas pressure switch.

g. Provide parking stands for each switched and interrupter way.

2.4.4 Accessories

Provide the following accessories for each switch.

2.4.4.1 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.

2.4.4.2 Other Operational Features

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

2.4.4.3 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.

2.5 SWITCH ENCLOSURES

2.5.1 Pad-Mounted Switch Enclosures

Enclosures shall be in accordance with IEEE 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:

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

2.5.2 Vault-style Switch Mounting Frames and Enclosures

Mounting frames of angle iron construction shall be furnished for all vault-style switches and shall be hot-dipped galvanized after fabrication in accordance with ASTM A 123/A 123M and ASTM A 153/A 153M.

Enclose mounting frame with a minimum 11 gauge galvanized sheet steel front panel and galvanized expanded metal back and side panels. After fabrication, clean and paint all exposed ferrous metal surfaces with No. 70 light gray. Paint coating system shall comply with the manufacturer's standard equipment finish for highly corrosive areas and IEEE C57.12.29.

PART 3 EXECUTION

3.1 INSTALLATION

Provide Installation Manuals for SF6 insulated switchgear. Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein. Installation shall be in accordance with the manufacturer's requirements.

3.2 GROUNDING

Grounding shall be as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION 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 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.2 Switchgear Grounding

Connect #4/0 bare stranded copper conductor ground loop (counterpoise), not less than 24 inches below grade, to the upper end of the ground rods by exothermic welds. Provide #4/0 bare stranded 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 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

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 pad as detailed on drawings.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training areas.

3.3.1 Cast-in-Place Concrete

Cast-in-place concrete work shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3.2 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

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.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS and Section 26 08 00 APPARATUS INSPECTION AND TESTING.

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, alignment, required area clearances, and grounding. Ensure 15 kV cable shields are bonded to the switch ground pad.

(4) Perform mechanical operator tests in accordance with manufacturer's instructions.

(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 trip unit settings from the government, in writing, a minimum of 30 days prior to scheduling electrical tests.

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.

-- End of Section --

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM
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 in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
ASTM B3	(2001; R 2007) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2011) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2012) National Electrical Safety Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2005) American National Standard for Electrical Metallic Tubing (EMT)
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA FU 1	(2002; R 2007) Low Voltage Cartridge Fuses

NEMA ICS 6	(1993; R 2011) Enclosures
NEMA KS 1	(2001; R 2006) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA RN 1	(2005) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(1992; R 1997) Standard for Dry-Type Transformers for General Applications
NEMA TC 3	(2004) Standard for Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA TP 1	(2002) Guide for Determining Energy Efficiency for Distribution Transformers
NEMA WD 1	(1999; R 2005; R 2010) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2002; R 2008) Wiring Devices Dimensions Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code
NFPA 70E	(2012) Standard for Electrical Safety in the Workplace

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.147	Control of Hazardous Energy (Lock Out/Tag Out)

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Jul 2007) Standard for Flexible Metal Conduit
UL 1660	(2004; Reprint Apr 2008) Liquid-Tight Flexible Nonmetallic Conduit
UL 198M	(2003; Reprint Oct 2007) Standard for Mine-Duty Fuses
UL 20	(2010) General-Use Snap Switches
UL 360	(2009; Reprint Jun 2009) Liquid-Tight Flexible Steel Conduit
UL 4248	(2007) UL Standard for Safety Fuseholders
UL 467	(2007) Grounding and Bonding Equipment

UL 486A-486B	(2003; Reprint Feb 2010) Wire Connectors
UL 486C	(2004; Reprint Feb 2010) Splicing Wire Connectors
UL 498	(2001; Reprint Apr 2010) Attachment Plugs and Receptacles
UL 50	(2007) Enclosures for Electrical Equipment, Non-environmental Considerations
UL 510	(2005; Reprint Apr 2008) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2004; Reprint Apr 2010) Metallic Outlet Boxes
UL 514B	(2004; Reprint Nov 2009) Conduit, Tubing and Cable Fittings
UL 514C	(1996; Reprint May 2011) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 6	(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
UL 651	(2005; Reprint Mar 2010) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
UL 67	(2009; Reprint Sep 2010) Standard for Panelboards
UL 797	(2007) Electrical Metallic Tubing -- Steel
UL 817	(2001; Reprint Oct 2009) Standard for Cord Sets and Power-Supply Cords
UL 83	(2008) Thermoplastic-Insulated Wires and Cables
UL 854	(2004; Reprint Oct 2007) Standard for Service-Entrance Cables
UL 869A	(2006) Reference Standard for Service Equipment
UL 870	(2008) Standard for Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2006; Reprint May 2010) Ground-Fault Circuit-Interrupters

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms

used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panelboards; G

Transformers; G

Wireways; G

SD-03 Product Data

Conduit, raceways and fittings; G

Outlet boxes and covers; G

Cabinets, junction boxes, and pull boxes; G

Wire and cable; G

Splices and termination components; G

Receptacles; G

Device plates; G

Switches; G

Fuses; G

Transformers; G

Ground rods; G

Ground conductor; G

Ground connectors and fasteners; G

Surge protective devices; G

Submittals shall include performance and characteristic curves.

SD-06 Test Reports

600-volt wiring test; G

Grounding system test; G

Transformer test; G

Ground-fault receptacle test; 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.

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 MATERIALS AND EQUIPMENT

Materials, equipment, and devices shall, as a minimum, meet requirements of UL, and shall be UL labeled where UL standards are established for those items. Comply with the requirements of NFPA 70.

2.2 CONDUIT AND FITTINGS

Shall conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6, hot dipped galvanized finish only.

2.2.2 Polyvinyl Chloride (PVC) Conduit

UL 651, Schedule 40 for concrete encasement and Schedule 80 for exposed and direct buried installations.

2.2.3 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3.

2.2.4 Plastic-Coated Rigid Steel Conduit

NEMA RN 1, Type 40 (40 mils thick).

Provide coated conduit and fittings where installed underground and in corrosive areas. Provide coated conduit and fittings where indicated in exterior areas.

2.2.5 Flexible Metal Conduit

UL 1.

Provide galvanized steel type and use in dry locations only.

2.2.5.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360.

Provide protective jacket of PVC extruded over a flexible interlocked galvanized steel core conduit to protect wiring against moisture, oil, chemicals, and corrosive fumes.

2.2.6 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings shall be cadmium- or zinc-coated in accordance with UL 514B.

2.2.6.1 Fittings for Rigid Metal Conduit

Threaded-type. Split couplings unacceptable.

Provide fittings, (pulling-type) conduit bodies, bushings, locknuts and supports constructed of hot dipped galvanized malleable iron or steel.

Gaskets shall be the solid type. 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.

Bushings shall be insulated type. Provide grounding type bushings at both ends on conduit containing service entrance conductors with lug suitable for a copper grounding conductor up to (4/0). Provide capped bushings for spare underground conduits.

Provide gasketed liquid-tight hubs with hot-dipped galvanized finish when connecting rigid steel conduit to steel enclosures in wet or damp locations.

2.2.6.2 Fittings for EMT

Zinc coated steel compression type. Provide connectors with insulated throat.

2.2.7 Fittings for PVC Conduit

NEMA TC 3 and UL 514B.

Provide solvent welded type; cement shall be less than 1 year old.

2.2.8 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

Fitting for flexible nonmetallic conduit shall be hot dipped galvanized malleable iron. Provide external grounding lug for conduit sizes greater than (1-1/4 inch).

2.3 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic. Box type shall be suitable for mounting service installed. Provide required rings, covers, and device plates for all boxes.

2.4 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 100 cubic inches, UL 50 and NEMA 250.

Pull and junction boxes in dry locations shall be hot-dipped galvanized steel without knockouts and with screw fastened covers.

Cabinets or boxes installed in interior dry locations shall be rated NEMA 1 except for boxes in mechanical equipment rooms which shall be rated NEMA 12.

Cabinets or boxes installed in wet or damp locations shall be rated NEMA 4X and fabricated from Type 316 stainless steel.

Boxes with terminal strips or components installed shall include hinged covers, latch, pad-lock provisions, and interior mounting panel.

2.5 WIRES AND CABLES

Wires and cables shall meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.

2.5.1 Conductors

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and capacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.5.1.1 Minimum Conductor Sizes

Minimum size for branch circuits shall be No. 12 AWG; for Class 1 remote-control and signal circuits, No. 14 AWG; for Class 2 low-energy, remote-control and signal circuits, No. 16 AWG; and for Class 3 low-energy, remote-control, alarm and signal circuits, No. 22 AWG.

2.5.2 Color Coding

Provide for service, feeder, branch, control, and signaling circuit conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals shall be white with a different colored

(not green) stripe for each. Color of ungrounded conductors in different voltage systems shall be as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 120/240 volt, single phase

(1) Phase A - black

(2) Phase B - red

d. DC

(1) Positive (+) - red

(2) Negative (-) - black

2.5.3 Insulation

Unless specified or indicated otherwise (e.g. service entrance, outdoors, underground, and wet locations) or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN/THHN-2 conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW or TF, conforming to UL 83. Where lighting fixtures require (90 degrees C) 194 degrees F conductors, provide only conductors with (90 degrees C) 194 degrees F insulation or better.

2.5.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

Equipment grounding conductors installed in PVC conduit shall be bare copper wire.

2.5.5 Service Entrance, Outdoor, Underground, and Wet Locations Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

Use Type RHW-2/USE-2 with EPR insulation where installed as service entrance, outdoors, underground, and in wet locations.

2.5.6 Cable Tray Cable

UL listed; type TC.

2.5.7 Cord Sets and Power-Supply Cords

UL 817.

2.6 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

Make all splices in AWG No. 8 and larger with copper indentor crimp-type connectors and compression tools. Joints shall be factory insulated or wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

Make terminations to NEMA type cable pads using copper 2-hole standard or long barrel (as required) indentor crimp-type lugs.

Manufacturer's required tooling and dies shall be used on indentor crimp-type lugs.

Vinyl electrical tape shall be 8.5-mil thickness suitable for high and low temperature use.

Rubber splicing tape shall be 30-mil Ethylene Propylene Rubber (EPR) rated (90 degrees C) 194 degrees F.

Insulate and waterproof splices in conductors installed underground by one of the following methods which are suitable for continuous submersion in water:

a. Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material which shall be applied in accordance with the manufacturer's written instructions.

b. Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation shall not require heat or flame, or any additional materials such as covering or adhesive. It shall be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

2.7 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets to suit the devices installed. For metal outlet boxes, plates on unfinished walls shall be of zinc-coated sheet steel or cast metal having round or beveled edges. Plates on surface mounted boxes shall not extend past the box or box cover edge. For nonmetallic boxes and fittings, other suitable plates may be provided. Plates on finished walls shall be satin finish stainless steel, minimum 0.03 inch thick. Screws shall be machine-type with countersunk heads in color to match finish of plate. Sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed and UL listed for "wet locations."

2.8 SWITCHES

2.8.1 Toggle Switches

NEMA WD 1, UL 20, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Handles shall be brown thermoplastic. Wiring terminals shall be screw-type, side-wired. Contacts shall be silver-cadmium and contact arm shall be one-piece copper alloy. Switches shall be rated quiet-type ac only, 120/277 volts, with current rating, switching arrangement, and number of poles indicated on the drawings.

2.8.2 Disconnect Switches

NEMA KS 1. Where switches are rated higher than 240 volts, provide heavy duty type switches. Fused switches shall utilize Class R fuseholders and fuses, unless indicated otherwise. Switches serving as motor-disconnect means shall be horsepower rated.

Provide equipment ground bus bar for equipment grounding conductors and isolated neutral assembly for neutral conductors.

Provide switches in enclosures per NEMA ICS 6 as follows:

a. Dry Locations except Mechanical Equipment Rooms - NEMA 1.

b. Mechanical Equipment Rooms - NEMA 12.

c. Damp or Wet Locations - NEMA 4X Type 316 stainless steel.

2.9 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch. Time-current characteristics curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Fuses shall have voltage rating not less than circuit voltage.

2.9.1 Fuseholders

Provide in accordance with UL 4248.

2.9.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 198M, Class RK-5. Associated fuseholders shall be Class R only.

2.9.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type CC

UL 198M, Class CC for zero to 30 ampere control and instrumentation circuits.

2.10 RECEPTACLES

UL 498, hard use, heavy-duty, grounding-type. Ratings and configurations shall be as indicated on the drawings. Bodies shall be of brown as per NEMA WD 1. Face and body shall be thermoplastic supported on a metal mounting strap. Dimensional requirements shall be per NEMA WD 6. Provide screw-type, side-wired wiring terminals. Connect grounding pole to mounting strap. The receptacle shall contain triple-wipe power contacts

and double or triple-wipe ground contacts.

2.10.1 Weatherproof Receptacles

Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Receptacle shall be UL listed for use in "wet locations with plug in use."

2.10.2 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.11 PANELBOARDS

UL 67 and UL 50 having a short-circuit current rating as indicated. Panelboards for use as service disconnecting means shall additionally conform to UL 869A. Panelboards shall be bolt-on circuit breaker-equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise. Main breaker shall be top or bottom mounted as indicated with provisions for connecting the sizes and quantities on incoming cables indicated. Where "space only" is indicated, make provisions for future installation of breakers and shall be oriented for vertical up/down on/off operation. Directories shall indicate load served by each circuit in panelboard. Directories shall also indicate ratings and source of service to panelboard (e.g., Panel PA, 120/208VAC - 100 Amp, served from Panel MDP, Circuit 9). Provide new directories for existing panels modified by this project as indicated on the drawings. Type directories and mount in holder behind transparent protective covering. Panelboards shall be listed and labeled for their intended use. Panelboard shall have nameplates in accordance with paragraph "Field Fabricated Nameplates."

2.11.1 Enclosure

Enclosures shall meet the requirements of UL 50. All cabinets shall be fabricated from sheet steel of not less than No. 10 gauge if flush-mounted or mounted outdoors, and not less than No. 12 gauge if surface-mounted indoors, with full seam-welded box ends. Indoor surface mounted or flush-mounted cabinets shall be hot-dipped galvanized after fabrication; cabinets shall be painted in accordance with paragraph "Painting." Cabinets mounted outdoors shall be NEMA 4X Type 316 stainless steel. Front edges of cabinets shall be form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front. All cabinets shall be so fabricated that no part of any surface on the finished cabinet shall deviate from a true plane by more than (3 mm) 1/8 inch. Holes shall be provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a (13 mm) 1/2 inch clear space between the back of the cabinet and the wall surface. Provide enclosure dead-fronts with latchable hinged doors, door-in-door construction. Flush doors shall be mounted on

hinges that expose only the hinge roll to view when the door is closed. Each door shall be fitted with a combined catch and lock, except that doors over (610 mm) 24 inches long shall be provided with a three-point latch having a knob with a T-handle, and a cylinder lock. Two keys shall be provided with each lock, and all locks shall be keyed alike. Finished-head cap screws shall be provided for mounting the panelboard fronts on the cabinets.

2.11.2 Panelboard Buses

Panelboard buses shall be copper bus bars. Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide main-lug-only where indicated, top or bottom mount as indicated or required, with provisions for connecting the sizes and quantities of incoming cables indicated. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.11.3 Circuit Breakers

Provide molded-case circuit breakers in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.11.4 Surge Protective Devices (for Panelboards)

Provide integral factory installed surge suppression equipment in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.12 ENCLOSED CIRCUIT BREAKERS

Provide enclosed molded-case circuit breakers in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.13 TRANSFORMERS

NEMA ST 20, general purpose, dry-type, self-cooled, ventilated with copper windings. Provide transformers in NEMA 1 enclosures where installed indoors and NEMA 3R Type 316 stainless steel outdoors, respectively, unless otherwise indicated on the drawings. Transformer shall have (220 degrees C) 428 degrees F insulation system for transformers 15 kVA and greater, and shall have (180 degrees C) 356 degrees F insulation for transformers rated 10 kVA and less, with temperature rise not exceeding (80 degrees C) 176 degrees F under full-rated load in maximum ambient of (40 degrees C) 104 degrees F. Transformer of (80 degrees C) 176 degrees F temperature rise shall be capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating. Transformers shall be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

2.13.1 Specified Transformer Efficiency

Transformers shall be energy efficient type. Minimum efficiency, based on factory test results, shall not be less than NEMA Class 1 efficiency as defined by NEMA TP 1.

2.14 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147.

2.15 GROUNDING AND BONDING EQUIPMENT

2.15.1 Ground Rods

UL 467. Ground rods shall be sectional type, solid copper, with minimum diameter of (19 mm) 3/4 inch and minimum length (3 m) of 10 feet.

2.15.2 Ground Bus

Provide copper ground buses in the locations, and as indicated, in the drawings.

2.15.3 Counterpoise

Ground and bond wires for duct bank systems, substations, main panels and distribution points, and ground rod connections must be annealed bare copper conforming to ASTM B3, stranded, with 98 percent conductivity. Wire size must be in accordance with the grounding requirements of NFPA 70. Minimum size shall be 4/0 unless otherwise indicated.

2.15.4 Connectors and Fasteners

Grounding and bonding fasteners above ground or within ground test wells must be copper or bronze and conform to the requirements of UL 467.

Inaccessible ground connections installed underground shall be made by exothermic weld process. Within the welding procedure, include the proper mold and powder charge and conform to the manufacturer's recommendations.

Bonding straps and jumpers must be copper and size must be in accordance with the grounding requirements of NFPA 70. Minimum size shall be No. 4 unless otherwise indicated.

2.16 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.

2.17 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified herein and as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, (3 mm) 0.125 inch thick, white with black center core. Provide red laminated plastic label with white center core where indicated on the drawings. 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 64 mm) one by 2.5 inches. Lettering shall be a minimum of (6 mm) 0.25 inch high normal block style.

2.18 WARNING SIGNS

Provide warning signs for flash protection in accordance with Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS for switchboards, panelboards, industrial control panels, and motor control centers. The Contractor shall assume that switchboards, panelboards, industrial control panels, and motor control centers will likely require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. The marking shall be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.19 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations as indicated.

2.20 WIREWAYS

UL 870. Material shall be steel galvanized 16 gauge for heights and depths up to (150 by 150 mm) 6 by 6 inches, and 14 gauge for heights and depths up to (305 by 305 mm) 12 by 12 inches. Provide in lengths as indicated on the drawings with hinged-cover NEMA Type enclosure and rated per NEMA ICS 6 as follows:

a. Dry Locations except Mechanical Equipment Rooms - NEMA 1

b. Mechanical Equipment Rooms - NEMA 12.

c. Damp or Wet Locations - NEMA 4X Type 316 stainless steel.

2.21 FACTORY APPLIED FINISH

Electrical enclosures installed outdoors should be NEMA 4X, Type 316 stainless steel. Indoor electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements as specified herein. Interior and exterior steel surfaces of equipment enclosures shall be thoroughly cleaned and then receive a rust-inhibitive phosphatizing or equivalent treatment prior to painting. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice. Equipment located indoors shall be ANSI Light Gray. Provide manufacturer's coatings for touch-up work and as specified in paragraph "Field Applied Painting."

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces, shall conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

3.1.1 Underground Service

Underground service conductors and associated conduit shall be continuous with no splices from service entrance equipment to outdoor power system connection.

3.1.2 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures shall be labeled and identified as such.

3.1.2.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, each enclosure, new and existing, shall be labeled as one of several enclosures containing service entrance disconnect devices. Label, at minimum, shall indicate number of service disconnect devices housed by enclosure and shall indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph "Field Fabricated Nameplates." Use lettering of at least (6 mm) 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure, shall be provided only as permitted by NFPA 70.

3.1.3 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Schedule 40 PVC conduit shall be used for underground concrete encasement applications. Schedule 80 PVC conduit shall be used for exposed and direct buried applications where indicated on the drawings. EMT, not to exceed (19 mm) 3/4 inches trade size, may be used in dry indoor locations for feeder and branch circuit wiring not to exceed 240Vac phase-to-phase. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Minimum conduit size shall be (13 mm) 1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings shall be made with metal conduit in fire-rated shafts. Metal conduit shall extend through shafts for minimum distance of (150 mm) 6 inches. Conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors shall be firestopped as indicated.

3.1.3.1 Pull Wire

Install pull wires in empty conduits. Pull wire shall be plastic having minimum (91kg) 200-pound force tensile strength. Leave minimum (915 mm) 36 inches of slack at each end of pull wire.

3.1.4 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum (150 mm) 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

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, corroded 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. Replace clogged conduit that cannot be cleared of obstructions with new.

3.1.4.1 Rigid Steel Conduit

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

3.1.4.2 Electrical Metallic Tubing (EMT)

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

3.1.4.3 Flexible Metallic Conduit

Use flexible metallic conduit to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

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

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

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

3.1.4.4 Rigid Nonmetallic Conduit

Rigid PVC conduit shall be direct buried.

A bare 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.

3.1.4.5 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use in hazardous areas.

e. Do not use in wet or damp locations.

f. Do not use in fire pump rooms.

g. Do not use for feeder or branch circuit wiring larger than (19 mm) 3/4 inches trade size.

h. Do not use for feeder or branch circuits that exceed 240 Vac phase-to-phase.

3.1.4.6 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40 and PVC Schedule 80

(1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, hospitals, power plants, missile magazines, and other such areas.

(2) Do not use in hazardous (classified) areas.

(3) Do not use in fire pump rooms.

(4) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

(5) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

3.1.4.7 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph "Flexible Connections."

3.1.4.8 Service Entrance Conduit, Underground

PVC, Schedule 40. Underground portion shall be encased in minimum of 3 inches of concrete and shall be installed minimum 18 inches below slab or grade.

3.1.4.9 Underground Conduit Other Than Service Entrance

PVC, Schedule 40.

3.1.4.10 Conduit for Circuits Rated Greater Than 600 Volts, Above Ground

Rigid steel conduit.

3.1.4.11 Conduit Installed Under Concrete Slabs

Conduit run under concrete slab shall be located a minimum of (305 mm) 12 inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier.

3.1.4.12 Conduit Through Concrete Slabs

Where conduits rise through concrete slabs, curved portion of bends shall not be visible above finished slab.

3.1.4.13 Conduit Support

Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, beam clamps, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed one-fourth proof test load. Fasteners attached to concrete ceiling shall be vibration resistant and shock-resistant. Holes cut to depth of

more than (38 mm) 1 1/2 inches in reinforced concrete beams or to depth of more than (19 mm) 3/4 inch in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems shall be supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Installation shall be coordinated with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Where conduit crosses building expansion joints, provide suitable expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than (64 mm) 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.4.14 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine.

3.1.4.15 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits where required by NFPA 70.

3.1.4.16 Flexible Connections

Provide flexible steel conduit between (915 and 1829 mm) 3 and 6 feet in length for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size shall be (19 mm) 1/2 inch diameter. Provide liquidtight flexible conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

3.1.5 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, or when surface mounted on interior walls exposed up to (2134 mm) 7 feet above floors and walkways, and where indicated on the drawings. Boxes in other locations shall be sheet steel. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures shall be minimum (100 mm) 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having

square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with beam clamps on steel. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum (610 mm) 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.5.1 Boxes

Boxes for use with raceway systems shall be minimum (38 mm) 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets shall be minimum (100 mm) 4 inches square, except that (100 by 50 mm) 4 by 2 inch boxes may be used where only one raceway enters outlet. Mount outlet boxes flush in finished walls.

3.1.5.2 Pull Boxes

Construct of at least minimum size required by NFPA 70. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.5.3 Extension Rings

Extension rings are not permitted for new construction. Use only on existing boxes in concealed conduit systems where wall is furred out for new finish.

3.1.6 Mounting Heights

Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of operating handle at its highest position is maximum (1981 mm) 78 inches above floor. Mount lighting switches (1220 mm) 48 inches above finished floor. Mount receptacles (457 mm) 18 inches above finished floor, unless otherwise indicated. Mount other devices as indicated. Measure mounting heights of wiring devices and outlets in non-hazardous areas to center of device or outlet. Measure mounting heights of receptacle outlet boxes in hazardous areas to the bottom of the outlet box.

3.1.7 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 2 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 1 AWG and larger diameter, color coding shall be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves.

3.1.8 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make all splices in AWG No. 8 and larger with indentor crimp-type connectors and compression tools. Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

3.1.9 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of (1.6 mm) 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.10 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings as indicated.

3.1.11 Grounding and Bonding

Provide in accordance with NFPA 70 and as indicated on the drawings. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, and neutral conductor of wiring systems. Make ground connection at main service equipment as indicated. Make ground connection to driven ground rods on exterior of building. Interconnect all grounding media in or on the structure to provide a common ground potential. This shall include lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

Ground grids and duct bank ground systems 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 24 inches below the finish grade. Grounding conductors must be exothermically fusion welded together at crossover points and to ground rods.

3.1.11.1 Ground Rods

Provide cone pointed ground rods installed full depth plus (150 mm) 6 inches minimum, installed to provide an earth ground of the appropriate value for the particular equipment being grounded. Ground rods shall be installed using a water jetting procedure. The resistance to ground shall be measured using the fall-of-potential method described in IEEE 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.11.2 Grounding and Bonding Connections

a. Make grounding connections which are buried or otherwise normally inaccessible, excepting specifically those connections for which access

for periodic testing is required, by exothermic weld. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable.

b. Bond metallic enclosures, raceway systems, and all electrical equipment to equipment and earth grounds.

c. Conduits entering boxes and enclosures must be bonded to the box with locknuts and grounding-type bushings connected to the equipment and earth ground systems. Provide adequate bushing ground lug size to accept bonding conductors sized in accordance with NFPA 70.

d. Flexible conduit must have an integral grounding conductor.

e. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

f. Where indicated at ground test wells, make all connections to the ground rod using bolted mechanical connectors. Locate the ground rod near the corner of the hand-hole with enough space to allow attachment of a clamp-on ground test meter to the rod and conductors within the hole.

3.1.11.3 Ground Bus

A copper ground bus shall be provided where indicated on the drawings. Noncurrent-carrying metal parts of transformer neutrals and other electrical equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the service entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately (100 mm) 4 inches above the floor. Connections and splices shall be of the brazed, welded, or bolted, except that bolted connections shall be used for connections to removable equipment.

3.1.11.4 Resistance

Maximum resistance-to-ground of grounding system shall not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Contracting Officer for further instructions.

3.1.12 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications but shall be provided under the section specifying the associated equipment.

3.1.13 Manhole and Duct Bank Grounding

Provide counterpoise and ground rods for new duct bank systems as indicated on the drawings. Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable

across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

Provide bare grounding conductors. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 4 AWG.

Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately (305 mm) 12 inches above finished floor. Secure the conductor to the manhole walls at intervals not exceeding (915 mm) 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 4 AWG conductor.

3.1.14 Repair of Existing Work

3.1.14.1 Workmanship

Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

3.1.14.2 Existing Concealed Wiring to be Removed

Existing concealed wiring to be removed shall be disconnected from its source. Remove conductors; cut conduit flush with floor, underside of floor, and through walls; and seal openings.

3.1.14.3 Removal of Existing Electrical Distribution System

Removal of existing electrical distribution system equipment shall include equipment's associated wiring, including conductors, cables, exposed conduit, surface metal raceways, boxes, and fittings, back to equipment's power source and as indicated on the drawings.

3.1.14.4 Continuation of Service

Maintain continuity of existing circuits of equipment to remain. Existing circuits of equipment shall remain energized. Circuits which are to remain but were disturbed during demolition shall have circuits wiring and power restored back to original condition.

3.1.15 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS. Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 14 calendar working days' notice prior to each test.

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

Perform all applicable inspections and electrical tests, including optional tests unless indicated otherwise, in accordance with NETA ATS for all equipment provided including but not limited to:

1. Transformers

2. Circuit Breakers, Air, Insulated-Case/Molded-Case - Do not perform current injection trip tests.

3. Grounding Systems

4. Low Voltage Conductors

3.5.1 Conductors

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.

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 panelboards, 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 8 AWG 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 damage to existing or new electrical equipment resulting from Contractor mis-wiring will be repaired and re-verified at the Contractor's expense. All repairs shall be approved by the Contracting Officer prior to acceptance of the repair.

3.5.2 Panelboards

Panelboards shall be given continuity and insulation tests after the installation has been completed and before the panelboard is energized.

Conduct insulation tests on 480-volt panelboards using a 1,000-volt insulation-resistance test set. Record readings every minute until three equal and consecutive readings have been obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Conduct insulation tests on panelboards rated 300 volts or less using a 500-volt minimum insulation-resistance test set. Record readings after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Record test data and include the location and identification of panelboards and megohm readings versus time.

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 Contracting Officer.

3.5.3 Ground-Fault Receptacle Test

Test ground-fault receptacles with a tester that trips the receptacle. Verify receptacle is reset after tester is removed.

3.5.4 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

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

3.5.4.1 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.

3.5.4.2 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 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.

Place auxiliary grounding electrodes in accordance with instrument manufacturer's recommendations but not less than 50 feet apart, in accordance with IEEE 81.

-- End of Section --

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SECTION 26 23 00.00 98

LOW-VOLTAGE SWITCHGEAR
10/07

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 WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2011) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM A276	(2010) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A572/A572M	(2007) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A666	(2010) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM E84	(2012) Standard Test Method for Surface Burning Characteristics of Building Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2012) National Electrical Safety Code
IEEE C37.121	(1989; R 2006) American National Standard for Switchgear-Unit Substations - Requirements
IEEE C37.20.1	(2002; INT 1 2005; AMD A 2005; AMD B 2006; R 2007) Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker

Switchgear

IEEE C37.90 (2005) Standard for Relays and Relay Systems Associated With Electric Power Apparatus

IEEE C37.90.1 (2002; Errata 2003; Errata 2004) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

IEEE C57.12.28 (2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity

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

IEEE 4 (1995; Amendment A 2001) Standard Techniques for High Voltage Testing

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NETA MAINT (2011) Standard for Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-104-696 (2001) Standard for Indoor-Outdoor Optical Fiber Cable

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1 (2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2011; Errata 2 2012) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568-C.3 (2008; Corrections 2008) Optical Fiber Cabling Components Standard

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595 (Rev C) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 1558 (1999; Reprint Apr 2010) Metal-Enclosed

	Low-Voltage Power Circuit Breaker Switchgear
UL 1666	(2007; Reprint May 2011) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
UL 467	(2007) Grounding and Bonding Equipment

1.2 SYSTEM DESCRIPTION AND GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS and Section 26 08 00 APPARATUS INSPECTION AND TESTING apply to work specified in this section.

This specification details the requirements for electrical switchgear rated 600 volts and less.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submit these items together with NASA Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES submittals which is referenced in this section.

SD-02 Shop Drawings

Submit Shop Drawings, including connection diagrams, for approval prior to switchgear fabrication indicating the relations and connections of the following items by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

All Shop Drawings shall be computer aided design (CAD) generated. With each submittal, provide a CD with a complete copy of the drawings in PDF format.

Submit Shop Drawings for the following:

Switchgear Assemblies; G

Buses; G

Switchgear Components; G including all control switches and auxiliary relays

Control-Power Circuit Transfer Contactor; G

Space Heaters; G

One-Line Diagrams; G These diagrams shall cover all electrical equipment and system.

Programmable Logic Controller; G

Sequence of Operation; G This document shall cover all switchgear operational modes including Local Only Mode, Remote-Automatic Mode, and Remote-Manual Mode.

Multi-Function Relays; G

Schematics and Wiring Diagrams; G

Switchgear Monitoring and Control Systems; G Include hardware with touch screen monitor, software, and interconnection drawings which include details of the power sources and communications pathways for devices accessed by KCCS.

Electrical Power Monitoring System; G

KCCS Project Integration Data; G Provide prior to the second and third KCCS integration review meetings.

Switchgear Electrical Interlocks; G

Final Coating; G

Certificate of Compliance; G showing Switchgear Monitoring and Communication System hardware successfully communicate with existing Citect Software.

Submit fabrication drawings for fabrication and assembly details to be performed in the factory; G

Fabrication drawings shall cover the following:

- Switchgear Assemblies

- Enclosures

- Buses

- Switchgear components including all control switches and auxiliary relays.

- Weatherproof prefabricated housing

- Local/remote switches

- Control-power circuit transfer contactor

- Switchgear electrical interlocks

- Space heaters

Submit Installation Drawings; G These drawings shall cover the switchgear assemblies in accordance with the paragraph entitled "Installation" of this section. Include in these drawings complete details of equipment layout and design.

Switchgear Foundation Data; G This document shall cover switchgear assemblies and shall include dimensioned plans of foundations and

relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

Submit "As-Built" Shop Drawings after installation, inspection and testing is complete which document all field changes made. Provide digital media compact disc (CD) with all submittals including .DWG or .DXF CAD source files as well as PDF format files for all drawings.

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Switchgear Assemblies; G

Enclosures; G

Buses; G

Switchgear Components; G Include all control switches and auxiliary relays.

Local/Remote Switches; G

Weatherproof Prefabricated Housing; G

Control-Power Circuit Transfer Contactor; G

Space Heaters; G

Programmable Logic Controller; G

Switchgear Monitoring and Control System; G Include hardware with touch screen monitor, software, and interconnection drawings which include details of the power sources and communications pathways for devices accessed by KCCS.

Electrical Power Monitoring System; G

Uninterruptible Power Supply; G

Recommended Spare Parts List; G

SD-06 Test Reports

Submit Factory Test reports on switchgear assemblies in accordance with paragraphs entitled "Factory Testing" of this section; G

Include the following Production Test reports on switchgear assemblies with the Factory Test reports:

- Dielectric Tests
- Relay and Metering circuit performance tests
- Mechanical Operation Tests
- Complete Functional Testing of the entire system

- Grounding of Instrument Transformer Casing Test

- Electrical Operation and Control Wiring Tests including Circuit Continuity

- Polarity Verification

Submit field test reports on switchgear assemblies in accordance with paragraph entitled "Field Testing," of this section; G

Submit field test reports on switchgear assemblies in accordance with paragraph entitled "Relay Settings and Tests," of this section; G

Submit field test reports on switchgear assemblies in accordance with paragraphs entitled "Field Testing for Communications," of this section; G

Do not energize switchgear assemblies until recorded test data has been approved by the Contracting Officer.

SD-07 Certificates

Controls Specialist Qualifications; G Include the qualifications of the controls engineer that will perform PLC controls installation, KCCS system integration, and overall system validation.

Submit Certificate of Compliance showing successful completion of the certification testing as required by the paragraph entitled "Certification Testing" of this section; G

SD-08 Manufacturer's Instructions

Submit Manufacturer's Instructions for the Switchgear Assemblies; G Include special provisions required to install equipment components and system packages, and special notices detailing impedances, hazards, safety precautions, and installation instructions.

SD-10 Operation and Maintenance Data

Provide six (6) bound, and six (6) CD ROMs in PDF format, Operation and Maintenance Manuals for each switchgear assembly; G

Include data on the following elements in Operation and Maintenance Manuals:

- Multi-Function Relays

- Circuit Breakers

- Trip Units

- Contactors

- Control Switches

- Electrical Power Monitoring System

- Programmable Logic Controller

- Touch Screen

- Uninterruptible Power Supply

- As-Built Schematics

- As-Built Wiring Diagrams

- As-Built One-Lines

- Switchgear Operation Procedures

Provide six (6) bound, and six (6) CD ROMs in PDF format, copies of the Switchgear Monitoring and Control Systems Manuals for each switchgear assembly; G

Include data on the following elements in Switchgear Monitoring and Control Systems Manuals:

- Complete system description

- All instruction leaflets and technical data

- All software programs

- Device address listing

- Software data files

- Function block program

- All application software screens

- Detailed start-up report, including a list of customer trained individuals

- List of programming and monitoring software and hardware

1.4 SERVICE CONDITIONS

1.4.1 General Requirements

Items provided under this section shall be specifically suitable for the following service conditions:

a. Ambient Temperature: (50 degrees C) 120 degrees F

b. Frequency: 60 Hz

c. Humidity Control

d. Hurricane Force Winds

e. Salt Fog Corrosive Atmosphere

1.4.2 Humidity Control

Provide thermostatically and humidistatically controlled space heaters inside each section/cubicle of the substation as required to preclude the buildup of condensation within the substation.

1.4.3 Hurricane Force Winds

Substation housing and associated substructure shall be of sufficient construction to withstand a Basic Wind Speed of 130 mph (3 sec. gust) without physical damage due to wind loading or wind driven rain water infiltration.

1.5 DRAWINGS

1.5.1 Shop Drawings

Provide dimensioned plan, elevation, and cross-section details and schematic, one-line, and wiring diagrams (full point-to-point wiring tags) for the switchgear.

1.5.2 Fabrication Drawings

Provide fabrication and assembly drawings detailing the work to be performed in the factory. Fabrication drawings shall cover the following:

- Switchgear Assemblies
- Enclosures
- Buses
- Switchgear components including all control switches and auxiliary relays.
- Weatherproof prefabricated housing
- Local/remote switches
- Control-power circuit transfer contactor
- Switchgear electrical interlocks
- Space heaters

1.6 OPERATION AND MAINTENANCE DATA REQUIREMENTS

Include Operation and Maintenance Manuals for each switchgear assembly to include the following:

- Instruction manuals for each device, including but not limited to multi-function relays, circuit breakers, trip units, contactors, control switches, metering, touch screens, uninterruptible power supplies (UPS), spare parts lists, and Programmable Logic Controllers (PLC) furnished in the switchgear.
- Maintenance Manuals for each device, including but not limited to multi-function relays, circuit breakers, trip units, contactors, control switches, metering, touch screens, UPS units, recommended spare

parts list, and PLCs furnished in the switchgear.

- Final as-built schematics, as-built one-lines, and as-built wiring diagrams (full point-to-point wiring tags) for the switchgear.

- Integral switchgear operation procedures detailing all switching modes including, but not limited to loss of one source, loss of both sources, closed transition loss of PLC, loss of touch screen.

- Sequence of Operation for all switchgear operational modes including Local Only Mode, Remote-Automatic Mode, and Remote-Manual Mode.

Provide Operation and Maintenance Manuals for the Switchgear Monitoring and Control System (SMCS) to include the following:

- Instruction manuals for each device

- Complete system description

- All instruction leaflets and technical data

- All software programs on CD ROM

- Function block program and device address listing

- Software data files and screens

- Detailed start-up report including a list of customer trained individuals

- List of programming and monitoring software and hardware

- All application software screens

Provide two (2) original licensed copies of all software manuals with the final Operation and Maintenance Manuals package.

1.7 DEFINITIONS

The Kennedy Complex Control System (KCCS) is a combination of hardware and software components that are used to monitor and control Power, HVAC, Water and Waste and Pneumatic Utilities across the Kennedy Space Center.

Citect is an Industrial Controls, Supervisory Control and Data Acquisition (SCADA) software application that is used to monitor and control the I/O devices connected to the KCCS network. The Citect application provides the Human Machine Interface (HMI) to display, trend, alarm and control and/or monitor the I/O points connected to or through the I/O devices. Information is transferred to and from the Citect server over a dedicated Ethernet controls network using Modbus TCP/IP as the transportation protocol.

1.8 MANUFACTURER QUALIFICATIONS

Material and equipment to be provided under this specification must be the standard catalog product of a manufacturer regularly engaged in the manufacture of switchgear assemblies and their component parts and equipment. Equipment must be of the latest standard design, and must have been in repetitive manufacture for at least 150 units.

1.9 ENGINEERING SERVICES

Power system analysis, arc-flash studies, and protective relay settings for all equipment specified in this section shall be in accordance with Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS.

The Contractor shall provide a Controls Specialist to oversee the integration and validation of the substation PLC controls and the integration of the PLC, trip units, and metering into the KCCS system. Submit the qualifications of the controls engineer for approval.

1.10 ARRANGEMENT AND AUXILIARY EQUIPMENT

a. Substations SS-227A and -227B circuit breaker and auxiliary compartments shall be arranged as indicated.

b. Auxiliary compartments for each substation, both SS-227A and -227B, shall be equipped with instrumentation and control components as indicated in the paragraph entitled "Switchgear Assemblies."

PART 2 PRODUCTS

2.1 EQUIPMENT STANDARDS

IEEE C37.20.1 and UL 1558, arrangement as indicated, consisting of main, distribution, bus-tie, and auxiliary sections. Switchgear shall be listed and labeled by the manufacturer as suitable for use as service equipment. The main, distribution, bus-tie, and auxiliary sections shall be of indoor construction, installed in a pre-fabricated custom walk-in style weather-tight corrosion-resistant housing. Two separately housed single-ended arrangement single line-ups of switchgear, each with a bus-tie, shall be connected together as shown on the drawings, to form a double ended arrangement. The housing shall be designed for outdoor service with ventilation openings, gasketing provided to ensure a weather-tight assembly under rain, snow, sleet, corrosive atmospheres, and hurricane conditions. The housing shall include hinged external rear doors to provide unfettered access to the cable terminations in the rear of each section (main, distribution, bus-tie, and auxiliary) without requiring the removal of any bolts. There shall be no other barriers between the cable terminations and the external rear doors. External doors shall have handles/latching mechanisms with provisions for padlocking.

2.2 CONSTRUCTION

2.2.1 Switchgear and Auxiliary Compartments

Switchgear assemblies and auxiliary equipment must be stationary, mounted in self-supporting, self-contained, sheet metal enclosures with front and rear hinged full size doors. Secure switchgear front compartment doors and covers with knurled knob bolts. Provide the capability to lock doors with standard padlock type lock. Join sheet metal compartments together to form a continuous structure. Construct sheet metal barriers, enclosures, external covers and doors from cold-rolled carbon-steel sheets of commercial quality not less than 14-gage, with stretcher-level flatness in accordance with ASTM A1008/A1008M.

Unit sheet metal must enclose one or more vertically mounted power circuit breakers or auxiliary equipment in individual sheet metal compartments and

a full height rear compartment. Provide enclosure of approximately 90 inches high with individual ventilated front hinged panels and bolted side and top covers. Rear compartment must contain the main bus, main bus-tap connections, cable connections, and instrument transformers. Rear compartment shall be accessible via the housing external rear doors without the need to remove any other barriers. Provide closure plates/flanges to close openings between the rear of the switchgear enclosure and the housing. Fasten closure plates/flanges to switchgear enclosure and housing.

2.2.2 Compartment Details

Completely wire compartments with cable terminals, cable clamps, control bus, control power switch, and terminal blocks. Generate and submit Schematics and Wiring Diagrams for each compartment. Make terminal blocks readily accessible for the external connections of metal-enclosed switchgear.

Run low-voltage wiring for controls and accessories to terminal blocks having numbered points, as indicated, to identify circuits. Run low-voltage wiring in conduit or wiring raceways to isolate the wiring from high-voltage circuits. Clearly identify all wiring connections.

Clearly identify and designate, by cubicle, all switchgear components, including but not limited to fuse blocks, push buttons, selector switches, indicating lights, and terminal blocks (i.e., 1A, 1B, 2A, 2B, this being cubicle 1 device A, cubicle 1 device B, etc.) Identify device designation with a label, with a minimum 1/4 inch high lettering. Wiring between sections/cubicles must identify the end devices by section/cubicle number and device designation.

Provide terminal blocks with engraved plastic terminal strips with screw type terminals having letter designations and numbered terminal points. Terminal blocks in each section/cubicle used for the same wiring as the adjacent sections/cubicles must have the same letter designation preceded by the section/cubicle number. Terminal blocks associated with current transformers must be short circuiting type. Terminal blocks with sliding links are not allowed. Terminal blocks for multi-ratio current transformers must be wired with all taps and ground, one terminal block per current transformer. Wiring must be SIS Class insulation, sized No. 12 AWG at 120/240 panel with 20 amp breakers, No. 14 AWG for control, No. 12 AWG for potential leads, and No. 10 AWG for current leads. Terminate all current conductors with compression ring terminal lugs and control and potential conductors with compression forked (with tabs) terminal lugs. Do not use male/female spade connectors. Final conductor leads for terminations on the switchgear heaters must be a minimum of 150 degrees high temperature wiring.

Locate at each end, wire marking for controls, metering, relaying, and accessory conductors. Wire markers must be white plastic tubing heat stamped with black block type letters. On all wire markers, indicate the device or equipment, including specific terminal numbers to which the other end of the wire is attached, and the terminal number to which the wire is directly attached (near end/far end marking).

Identify each compartment of the switchgear assembly by an identification plate engraved with circuit and function designations. Plate must be a minimum of 1 inch high and long.

Removable elements of the same type and rating in the switchgear assembly

must be physically and electrically interchangeable in corresponding compartments. Provide front-hinged panel suitable for mounting instruments, relays, control switches, and indicating lamps.

Barriers between a sectionalized bus with bus sectionalizing breakers in a compartment must be sheet steel not less than 11 gage. Other covers, barriers, panels, and doors must be not less than 14 gage.

Reinforce each compartment with structural members and weld together. Grind welds to a smooth flat surface before painting.

2.2.3 Mimic Bus

Provide mimic bus using 3/32 inch red plastic laminate. Mimic bus must show breakers and bus. Fasten to switchgear using stainless steel screws.

2.2.4 Buses

Switchgear assemblies must be completely bused utilizing electrical grade, high conductivity, solid copper bus bar having a rectangular cross section. Uniformly position and phase sequence main, riser and bus tap connections in accordance with IEEE C37.20.1. Support and brace buses to withstand, both electrically and mechanically, a short circuit current of not less than 65,000 amperes symmetrical.

Provide silver-plated termination and connection points on all bus bar used in the switchgear. Silver coating methods that do not use the flow of electrical current as part of the process are not acceptable. After plating the contact surface do not sand or abrade, clean only with a soft cloth immediately prior to final assembly.

All bus bar connections must be made using silicon bronze or Grade 5 steel bolts with wide flat silicon bronze or Grade 5 steel washers under the bolt head and nut. Tighten and check connections by use of a calibrated torque wrench. Other connection designs can be used with the written agreement of the Contracting Officer.

Make main bus readily accessible for connection of future switchgear assemblies at end opposite from main. Main and auxiliary control drawout type connections must be silver-to-silver contact, positive pressure, self-aligning, with enclosure-to-enclosure stationary mechanism when breaker is in drawout position.

Voltage rating and insulation level of switchgear assemblies must be as specified and conform to IEEE C37.20.1.

Temperature limits for buses and bus-tap connections in switchgear assemblies must be in accordance with IEEE C37.20.1.

Extend a continuous rigid copper ground bus throughout the entire assembly and ground the stationary structure and equipment. Ground bus must be capable of carrying the rated short circuit current of the protective devices in the switchgear assembly for a minimum period of 30 cycles.

Provide removable main bonding jumper bus bar of suitable size, between the neutral and ground buses.

Insulating supports must consist of track-resistant, flame-retardant IEEE

Class 130 electrical insulating materials. Voltage rating and insulation level must conform to IEEE C37.20.1.

2.2.5 Switchgear Assemblies

Provide general arrangement of the number of compartments and each compartment's components as shown.

Include a metal-enclosed low-voltage power circuit breaker in bus sectionalizing switchgear compartments.

Provide drawout power circuit breakers with three-position operation:

- Connected Position - Contacts are fully engaged. Breaker must be tripped before it can be racked into or out of this position.
- Test/Disconnect Position - Position must allow for complete testing and operation of the breaker without energizing the primary circuit.
- Withdrawn (Removed) Position - Places the breaker completely out of the compartment, ready for removal.
- Breaker truck switches shall be wired in series or parallel with each mechanism operated contact used in control sequences such that control sequences consider breaker position.

Drawout compartments must contain the mechanisms for racking the breaker on and off the bus. Provide a barrier that covers energized bus when the breaker is in the withdrawn position.

Secondary feeder switchgear compartments must include the following equipment:

- Metal-enclosed low-voltage power circuit breaker
- Provisions for terminating cables of the metal-enclosed bus

Auxiliary station power compartments must include the following:

- Control-power transformer and primary fuses
- Circuit overload protection
- Potential transformers for relaying purposes
- Lamp ground detectors
- Batteries and battery charger
- Circuit breaker control transformer

Auxiliary compartments for both Substations SS-227A and -227B, must include the following:

- Main breaker line-side source potential transformers; use three potential transformers for inputs to voltage relay, metering, and synchronization check relay.
- Three main breaker line-side source current transformers; 2500:5

multi-ratio.

- Main breaker multi-function voltage relay.
- Main breaker synchronization check relay, transformer source to substation bus check.
- Main source power meter - Square D CM4250 network connected to the unmanaged Ethernet switch.
- Test switches for main breaker relays and metering.
- Main breaker load-side (substation bus) potential transformers; use three potential transformers for inputs to metering and synchronization check relay.
- Test switches for automatically controlled tie relays.
- Three future MCC breaker line-side source current transformers for sub-metering; 1600:5 multi-ratio.
- Future MCC Feeder power sub-meter - Square D PM820 network connected to the unmanaged Ethernet switch.
- Test switches for future MCC sub-meter.
- Control power transformer and source transfer contactor.
- UPS unit.
- Programmable Logic Controller (PLC) and touch-screen interface. PLC shall be mounted such that the modules are facing out, away from the back panel of the switchgear.
- Miscellaneous switches, relays, time relays, and indicating lights.

Auxiliary compartments for Substation SS-227A only must include the following additional components:

- Automatically controlled tie breaker (Substation SS-227A only) line-side source potential transformers; use three potential transformers for inputs to voltage relay and synchronization check relay.
- Automatically controlled tie breaker (Substation SS-227A only) multi-function voltage relay.
- Automatically controlled tie breaker (Substation SS-227A only) synchronization check relay, substation bus to tie breaker source check.
- Test switches for automatically controlled tie relays.
- Three MCC-A breaker line-side source current transformers for sub-metering; 1600:5 multi-ratio.
- MCC-A Feeder power sub-meter - Square D PM820 network connected to the unmanaged Ethernet switch.
- Test switches for MCC-A sub-meter.

Fully equip switchgear spare breaker compartments for future use to receive the removable element with complete bus connections, disconnecting devices, rails, and cell interlocks.

Provide filler compartments incidental to the switchgear assembly as empty compartments with hinged cover plates.

Main and feeder power circuit breakers must be suitable for fully rated nonselective trip systems in accordance with IEEE C37.121.

Supply a breaker lifting device and racking handle for each switchgear.

2.2.6 Corrosion Protection

Frames, channels, panels, and doors of switchgear housing shall be corrosion resistant and shall be fabricated of 304 stainless steel. Base shall include any part of switchgear that is within 3 inches of concrete pad. Paint switchgear housing, including bases with manufacturer's high perform coating system per IEEE C57.12.29. Prepare stainless steel surfaces per coating manufacturer's instructions. Paint color shall match the adjacent O&C M7-355 building exterior finish color.

2.2.6.1 Stainless Steel

Stainless steel sheet, strip, plate, and flat bars shall conform to ASTM A666, Type 304. Stainless steel bars and shapes shall conform to ASTM A276, Type 304.

2.2.7 Weatherproof Prefabricated Housing

2.2.7.1 Construction

Housing shall be weatherproof, prefabricated, with exterior walls and roof constructed from self-framing interlocking panels to house and protect the internal equipment installed in configuration shown on the drawings. Structural grid base and floor shall be designed for applicable floor loading allowing the structure to be lifted and transported with (as applicable) the interior equipment installed.

Basic design loads, as well as auxiliary and collateral loads include live load and wind load, in addition to the dead load.

Housing shall provide for an aisle along the front of the switchgear of adequate width and height to allow the removal and insertion of circuit breakers.

2.2.7.2 Materials

Structural steel frame fabricated from steel channel, wide flange and angle sections forming a self-supporting grid to support floor.

a. Steel Grade: ASTM A572/A572M (C10 and larger) or ASTM A36/A36M (C8 and smaller).

b. One (1) set of removable lift lugs. (Due to shipping considerations, these items are shipped loose with the building).

c. All welding to be in accordance with AWS D1.1/D1.1M Structural Welding

Code.

d. All bolts for field assembly of primary structural members (where required) shall be high strength bolts conforming to ASTM A307 and be a minimum of 1/2-inch diameter.

Floor Plate - 5/16-inch, stainless steel.

Base Structure - galvanized steel with epoxy paint finish.

Exterior Walls - 12 gauge interlocking stainless steel panels with Series 300 stainless steel (18-8) fasteners.

Insulated Roof Panels - 12 gauge interlocking stainless steel insulated panels (2 inch thick rigid insulation between stainless steel sheets) with Series 300 stainless steel (18-8) fasteners. Insulation shall be polyurethane, polyisocyanurate, or manufacturer's standard with a maximum flame spread of 25 and a smoke developed rating of 450 per ASTM E84. Penetrations of, or through insulated roof panels are not permitted.

2.2.7.3 Doors and Hardware

Provide the following Personnel Doors and Hardware.

a. Personnel Doors, 3ft x 7ft x 1-3/4in, 18 Gauge Stainless Steel, swing as indicated, with 3-inch Factory Stainless Steel Frame. Each shall include the following:

- Stainless Steel Hinges
- Stainless Steel TOUCH Type Panic Hardware - Lockwood/Magnokrom N1500-5XOT53 x 32D w/Cylinder Lock Exterior Trim
- Closer w/Stopping Arm
- Crash Chain
- Aluminum Threshold
- Weatherstripping
- Stainless Steel Drip Edge
- Removable Transom above Door (MRT)

Sign "Danger Electrical Equipment / Authorized Personnel Only"

Provide the following Equipment Doors and Hardware.

a. Equipment Doors, Louvered (stamped louvers in doors), 12 Gauge Stainless Steel, size and swing as indicated and/or as required. Each shall include the following:

- Stainless SteelHinge
- Hold Open Device
- Padlocking Handle
- Adjustable Cam w/2 Notches Hub for Unthreaded Shank Pawl Equipment Door Locking
- Equipment Door Access Brackets
- Adjustable Rod Guide
- 60-inch Closer Rods
- Full Gasketing
- Drip Shield
- Sign (as appropriate) "Danger High Voltage / Keep Out" or "Danger Electrical Equipment / Authorized Personnel Only"

2.2.7.4 Finishes/Colors

Finish system as follows:

a. Exterior Wall and Roof Surfaces: Type 304 Stainless Steel with High Performance Coating

- Prepare surface per coating manufacturer's instructions/recommendations.
- Shop Applied High Performance Primer and Finish coats per requirements of IEEE C57.12.29.
- Provide one (1) quart touch-up paint shipped inside structure.
- Color shall match adjacent O&C M7-355 building.

b. Interior Wall and Ceiling Surfaces: Type 304 Stainless Steel with High Performance Coating

- Prepare surface per coating manufacturer's instructions/recommendations.
- Shop Applied High Performance Primer and Finish coats per requirements of IEEE C57.12.29.
- Provide one (1) quart touch-up paint shipped inside structure.
- Color to be "White."

c. Floor and Base: Type 304 Stainless Steel with High Performance Coating

- Prepare surface per coating manufacturer's instructions/recommendations.
- Shop Applied High Performance Primer and Finish coats per requirements of IEEE C57.12.29.
- Provide one (1) quart touch-up paint shipped inside structure.
- Color to be ANSI 61 "Gray."

d. Floor Underside:

- Clean and prepare all surfaces per SSPS standards as recommended by coating manufacturer.
- Undercoat - Transcoat 101™, 10 mils DFT
- VOC - 0.0
- Federal Specification TT-C-520B
- Asbestos Free
- Flame Spread Rating = 0

2.2.7.5 Electrical Utilities

Provide in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS for all electrical utility systems.

Conduit

a. Indoor, Dry Locations - Exposed EMT conduit (set screw fittings) as required by NEC.

b. Outdoor, Underground, and Wet Locations - Exposed PVC coated galvanized rigid steel conduit as required by NEC, 3/4-inch diameter minimum, ANSI C80.1.

Panelboards, Interior

a. Provide in switchgear auxiliary compartments. Power 120 and 240 V ac for all lighting, receptacle and equipment circuits from this panelboard.

Wire

a. Power Wiring - Use Type THHN/THWN-2 in indoor dry locations and Type RHW-2/USE-2 in outdoor, underground, and wet locations, #12 AWG Stranded Minimum

- Temperature Rating 600V 90 degrees C Dry and 75 degrees C Wet
- Insulation - Flame Resistant PVC
- Meets UL "VW-1" Flame Test Requirements
- Standard Color Coding:

Single Phase Circuits	Three Phase Circuits	DC Circuits
A-Black	A-Black	Pos(+)-Red
B-Red	B-Red	Neg(-)-Black
	C-Blue	
N-White	N-White	
G-Green	G-Green	Ground-Green

Provide color identification within each enclosure where tap, splice, or termination is made. For conductors No. 2 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 1 AWG and larger diameter, color coding shall be by plastic coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink sleeves.

Interior Lighting and GFCI Receptacles

a. Provide a minimum average maintained illumination on the floor of 300 lux 30 footcandles. Lighting shall be accomplished using vapor-tight fluorescent luminaires employing F32T8 fluorescent lamps and (-18 degrees C) 0-degrees F ballasts.

b. Provide a timer switch for controlling lighting located adjacent to the main access door.

c. Provide one exterior and two interior 20A, 120V ac, NEMA 5-20R, industrial grade ground fault circuit interrupter (GFCI) type duplex receptacles. The interior receptacles shall be located, on each, at each end of the housing for servicing the switchgear.

d. Combination Emergency Light/Exit Sign (Green)

- AC Input Voltage 120/277 Volts
- Lamp LED/Color Green
- Wall or Ceiling Mount
- Power Circuit - 120V, 1 Phase 20A

Item(s) shall be powered every 4-6 weeks during storage to prevent

battery failure and meet manufacturer's warranty requirements.

Exterior Lighting

a. Exterior Light, Wallpack 4000K LED Type III (SR3) 3250 lumens (min.)

- Internal Photo Cell (1 per system)
- Listings - UL 1598 Listed for Wet Location
- Power Circuit - 120V, 1 Phase 20A

Grounding

a. Ground Pads - 4 Hole Stainless Steel Welded

b. Ground Lug - #4/0

c. Copper Bar Ground Loop

Copper Bar 2-inch x 1/4-inch
Mounting Anchors
3 Inches Below Ceiling Mounted on Wall

d. Ground Drops from Ground Loop to Ground Lugs @ Base or Equipment Ground Bus

Ground Circuit 4/0 Bare Copper Cable

e. Ground Drops from Ground Loop to Small Equipment

M Ground Circuit (Sized as Required $\leq$ #8) Copper Wire)

Ventilation

a. Exhaust Fan Assembly 16-inch diameter - 117 CFM w/Aluminum Damper and Thermostat

b. Power Circuit - 120 VAC, 1-Phase, 20A

c. Intake Louver Assembly - 24-inch x 24-inch w/Damper and Aluminum Mesh Filter

2.2.7.6 Lifting and Transporting Housing

During lift and transport, the housing shall be supported at all times at the lift lug locations.

2.2.8 Switchgear Foundations

Submit Switchgear Foundation Data for switchgear assemblies. Include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

2.3 SWITCHGEAR COMPONENTS

Switchgear components including but not limited to circuit breakers, trip units, protective relays, metering, surge protective devices, instrument transformers, control-circuit transformers, indicating lights, and control components in accordance with NASA Section 26 05 71.00 40 LOW-VOLTAGE

OVERCURRENT PROTECTIVE DEVICES.

2.3.1 Power Circuit Breakers

All switchgear, main, tie, and feeder breakers must be drawout type power circuit breakers and conform to Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.3.2 Molded-Case Circuit Breakers

Molded-case circuit breakers must conform to Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.3.3 Instruments and Instrument Transformers

Indicating instruments, protective relays, current and potential transformers, instrument transfer switches, and control-circuit transformers must conform to the applicable requirements of Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.3.4 Control-Power Transformer and Panelboard

Provide 480 V ac single-phase primary to 120/240 V ac single-phase secondary transformer to serve the switchgear ac loads. Transformer kVA rating shall be equal to the sum of the loads connected thereto plus 100 percent spare capacity, or 15kVA, whichever is greater. Transformer shall be designed for continuous operation at rated kVA 24 hours a day, 365 days a year with normal life expectancy as defined in IEEE C57.96. Dry-type, two-winding type, (115 degrees C) 239 degrees F rise above (40 degrees C) 104 degrees F maximum ambient, with copper windings, designed for mounting in switchgear cubicle. Provide 2-pole, 65kAIC rated thermal-magnetic molded-case transformer primary circuit breaker. Primary circuit breaker shall have ampere rating in accordance with NFPA 70 for the primary current of the transformer while operating at rated kVA with rated primary voltage applied. Provide 2-pole, 10kAIC rated thermal-magnetic molded-case transformer secondary main circuit breaker and distribution panelboard to individually supply all switchgear loads indicated or required. Secondary circuit breaker shall have ampere rating in accordance with NFPA 70 for the secondary current of the transformer while operating at rated kVA with rated primary voltage applied. Provide branch-circuit breakers group mounted within the switchgear panelboard to serve heaters, exhaust fans, lights, convenience outlets,and other devices.

2.3.5 Control-Power Circuit Transfer Contactor

Design contactor for automatic transfer of control-power for 120/240-volt, single-phase, 60-Hz service with current rating as required. Make contactor the open type, two-pole, double-throw with solid neutral connections and must automatically transfer its load circuits to the alternate power supply upon loss of power in the normal supply. Device must be electrically operated and mechanically held and obtain its operating current from the source to which the load is transferred. Provide contactors for automatic transfer of control power suitable for installation in metal-enclosed switchgear. Provide two extra normally open and two extra normally closed contacts. One set of contacts must be wired to the PLC for status indication.

2.3.6 Service and Maintenance Devices

Include the following service and maintenance devices as a part of the switchgear:

- A manual handle for operating the air and power circuit breaker isolating mechanism
- Removable manual maintenance closing devices for air and power circuit breakers
- Facilities for operating air and power circuit breakers in the test or removed position
- Facilities for withdrawing air and power circuit breakers for inspection or maintenance
- Test plugs and cable for meters and relays
- A NEMA 5-20R GFCI receptacle at each switchgear end for service tools

2.3.7 Protective Relays and Devices

Protective relays and devices must test and comply with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES and IEEE C37.90.1.

2.3.8 Circuit Breaker Control Switches

Control switch must be miniature rotary cam operated devices with individual stages, a dust-tight cover and contacts with a positive wiping action, and conform to IEEE C37.90. Make contacts silver-to-silver or an approved substitute which provides equal or superior performance. Contacts must have a rating adequate for the duty performed, but not be less than 600 volts, 20 amperes continuous. Provide circuit breaker control switches with a red and green target and a combination of maintained action and spring return type of operation. Provide pistol grip handle on circuit breaker control switch. Switch must be equipped with engraved plastic escutcheons identifying its function ("Breaker Control") and ("Trip/Close") position.

2.3.9 Local/Remote Switches

Install a manually operated, three position rotary snap-action switch with silver-plated contacts to disengage all automatic and remote controls from the switchgear when in local mode. Locate this switch in the bus tie section of the switchgear.

Label the states of the switch "Local Only" and "Remote-Automatic" and "Remote-Manual." Provide at least two extra normally open and two extra normally closed sets of switch contacts for each position. One set of contacts must be wired to the PLC for status indication.

2.3.10 Indicator Lights

Indicator lights must comply with Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Make indicator light colors as follows and label according to the following functions:

Function	Color
Breaker Open	Green
Breaker Closed	Red
Power On	Red - (Control Power)
Local Only Mode	Green
Automatic Transfer Mode	Blue
Manual Transfer Mode	White
Auto Lockout	Amber

2.4 ZONE-SELECTIVE INTERLOCKING SYSTEMS

Provide a separate zone-selective interlocking system for each switchgear. The zone selective interlocking system for each switchgear shall interconnect the switchgear main, tie-bus, and feeder power circuit breakers together such that a short circuit and/or ground fault on the switchgear internal bussing will be cleared by the main power circuit breaker, or the tie-bus power circuit breaker in sequence with the main power circuit breaker, with no intentional time delay. Refer to Section 26 05 71.00 40 paragraph "Power Circuit Breakers" for additional requirements.

2.5 SWITCHGEAR MONITORING AND CONTROL SYSTEMS

Provide complete switchgear monitoring and control systems as described in this section. These systems are defined to include, but are not limited to, a programmable logic controller (PLC) that monitors and controls remote devices, touch screen display human machine interface (HMI), electrical power monitoring system, device communications interface hardware, intercommunication wiring, software, startup and training services, and ongoing technical support. This system shall comply with the applicable portions of IEEE 802.3. The Manufacturer and Controls Specialist shall demonstrate that the communication systems provided under this project will communicate efficiently with the KCCS Citect software. Efficiently implies that the data will be transmitted and received such that the response time to the KCCS workstation will be less than 4 seconds. This demonstration shall include multiple trip units, meters, a PLC and a laptop loaded with the KCCS Citect project software. Provide two licensed copies of all software and all hardware necessary to modify and download the program to the touch screen.

Provide the Citect operator screens to monitor and control the new data points on any new or modified switchgear that communicates to KCCS. The Government will perform the final integration of the new screens, Genies, and Super Genies into the existing KCCS Citect file server. The Citect project modifications shall include but not be limited to creating variable, alarm and trend tags, modifying/developing Genies and Super Genies and modifying/developing operator screens.

A Government sample KCC Citect project containing a library of Citect symbols, Genies and Super Genies will be provided to the Contractor to use for development of the new operator screens. The sample project includes the Citect interfaces for the CM 4250 power meters, the Modicon Quantum PLC and the Square D Micrologic trip units. If the SMCS communication architecture described in the design documents are followed, new development for existing components will not be required. New operator screens depicting the new switchgear are still required but they can be developed using the existing KCCS Citect library.

Three KCCS integration design reviews will be scheduled by the Contractor

to ensure that all of the parties involved in developing any new Citect interfaces (screens, Genies, Super Genies, alarms data exchange methods) are properly coordinated. The first meeting will be a kickoff meeting where the Government will provide a sample KCCS Citect project to assist in the development of new interfaces. Provide KCCS Project Integration Data for the second and third review meetings. At the second meeting, the Contractor will provide a sample of all the new types of Citect interfaces that are being developed. At the third meeting, the Contractor will provide a fully working sample of the entire project. The first meeting shall be scheduled within 75 days of the contract award.

Main and tie-bus circuit breakers shall be electrically operated with capability to be both operated locally via touch screen and remotely via KCCS. Main-Tie-Main (M-T-M) circuit breakers shall be electrically interlocked so that only two of the three breakers may be closed for any extended length of time by operation of the respective breaker closing.

A separate hardware timer shall be provided that will trip the tie-bus circuit breaker if all three circuit breakers are closed for a period adjustable from 0-60 seconds.

Main circuit breakers shall include multi-function voltage relays with adjustable pick-ups and time delay.

A control-power circuit transfer contractor shall be provided for the automatic transfer of control power.

The UPS unit shall supply power to the power meters, trip units, shunt trip/close coils, indicating and status lights, PLC touch screen, and a double duplex receptacle in the controls compartment for the communication equipment such as the unmanaged Ethernet switch and media converters. The receptacle on UPS power shall be clearly marked "UPS POWER" using a laminated plastic nameplate having 3/16-inch high white letters on black background.

Main and tie-bus circuit breakers shall be equipped with three-phase sync-check relays, hardwired to main and tie-bus circuit breaker control schemes for fail safe operation. These functions will be available even when the PLC is not functioning.

Any main or tie circuit breaker trip shall activate a separate lockout relay that electrically blocks any subsequent close operation, automatic or manual, for that breaker. If a main or tie breaker trips, block close circuits shall ensure that the faulted section cannot be re-energized from another source until the lockout relay is reset.

All transfer control functions shall be accomplished via the PLC. Circuit breakers shall remain in the last state if PLC is taken off-line.

All timing and control for automatic transfer shall be performed via the PLC. Auxiliary relays shall only be used where circuit breaker control circuit exceeds the rating of the PLC output contacts. Auxiliary relays shall only be used to directly connect one circuit breaker control circuit. Use of auxiliary relays to provide relay logic or timing functions is not permitted. Relays shall be industrial grade, octal based, single tier with screw terminals, pilot light, retainer clip, vibration resistant 10 amp rated output contacts.

The switchgear transfer control shall be designed to auto transfer load on

loss of power on either of the two sources and provide automatic re-transfer on source return after an adjustable time period. The re-transfer operation shall be selectable either open or closed transition from touch screen display or KCCS remote operator.

The touch screen display controls shall allow the user to enable/disable the automatic transfer function and initiate the appropriate changes to the PLC logic to allow the selection of the desired unit substation modes of operation. Modes of operation are 'Automatic' or 'Manual' with re-transfer options for either 'Open' or 'Closed' transition. The touch screen display controls shall also allow the user to change the time delays for the transfer scheme. These changes shall not require the use of additional equipment such as a laptop computer or additional PLC programming software. Touch screen display controls for operating circuit breakers shall require two step commands, the first to initiate the command and the second to confirm command. The touch screen shall be Magelis Touch Screen XBTF034510 or approved equal.

Selection of 'Closed' transition, selectable from the touch screen display, also disables electrical interlocks functions, specifically, circuit breakers can be configured such that all three (M-T-M) can be closed simultaneously for a limited duration. This protective function is intended to ensure the three circuit breakers are not closed for an extended duration.

2.5.1 Programmable Logic Controller (PLC)

For compatibility, PLC shall be NASA KSC Standard, Schneider Electric Modicon Quantum Series, and no other. Provide touch screen display with the following characteristics and features:

a. Industrial grade
b. Impact and scratch resistant
c. Color screen with greater than or equal to (228 mm) 9 inch screen size
d. Screen lockout for cleaning
e. Field replaceable display that is capable of being replaced while in service
f. Provide one spare display for each display installed
g. Integrated drivers for direct serial connection to PLC
h. Simultaneous communications with multiple PLCs
i. Dual serial communication ports
j. Windows based configuration software
k. Support for third party graphics
l. Dynamic object based graphics
m. Bitmap graphics
n. Software manuals
o. Users manuals
p. Interface cables

2.5.1.1 Discrete Input Points

Provide the following discrete input points to the PLC:

a. Secondary voltage monitors
b. Main circuit breaker status open/close
c. Tie-bus circuit breaker status open/close
d. Automatic/Manual transfer mode status
e. Trip lockout indications on all electrically operated circuit breakers
f. Normal configuration

g. UPS control contactor position indication
h. Internal status registers of the PLC (communication via Ethernet connection TCP/IP or connection with Modicon quantum PLC)

2.5.1.2 Discrete Outpoint Points

Provide the following discrete output points to the PLC:

a. Main circuit breaker open/close
b. Tie-bus circuit breaker open/close
c. Automatic/Manual transfer control function
d. Open/Close retransfer control function

2.5.2 Power Circuit Breaker Trip Units

Power circuit breaker trip units shall conform to Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.5.3 Electrical Power Monitoring System

Provide the following metering equipment:

a. Main: Where indicated, provide metering equipment to monitor energy usage on the circuit indicated. For compatibility, metering equipment shall be NASA KSC Standard, Schneider Electric Square D CM4250 with ECC21 Ethernet communications card, IOC input/output card, and CMDLC backlit LCD display, and no other. Provide meter appurtenances, including cables, as required for complete and proper operation. Metering equipment shall conform to Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Install metering equipment in accordance with the metering equipment manufacturer's published installation instructions. Mount metering equipment in strict accordance with the orientation recommendations of the metering equipment manufacturer. Mount LCD display on the front panel of the compartment containing the circuit being monitored.

b. Feeder: Where indicated, provide metering equipment to monitor energy usage on the circuit indicated. For compatibility, metering equipment shall be NASA KSC Standard, Schneider Electric Square D PM820 with PM8ECC Ethernet communications card, and no other. Provide meter appurtenances, including cables, as required for complete and proper operation. Metering equipment shall conform to Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Install metering equipment in accordance with the metering equipment manufacturer's published installation instructions. Mount metering equipment in strict accordance with the orientation recommendations of the metering equipment manufacturer. Mount LCD display on the front panel of the compartment containing the circuit being monitored.

2.5.4 Communications

Provide for the exchange of data via Ethernet communications with the following:

a. KCCS
b. Circuit breaker trip unit interface
c. Electrical Power Monitoring System (Modbus TCP)

Provide industrial unmanaged Ethernet switch N-TRON 309FX-ST or equal.

Provide industrial media adapters as required. Ethernet communications contained completely within switchgear shall employ 4-pair #23 AWG CAT6 Type CM indoor/outdoor rated fully water blocked and sunlight resistant cable. Ethernet communications extending outside of switchgear shall employ 62.5/125 um multimode (OM1) indoor/outdoor all dielectric riser (OFNR) rated backbone fiber optic cable (FOC) conforming to ICEA S-104-696, TIA-568-C.3, UL 1666, and NFPA 70.

2.5.5 Sequence of Operation

Sequence of operation for the transfer scheme of the Main-Tie-Main (M-T-M) circuit breakers shall be as follows:

2.5.5.1 General

M-T-M transfer scheme shall have two operating modes: Automatic and Manual each with selectable open transition and closed transition switching. Modes of operation shall be selectable via the touch screen display or remotely via KCCS. Circuit breakers shall remain in the last state when mode is changed except when going to the automatic mode. Only controls under the current mode shall have any control capability over the circuit breakers. Over current, under voltage, and synchronization check trip or block close features shall not be defeated in any mode. Use synchronization relay (Device 25) and lockout relay (Device 86) contacts to provide trip and block close functions independent of the PLC.

The normal configuration for switchgear is with the main circuit breakers in the closed position, the tie-bus circuit breaker in the open position, the PLC program in 'Automatic' transfer and 'Closed' transition modes, and the mode selector switch in the "Remote-Automatic" position.

The switchgear transfer control shall be designed to auto transfer load on loss of power on either of the two sources and provide automatic re-transfer on source return after an adjustable time period. The re-transfer operation shall be selectable either Open or Closed transition from touch screen or KCCS remote operator.

2.5.5.2 Remote-Automatic Operation

The "Automatic" transfer mode is designed as the normal configuration for the M-T-M transfer scheme and gives the PLC at the unit substation complete and autonomous control of the switchgear. The PLC program shall be controlled by KCCS to allow KCCS to take control of the switchgear remotely through an Ethernet connection to the PLC by enabling or disabling the 'Automatic' transfer mode. An indicator light seen on the front of the switchgear shall illuminate while in the 'Automatic' transfer mode.

If KCCS has enabled the 'Automatic' transfer mode, the circuit breakers will remain in their current positions unless one of the following situations occur:

a. Loss of one feeder:

1. If the multifunction voltage relay (27,47,59) for main A or main B detects phase voltage imbalance, loss of voltage, under voltage, or over voltage, for a period adjustable from 1 to 120 seconds initially set at 10 seconds, the corresponding main breaker shall open. After the main breaker has opened, the tie-bus circuit breaker shall close. The switchgear will then act as a

single-ended switchgear.

2. When voltage returns to the affected main circuit breaker, all circuit breakers shall remain in the transferred state until a retransfer is initiated by the transfer scheme calling for an automatic closed transition retransfer. If the automatic retransfer scheme is not selected, retransfer shall be done by personnel at the site or remotely by KCCS disabling the automatic transfer control feature. A closed transition retransfer shall be allowed only through a sync-check relay either by the transfer scheme, personnel at the site or remotely by KCCS disabling the automatic transfer control feature.

3. In the event that the retransfer scheme is not set to automatically retransfer and a retransfer has not been accomplished locally or remotely, after voltage has returned to the affected side, and voltage is lost to the transferred side, the transferred side main circuit breaker shall open and the initial main circuit breaker shall close. All circuit breakers shall remain in the new transferred state as described above.

b. Loss of both source feeders:

1. If the multi-function voltage relay (27,47,59) detect phase voltage imbalance, loss of voltage, under voltage, or over voltage on both sides simultaneously (plus or minus 3 seconds adjustable), then two main circuit breakers shall remain closed and the tie-bus breaker shall remain open.

2. If the voltage returns to the main to one side of the unit substation for a period adjustable from 1 to 120 seconds initially set at 60 seconds, the main on the other side shall open and the tie-bus circuit breaker shall close.

c. A discrete indication of "Remote-Automatic" mode shall be sent to KCCS via a set of contacts.

2.5.5.3 Remote-Manual Operation

The "Remote-Manual" transfer mode is designed to give either a local operator or the KCCS operator (at a remote location) complete control of the switchgear. The operator takes control of the switchgear by enabling or disabling the 'Automatic' transfer mode. An indicator light visually seen on the front of the switchgear shall illuminate while in the 'Manual' transfer mode. When the KCCS operator remotely engages the 'Manual' transfer mode, the circuit breakers will remain in their current positions and the following shall apply:

a. Mains and Tie 'Open' functions shall operate directly from KCCS commands and touch screen display.

b. Mains and Tie 'Close' functions shall operate by KCCS and touch screen after verification of the sync-check relay and respective breaker trip lockout device.

c. Open Transition mode shall prevent the paralleling of the main and tie breakers.

d. Closed Transition mode (selectable from the touch screen) enables

closed transition switching if the sources are synchronized per the settings on the synchronization relay.

e. Breaker controls shall be electrically interlocked so that at the most two of the three breakers (M-T-M) can be closed for an extended amount of time. If two out of the three breakers are closed and if the third breaker is called to close, the source feeders shall be verified through the sync-check relays that each source feeder is synchronized before the third breaker is closed.

f. A discrete indication of "Remote-Manual" mode shall be sent to KCCS via a set of contacts.

2.5.5.4 Local Only Mode

This mode is designed to give the operator at the switchgear complete and autonomous control of the switchgear. When the local/remote switch is placed in the local position the control outputs of the PLC and all inputs and/or commands to the breakers from KCCS and the CM4250 power meters shall be disabled. This will ensure that once in the local only mode, KCCS, the PLC or any other communication network will not be capable of operating the breakers or changing the mode of operation. A set of contacts shall be provided for KCCS from the local/remote switch such that when the switch is in local position, a discrete signal is sent to KCCS. An indictor light visually seen of the inside of the switchgear shall illuminate while in the local only mode. Switchgear electrical interlocks shall be active for safe switchgear operations including closed transitions. When the operator has placed the local/remote switch in the local position, the following shall occur:

a. Any remote commands to the breakers, including the automatic functions (PLC) of the transfer scheme shall be disabled with the exception of the outputs from protective relays.

b. All breakers shall remain in their current state.

c. Mains and Tie OPEN functions shall operate directly from control switches.

d. Main and Tie CLOSE functions shall operate by the control switches after verification of the sync-check relay and respective breaker trip lockout device.

e. Breaker control switched shall be electrically interlocked so that at no more than two of the three breakers (two mains and the tie) can be closed for an extended period of time. If the third breaker is called to close, the zero to 60 second hardware timer shall be initiated. At the end of the designated time setting, the tie breaker will open.

f. The control switch for each breaker shall only be operational in the local mode.

g. A discrete indication shall be sent to KCCS via a set of contacts indicating the switchgear is in the local only mode.

2.6 SWITCHGEAR FINISH

2.6.1 Protective Coatings

The equipment finish must meet the requirements of IEEE C57.12.28. Holidays, sags, pinholes, blistering, solvent popping or rust as part of the finish are not acceptable. Provide smooth and even finish resistant to corrosion, sunlight and abrasion with high impact strength.

2.6.2 Surface Preparation

Steel parts must be free of weld slag and mill scale. Chemically clean, rinse, phosphate coat, rinse, and de-ionize switchgear enclosure in preparation for the powder coat.

2.6.3 Powder Coat

Coat the switchgear enclosure with a corrosion resistant thermosetting polyester coating applied by electrostatic powder spray. Apply a minimum coating of 2.5 mils uniformly and pinhole free.

2.5.4 Final Coating

Following the application and cure of the powder coat and the manufacturing assembly of the switchgear enclosure, apply a final finish coat to the switchgear enclosure with silicone enamel, free from surface defects with a minimum 1.5 mil dry film thickness. The color of the final coating must be light gray in accordance with FED-STD-595 and must be approved by the Contracting Officer prior to shipping the switchgear from the factory.

2.7 SPACE HEATERS

Provide 120-volt ac space heater(s) in each switchgear section. Each space heater shall be of sufficient capacity to control moisture condensation in the compartments. Heaters shall be sized to provide approximately 4 watts per square foot of outer surface area. Provide heaters that have a power density that does not exceed 4 watts per square inch of heater element surface. Provide heaters that are rated at 240-volts for connection to 120-volts. Locate heaters at the lowest portion of each space to be heated. Cover terminals. Use thermostats to regulate the temperature.

Install operable heaters at the time of shipment for use immediately upon arrival at the site, during storage, or before installation. Prominently mark connection locations on drawings and shipping covers. Provide temporary leads capable of plugging into a standard 120 volt, 20 amp receptacle for storage operation. Make connections easily accessible without having to remove shipping protection.

2.8 UNINTERRUPTIBLE POWER SUPPLY

Provide an Uninterruptible Power Supply (UPS) system sized for a minimum of 15 minutes of battery backup for the control power loads. The UPS must be capable of operating in an ambient temperature of 0 to 60 degrees C (32 to 140 degrees F) and a relative humidity of 5 to 95 percent. Mount the UPS in a spare compartment or cubicle.

PART 3 EXECUTION

3.1 CERTIFICATION TESTING

Perform Certification Testing showing Switchgear Monitoring and Communication System successfully communicates with existing Citect Software prior to the approval of the switchgear. Compliance Certification Testing must include a Government witness qualification demonstration of at least, but not limited to the following equipment if the proposed hardware has not been previously approved (current approved hardware is from Square D):

Circuit breakers

Trip units

PLC

Meters

Include in testing verification of the Citect Screens using a PC and the current Citect software.

Submit certificate of compliance showing completion of certification testing.

3.2 FACTORY TESTING

Factory witness testing (source inspection), at Government's option, must occur at the switchgear manufacturer. The switchgear manufacturer must checkout the switchgear assembly as a connected system. The switchgear manufacturer must demonstrate that the communications system provided under this project communicates efficiently with the Citect software in accordance with the requirements in the paragraph entitled "Switchgear Monitoring and Control Systems" of this section.

Tests on switchgear assemblies must include polarity verification, grounding of instrument transformer casing test, mechanical operation tests, electrical operation and control wiring tests including circuit continuity, relay and metering circuit performance tests, and dielectric tests. Conduct tests in accordance with IEEE 4 and UL 467.

Manufacturer must provide written test results for all tests performed. Submit test reports to the Contracting Officer prior to shipping equipment.

3.3 INSTALLATION

Installation must conform to IEEE C2 and NFPA 70.

Electrically and mechanically connect the complete assembly at the site from coordinated subassemblies shipped in complete sections from the manufacturer. Carefully align, level, and secure complete installation in conformance with the manufacturer's recommendations.

Carefully join separated switchgear assemblies to present a neat appearance,with main and ground bus joints tightened to the manufacturer's recommended torque values. Handle assemblies with appropriate lifting devices.

Submit Installation Drawings for the switchgear assemblies. Include in drawings complete details of equipment layout and design. Include a plan drawing showing all electrical underground installation (duct banks, conduits, grounding) that meets the design requirements indicated on the drawings but is coordinated to actual equipment provisions provided.

3.4 FIELD TESTING

The switchgear manufacturer must provide the test equipment, labor and technical expertise for testing and checkout of the switchgear assembly as a connected system after it is installed. Provide manufacturer's written test results for all tests performed. Submit test reports including Certificate of Compliance to the Contracting Officer prior to energizing equipment. Replace any material, equipment or devices found to be defective at no cost to the Government.

Comply with NETA ATS and NETA MAINT for electrical acceptance tests of transformers, switchgear, breakers, relaying, metering and all related material, including secondary current injection tests and manufacturers recommendations. Submit a testing procedure 30 calendar days prior to field testing. Include in the testing procedure a complete functional testing of the entire system which evaluates the functionality and performance of all control and automatic sequencing and operation of the switchgear.

Additional testing to those described in NETA ATS and NETA MAINT are as follows:

a. Demonstrate switchgear automatic transfer scheme, timing functions and interlocks for mains and tie breaker operate as specified.

b. Remove all controls and UPS power from PLC/PC and verify when power is restored, programming automatically recovers with no anomalies. This test must ensure fully functional programming is restored and ready to operate on restoration of power to PLC/PC. Perform this test three separate times.

c. Demonstrate control voltage automatic transfer relay and components until on properly.

d. Functionally verify SMCS system through the Ethernet connection fully operational and all I/O functions are as specified.

e. Demonstrate switchgear local/remote switch, if installed, operates as specified.

Final acceptance is dependent upon the satisfactory performance of the equipment under test. Provide final test data to the Contracting Officer.

3.5 RELAY SETTINGS AND TESTS

Properly coordinate all circuit-interrupting devices before the switchgear assemblies are energized. Thoroughly inspect and adjust protective relays at the site in the presence of and at the discretion of the Contracting Officer.

3.6 FIELD TESTING FOR COMMUNICATIONS

3.6.1 Field Quality Control

Furnish the services of a manufacturer's representative and Controls Specialist to assist in starting-up and programming the system. The manufacturer's representative must be factory-trained and have a thorough knowledge of the software, hardware, and system programming. Provide the following services:

a. Perform full functionality tests on the communications network from all IEDs to the Ethernet gateway.

b. Setting all the addresses of all devices in the equipment.

c. Verifying and troubleshooting the integrity of the data line.

d. Assisting the Government in correcting any data line problems.

e. Configure the SMCS software to match the field devices.

3.6.2 Field Testing

Verify complete system operation including all hardware, software and communication devices. Verify networking performance with all interfacing systems by other manufacturers.

Perform all applicable inspections and electrical tests, including optional tests, in accordance with NETA ATS for all switchboard equipment including but not limited to:

a. Switchgear Assemblies
b. Circuit Breakers, Air Low-Voltage Power
c. Protective Relays
d. Instrument Transformers
e. Metering Devices
f. Grounding Systems
g. Ground-Fault Protection Systems, Low Voltage
h. Surge Arresters, Low Voltage

3.6.3 Manufacturers Certification

A qualified factory-trained manufacturer's representative must certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

3.6.4 Training

Furnish the services of manufacturer representatives to train the owner's personnel in operation and programming of the system. The manufacturer representatives must be factory-trained and must have a thorough knowledge of the switchgear, PLC and touch-screen software, hardware and system programming. Include in the training session on the PLC and all controls:

a. Switchgear on-site training

(1) Full operation demonstrations of all functions.

(2) Breaker electrical and mechanical operations.

(3) Explanations and instructions for all protective devices.

b. Classroom on-site training for programming the touch screen.

3.6.5 After Start-Up Support

The manufacturer must provide a 24-hour 800 telephone number manned with Engineers/Technicians expert in SMCS devices, software and communication system troubleshooting or capable of providing technical information. Provide this support at no cost to the Government for a period of five years.

3.7 ENERGIZING SWITCHGEAR ASSEMBLIES

Do not energize switchgear assembly until it is completely installed, tested, approved by the Contracting Officer, and ready for operation. Site testing must be conducted and approved by the Contracting Officer.

Using ammeter, voltmeter, and wattmeter or phase-angle meter, the values and polarities of voltage and current, measure and compare with those expected in the various relay circuits. Inspect and note all contact positions of directional elements and the voltage relays.

After inspection and satisfactory tests have been completed on all active relay circuits under a no-load condition, perform an operational test with diverted load currents or simulated ground faults on each relay.

Prepare a comprehensive report with records of connections, electrical constants, settings, test values, operating performance, and failures or weaknesses found on test.

Tests and procedures for testing must be in accordance with the paragraph entitled "Field Testing" in this section and the manufacturer's recommendations. Upon completion of all testing and approval of the Contracting Officer, the switchgear must be energized, as approved by the Contracting Officer.

-- End of Section --

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SECTION 26 23 00

SWITCHBOARDS
07/06

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 in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D1535	(2012) Specifying Color by the Munsell System
ASTM D709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2012) National Electrical Safety Code
IEEE C57.12.28	(2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA PB 2.1	(2007) General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 V or Less
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products
NEMA PB 2	(2011) Deadfront Distribution Switchboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Grounding and Bonding Equipment
UL 891	(2005) Switchboards

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 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 100.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchboard Drawings; G

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for

operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

All Shop Drawings shall be computer aided design (CAD) generated. Provide Digital media compact disc (CD) with all submittals including .DWG or .DXF files for all drawings. Also on this CD provide a complete copy of the drawings in PDF format.

Submit Shop Drawings for approval prior to equipment manufacturing.

Submit "As-Built" Shop Drawings after installation, inspection and testing is complete which document all field changes made.

SD-03 Product Data

Switchboard; G

SD-06 Test Reports

Acceptance checks and tests; G

Submit test forms showing compliance with NETA ATS inspections and tests for approval prior to testing.

Submit completed test forms showing the results of all inspections and tests in accordance with NETA ATS inspections and tests after inspections and testing is complete.

SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5; G

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G

1.5 QUALITY ASSURANCE

1.5.1 Switchboard Product Data

Each submittal shall include manufacturer's information for each component, device and accessory provided with the switchboard including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings.

b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

c. Manufacturer's standard switchboard application, installation, operation and maintenance manuals.

1.5.2 Switchboard Drawings

Drawings shall include, but are not limited to the following:

a. One-line diagram including breakers

b. Outline drawings including front elevation, section views, footprint, and overall dimensions

c. Bus configuration including dimensions and ampere ratings of bus bars

d. Markings and NEMA nameplate data

e. Circuit breaker type, interrupting rating, and trip devices, including available settings

1.5.3 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.

1.5.4 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.

1.5.4.1 Material and Equipment Manufacturing Date

Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.2 Assembled Operation and Maintenance Manuals

Manuals shall be assembled and bound securely in durable, hard covered, water resistant binders. The manuals shall be assembled and indexed in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

a. Manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data."

b. Catalog data required by the paragraph entitled, "SD-03, Product Data."

c. Drawings required by the paragraph entitled, "SD-02, Shop Drawings." Drawings shall be "as-built" indicating all changes made during the installation.

d. Spare parts and supply list.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be switchboards and related accessories are specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SWITCHBOARD

NEMA PB 2 and UL 891.

2.2.1 Ratings

The voltage rating of the switchboard shall be 480Y/277 volts AC, 4-wire, 3 phase. The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall beas indicated. The switchboard shall be UL listed and labeled for its intended use.

2.2.2 Construction

The switchboards shall be dead-front switchboards conforming to NEMA PB 2 and labeled under UL 891. The switchboards shall be completely enclosed self-supporting metal structures with the required number of vertical panel sections, buses, and molded-case circuit breakers as shown on the drawings. Switchboards shall be fully rated for a short-circuit current indicated.

Switchboard shall consist of vertical sections bolted together to form a rigid assembly and shall be front and rear aligned. All circuit breakers shall be front accessible. Switchboards shall have front accessible load connections. Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboard shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections.

2.2.2.1 Enclosure

The switchboard enclosure shall be indoor NEMA 1 or outdoor NEMA 3R stainless steel (ASTM A167 Type 304 or 304L) per NEMA ICS 6 as indicated built with selected smooth panels not less than 14 gauge. Exposed panels on the front and ends shall have bent angle or channel edges with all corner seams welded and ground smooth. The front outside surfaces shall not be drilled or welded for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front. The front panels shall be made in sections flanged on four sides and attached to the framework by screws and arranged for ready removal for inspection or maintenance.

Enclosure shall be bolted together with removable bolt-on covers, and sloping roof downward toward the rear. Front doors shall be provided with stainless steel padlockable vault handles with a three point catch. Ventilating openings shall be provided as required and shall be of the grille or louver type. All ventilating openings shall be provided with corrosion-resistant, inspect-proof screens on the inside.

Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of ASTM A167 type 304 or 304L stainless steel for outdoor units and galvanized steel for indoor units. Base shall include any part of enclosure that is within 3 inches of concrete pad. Galvanized steel shall be ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

Paint enclosure, including bases, ASTM D1535 light gray No. 61 or No. 49. Paint coating system shall comply with IEEE C57.12.28 for galvanized steel and IEEE C57.12.29 for stainless steel. Treat all interior and exterior steel parts to inhibit corrosion.

2.2.2.2 Bus Bars

Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of 0.0002 inch thick. Make bus connections and joints with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide copper ground bus secured to each vertical section along the entire length of the switchboard. The neutral bus shall be rated 100 percent of the main bus continuous current rating as indicated.

2.2.2.3 Main and Distribution Sections

The main and distribution sections shall consist of individually mounted, molded-case circuit breakers as indicated.

Provide integral factory installed surge suppression equipment in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.2.3 Protective Device

2.2.3.1 Molded-Case Circuit Breaker

Provide molded-case circuit breakers in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.3 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. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.4 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each switchboard and device. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch

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 one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.5 COORDINATED POWER SYSTEM PROTECTION

Provide a power system study as specified in Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS. Set switchboard protective devices in accordance with the approved study submittal.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

3.2.1 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Switchboard

ANSI/NEMA PB 2.1.

3.3.2 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.3.3 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.3.4 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.4.1 Exterior Location

Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 8 inches thick, reinforced with a 6 by 6 inch No. 6 mesh placed uniformly 4 inches from the top of the slab. Slab shall be placed

on a 6 inch thick, well-compacted gravel base. The top of the concrete slab shall be approximately 4 inches above the finished grade. Edges above grade shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4.2 Interior Location

Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 4 inches thick. The top of the concrete slab shall be approximately 4 inches above finished floor. Edges above floor shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turn-ups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS and Section 26 08 00 APPARATUS INSPECTION AND TESTING, with the additions and modifications specified herein.

3.5.1.1 Switchboard Assemblies

a. Perform applicable inspections and electrical tests for switchboard and molded case circuit breaker equipment including but not limited to:

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical, electrical, and mechanical condition.

3. Verify appropriate anchorage, required area clearances, and correct alignment.

4. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

5. Verify that circuit breaker sizes and types correspond to approved shop drawings.

6. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter and by verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

7. Clean switchboard.

8. Inspect insulators for evidence of physical damage or contaminated

surfaces.

9. Exercise all active components.

b. Electrical Tests

1. Perform insulation-resistance tests on each bus section.

2. Verify operation of switchboard heaters.

3.5.1.2 Circuit Breakers

a. Visual and Mechanical Inspection

1. Compare nameplate data with specifications and approved shop drawings.

2. Inspect circuit breaker for correct mounting.

3. Operate circuit breaker to ensure smooth operation.

4. Inspect case for cracks or other defects.

5. Inspect all bolted electrical connections for high resistance using low resistance ohmmeter and verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method.

b. Electrical Tests

1. Perform breaker adjustments for final settings in accordance with Government provided settings.

3.5.1.3 Grounding System

a. Perform inspections and electrical tests in accordance to include the following:

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

1. Measure bond resistance between the switchboard ground bus and the supplying source ground bus and between the switchboard ground bus and the earth ground.

3.5.2 Follow-Up Verification

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

Circuit breakers shall be tripped by operation of each protective device. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

SECTION 31 00 00

EARTHWORK
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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2010) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
AASHTO T 224	(2010) Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600	(2010) Installation of Ductile-Iron Water Mains and Their Appurtenances

ASTM INTERNATIONAL (ASTM)

ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1140	(2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 2487	(2011) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D 4318	(2010) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 6938	(2010) Standard Test Method for In-Place

	Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D 698	(2007e1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

1.2 DEFINITIONS

1.2.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP. Satisfactory materials for grading comprise stones less than 8 inches, except for fill material for pavements which comprise stones less than 3 inches in any dimension.

1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials.

1.2.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D 4318, ASTM C136, ASTM D 422, and ASTM D 1140.

1.2.4 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180 and corrected with AASHTO T 224. To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in AASHTO T 180.

1.2.5 Topsoil

Material suitable for topsoils obtained from excavations is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

1.2.6 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 3 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.2.7 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.2.8 Unstable Material

Unstable materials are too wet to properly support the utility pipe, conduit, or appurtenant structure.

1.2.9 Select Granular Material

1.2.9.1 General Requirements

Select granular material consist of materials classified as GW, GP, SW, or SP, by ASTM D 2487 where indicated.

1.2.10 Initial Backfill Material

Initial backfill consists of select granular material or satisfactory materials free from rocks 2 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, free the initial backfill material of stones larger than 2 inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

1.3 SYSTEM DESCRIPTION

Subsurface soil boring logs are appended to the SPECIAL CONTRACT REQUIREMENTS. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.3.1 Classification of Excavation

Finish the specified excavation on a classified basis, in accordance with the following designations and classifications.

1.3.1.1 Common Excavation

Include common excavation with the satisfactory removal and disposal of all materials not classified as rock excavation.

1.3.1.2 Rock Excavation

Submit notification of encountering rock in the project. Include rock excavation with blasting, excavating, grading, disposing of material classified as rock, and the satisfactory removal and disposal of boulders 1/2 cubic yard or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; firmly cemented conglomerate deposits possessing the characteristics of solid rock impossible to remove without systematic drilling and blasting; and hard materials (see Definitions). Include the removal of any concrete or masonry structures, except pavements, exceeding 1/2 cubic yard in volume that may be encountered in the work in this classification. If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock excavation, uncover such material and notify the Contracting Officer. Do not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

1.3.2 Blasting

Blasting will not be permitted.

1.3.3 Dewatering

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

b. Dewatering plan shall include, as a minimum, locations, method, pumping rate, duration of proposed disposal area, and management practices for sedimentation control. Dewatering shall be continued until construction subject to water pressure has obtained full specified strength and backfill is completed.

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

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

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Dewatering Plan; G

SD-03 Product Data

Utilization of Excavated Materials; G
Rock Excavation

SD-06 Test Reports

Testing

SD-07 Certificates

Testing

PART 2 PRODUCTS

2.1 BURIED WARNING AND IDENTIFICATION TAPE

Provide polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inches minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes

Red:	Electric
Orange:	Telephone and Other Communications

2.1.1 Warning Tape for Metallic Piping

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.003 inch and a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

2.1.2 Detectable Warning Tape for Non-Metallic Piping

Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.004 inch, and a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.2 DETECTION WIRE FOR NON-METALLIC PIPING

Insulate a single strand, solid copper detection wire with a minimum of 12

AWG.

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL

Where indicated or directed, strip topsoil to a depth of 4 inches. Spread topsoil on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inches in diameter, and other materials that would interfere with planting and maintenance operations. Remove from the site any surplus of topsoil from excavations and gradings.

3.2 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph "Finishing." Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Include such excavated material and the satisfactory material ordered as replacement in excavation. Dispose surplus satisfactory excavated material not required for fill or embankment in areas approved for surplus material storage or designated waste areas. Dispose unsatisfactory excavated material in designated waste or spoil areas. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

3.2.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown on Drawings. Do not excavate ditches and gutters below grades shown. Backfill the excessive open ditch or gutter excavation with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed, except in no case allow material be deposited a maximum 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.2.2 Drainage Structures

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete is to be placed.

3.2.3 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.2.4 Dewatering

Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. Do not permit French drains, sumps, ditches or trenches within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Take control measures by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, maintain the water level continuously, at least 1 foot below the working level.

3.2.5 Trench Excavation Requirements

Excavate the trench as recommended by the manufacturer of the pipe to be installed. Slope trench walls below the top of the pipe, or make vertical, and of such width as recommended in the manufacturer's printed installation manual. Provide vertical trench walls where no manufacturer's printed installation manual is available. Shore trench walls more than 4 feet high, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in. Shore vertical trench walls more than 4 feet high. Excavate trench walls which are cut back to at least the angle of repose of the soil. Give special attention to slopes which may be adversely affected by weather or moisture content. Do not exceed the trench width below the pipe top of 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter, and do not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures by the Contractor. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the Government.

3.2.5.1 Bottom Preparation

Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 3 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point

bearing.

3.2.5.2 Removal of Unyielding Material

Where overdepth is not indicated and unyielding material is encountered in the bottom of the trench, remove such material 4 inch below the required grade and replaced with suitable materials as provided in paragraph "Backfilling and Compaction."

3.2.5.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in paragraph "Backfilling And Compaction". When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional cost to the Government.

3.2.5.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members.

3.2.5.5 Jacking, Boring, and Tunneling

Unless otherwise indicated, provide excavation by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections. Refer to Section 33 05 23.13 UTILITY HORIZONTAL DIRECTIONAL DRILLING for more information.

3.2.6 Underground Utilities

The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. Perform work adjacent to non-Government utilities as indicated in accordance with procedures outlined by utility company. Excavation made with power-driven equipment is not permitted within two feet of known Government-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.2.7 Structural Excavation

Ensure that footing subgrades have been inspected and approved by the Contracting Officer prior to concrete placement. Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the Contracting Officer. Backfill and compact over excavations and changes in grade due to pile driving operations to 95 percent of ASTM D 698 maximum density.

3.3 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

Notify the Contracting Officer sufficiently in advance of the opening of any excavation or borrow pit or borrow areas to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, excavate borrow pits and other excavation areas providing adequate drainage. Transport overburden and other spoil material to designated spoil areas or otherwise dispose of as directed. Provide neatly trimmed and drained borrow pits after the excavation is completed. Ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.4 GRADING AREAS

Where indicated, divide work into grading areas within which satisfactory excavated material will be placed in embankments, fills, and required backfills. Do not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing. Place and grade stockpiles of satisfactory and unsatisfactory as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.5 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. Only use excavation methods that will leave the foundation rock in a solid and unshattered condition. Roughen the level surfaces, and cut the sloped surfaces, as indicated, into rough steps or benches to provide a satisfactory bond.

3.6 GROUND SURFACE PREPARATION

3.6.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 6 inches before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 6 inches, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inches and compact it as specified for the adjacent fill.

3.6.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to plus or minus 3 percent

of optimum moisture.

3.7 UTILIZATION OF EXCAVATED MATERIALS

Dispose unsatisfactory materials removing from excavations into designated waste disposal or spoil areas. Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. Submit procedure and location for disposal of unused satisfactory material. Submit proposed source of borrow material. Do not waste any satisfactory excavated material without specific written authorization. Dispose of satisfactory material, authorized to be wasted, in designated areas approved for surplus material storage or designated waste areas as directed. Clear and grub newly designated waste areas on Government-controlled land before disposal of waste material thereon. Stockpile and use coarse rock from excavations for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. Do not dispose excavated material to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

3.8 BURIED TAPE AND DETECTION WIRE

3.8.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.8.2 Buried Detection Wire

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over it's entire length. Install wires at manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, terminate the wire in the valve pit at the pump station end of the pipe.

3.9 BACKFILLING AND COMPACTION

Place backfill adjacent to any and all types of structures, and compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials, to prevent wedging action or eccentric loading upon or against the structure. Prepare ground surface on which backfill is to be placed and provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs "Ground Surface Preparation." Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.9.1 Trench Backfill

Backfill trenches to the grade shown. Backfill the trench to 1 foot above the top of pipe prior to performing the required pressure tests. Leave the joints and couplings uncovered during the pressure test.

3.9.1.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the trench with select granular material or initial backfill material.

3.9.1.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with select granular material placed in layers not exceeding 6 inches loose thickness.

3.9.1.3 Bedding and Initial Backfill

Place initial backfill material and compact it with approved tampers to a height of at least one foot above the utility pipe or conduit. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Compact backfill to top of pipe to 95 percent of ASTM D 698 maximum density. Provide plastic piping with bedding to spring line of pipe. Provide materials as follows:

a. Class I: Angular, 0.25 to 1.5 inch, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

b. Class II: Coarse sands and gravels with maximum particle size of 1.5 inch, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D 2487.

c. Clean, coarse-grained sand classified as SW or SP by ASTM D 2487 for bedding and backfill.

d. Clean, coarsely graded natural gravel, or crushed stone gradation #57 of the DOT or having a classification of GW in accordance with ASTM D 2487 for bedding and backfill as indicated. Do not exceed maximum particle size of 3 inches.

3.9.1.4 Final Backfill

Fill the remainder of the trench, except for special materials for roadways, railroads and airfields, with satisfactory material. Place backfill material and compact as follows:

a. Roadways, Railroads, and Airfields: Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction.

b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Deposit backfill in layers of a maximum of 12 inches loose thickness, and compact it to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Allow water flooding or jetting methods of compaction for granular noncohesive backfill material. Do not allow water jetting to penetrate the initial backfill. Apply this requirement to all other areas not specifically

designated above.

3.9.2 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed, place backfill in such a manner that the structure is not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.10 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.10.1 Gas Distribution

Excavate trenches to a depth that will provide a minimum 18 inches of cover in rock excavation and a minimum 24 inch of cover in other excavation.

3.10.2 Water Lines

Excavate trenches to a depth that provides a minimum cover of 3 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.10.3 Electrical Distribution System

Provide a minimum cover of 24 inches from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.11 EMBANKMENTS

3.11.1 Earth Embankments

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. Place the material in successive horizontal layers of loose material not more than 12 inches in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise brake up each layer; moisten or aerate as necessary; thoroughly mix; and compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements are identical with those requirements specified in paragraph "Subgrade Preparation." Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.12 SUBGRADE PREPARATION

3.12.1 Proof Rolling

Finish proof rolling on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing

subgrade with six passes of a 15 ton, pneumatic-tired roller. Operate the roller in a systematic manner to ensure the number of passes over all areas, and at speeds between 2-1/2 to 3-1/2 mph. When proof rolling, provide one-half of the passes made with the roller in a direction perpendicular to the other passes. Notify the Contracting Officer a minimum of 3 days prior to proof rolling. Perform proof rolling in the presence of the Contracting Officer. Undercut rutting or pumping of material to a depth of 12 inches and replace with fill and backfill material.

3.12.2 Construction

Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 6 inches below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. After rolling, the surface of the subgrade for roadways shall not show deviations greater than 1/2 inch when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area. Do not vary the elevation of the finish subgrade more than 0.05 foot from the established grade and cross section.

3.12.3 Compaction

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, compact each layer of the embankment to at least 95 percent of laboratory maximum density.

3.12.3.1 Subgrade for Pavements

Compact subgrade for pavements to at least 95 percentage laboratory maximum density for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, thoroughly blend, reshape, and compact the top 12 inches of subgrade.

3.13 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph "Subgrade Preparation." Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.13.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all

times. Do not disturb the finished subgrade by traffic or other operation. Protect and maintain the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, or frozen subgrade.

3.13.2 Capillary Water Barrier

Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.13.3 Grading Around Structures

Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.14 PLACING TOPSOIL

On areas to receive topsoil, prepare the compacted subgrade soil to a 2 inches depth for bonding of topsoil with subsoil. Spread topsoil evenly to a thickness of 2 inches and grade to the elevations and slopes shown. Do not spread topsoil when excessively wet or dry. Obtain material required for topsoil in excess of that produced by excavation within the grading limits from offsite areas.

3.15 TESTING

Perform testing by a Corps validated commercial testing laboratory or the Contractor's validated testing facility. Submit qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, Corps validated and approved by the Contracting Officer.

a. Determine field in-place density in accordance with ASTM D 1556.

b. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D 6938; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements.

c. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.15.1 Fill and Backfill Material Gradation

One test per 50 cubic yards stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM C136.

3.15.2 In-Place Densities

a. One test per 2500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 2500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per 50 linear feet, or fraction thereof, of each lift of embankment or backfill for roads.

3.15.3 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

3.15.4 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 50 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.15.5 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph "Subgrade Preparation" during construction of the subgrades.

3.16 DISPOSITION OF SURPLUS MATERIAL

Provide surplus material or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber as removed from Government property as directed by the Contracting Officer.

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SECTION 32 11 24

GRADED CRUSHED AGGREGATE BASE COURSE FOR FLEXIBLE PAVEMENT
11/11

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 C117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C29/C29M	(2009) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM D1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1883	(2007e2) CBR (California Bearing Ratio) of Laboratory-Compacted Soils
ASTM D2217	(1985; R 1998) Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
ASTM D4318	(2010) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D75/D75M	(2009) Standard Practice for Sampling Aggregates

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Aggregates

Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

SD-06 Test Reports

Gradation

Bearing ratio

Liquid limit

Plasticity index

Percentage of wear

Dry weight of slag

Density

Gradation

Smoothness

Thickness

1.3 DELIVERY AND STORAGE

Inspect materials delivered to site for damage and store as to prevent segregation and contamination.

1.4 WEATHER LIMITATIONS

Do not construct base course when atmospheric temperature is below 35 degrees F or when rainfall or other weather conditions detrimentally affect the quality of the finished course.

1.5 CONSTRUCTION EQUIPMENT

Equipment shall be dependable and adequate for the purpose intended. Maintain equipment in satisfactory and safe operating condition. Subject to approval, special equipment dictated by local conditions may be used. Calibrated equipment, such as scales, batching equipment, spreaders, and similar items, shall have been recalibrated by an approved calibration laboratory within 12 months of commencing work.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Aggregates

Consist of durable and sound crushed concrete, crushed masonry, crushed

tile, crushed gravel, crushed stone, or crushed slag, free of lumps or balls of clay or other objectionable matter. Materials shall originate primarily from on-site construction waste, then from off-site construction waste, and finally from other nearby sources as needed. Aggregate material shall contain in total a minimum of 5 percent post-consumer recycled content, or a minimum of 20 percent post-industrial recycled content. Crushed stone and gravel shall be free from flat, elongated, soft, or disintegrated pieces. Crushed gravel retained on a No. 4 sieve shall have at least 90 percent by weight with at least two fractured faces and 100 percent by weight with at least one fractured face. Base course materials samples shall have a bearing ratio of at least 100 as determined by laboratory tests on a 4-day soaked specimen in accordance with ASTM D1883; compact specimen in accordance with ASTM D1557, Method D. Determine grain size in accordance with ASTM C136 and amount of material finer than 200 mesh sieve in accordance with ASTM C117. Aggregate, other than slag, shall have a percentage of wear not exceeding 40 when tested in accordance with ASTM C131, Grading A. Slag shall be an air-cooled, blast furnace product having a dry weight of not less than 70 pounds per cubic foot when tested in accordance with ASTM C29/C29M and shall consist of angular fragments uniform in density and quality, reasonably free from thin, elongated pieces, dirt, or other objectionable material. Soil binder material, that portion of material passing the No. 40 sieve, shall be of such composition that the composite material conforms to the requirements specified herein. The base course shall be of such nature that it can be compacted readily with watering and rolling to a firm, stable base and shall conform to one of the following sizes:

Percentage by Weight Passing
Square Mesh Laboratory Sieves

	Size Numbers		
Sieves	1	2	3
2 inch	100	-	-
1 1/2 inch	70-100	100	-
1 inch	45-80	60-100	100
1/2 inch	30-60	30-65	40-70
No. 4	20-50	20-50	20-50
No. 10	15-40	15-40	15-40
No. 40	5-25	5-25	5-25
No. 200	0-10	0-10	0-10

That portion of the material passing the No. 40sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than 5 as determined by ASTM D4318. Prepare samples in accordance with ASTM D2217, Procedure A.

2.1.2 Pervious Base Course

Base aggregate for pervious pavement systems shall consist of aggregate as specified in paragraph Aggregates except as specified below. Material passing the No. 200 sieve is not permitted. Unevenly graded screenings and stone dust are not permitted.

2.1.2.1 Asphalt-Treated Permeable Base

Asphalt binder shall be steam-refined asphalt, grade AR-8000. "Popcorn mix" aggregate shall conform to the following grading:

Percentage by Weight Passing
Square Mesh Laboratory Sieves

Sieves	Percent Passing
1 inch	100
3/4 inch	90-100
1/2 inch	35-65
3/8 inch	20-45
No. 4	0-10
No. 8	0-5

2.1.2.2 Cement-Treated Permeable Base

Portland cement binder shall be Type II Modified. Pozzolan shall not be substituted for portland cement. Aggregate shall conform to the 1 inch by No. 4 primary nominal coarse aggregate grading, with 52 to 85 percent by weight passing through a 3/4 inch sieve.

PART 3 EXECUTION

3.1 BASE COURSE

Construct the graded aggregate base course on a prepared subgrade, as indicated. Verify compacted subgrade, granular base, or stabilized soil is acceptable and ready to support paving and imposed loads. Provide line and grade stakes for control. Place grade stakes in lanes parallel to the centerline of areas to be paved and space for string lining or other control methods. The base course shall consist of aggregate processed, deposited, spread, and compacted on a prepared surface. The Contractor shall be responsible for protection of completed areas against detrimental effects. Recondition, reshape, and recompact areas damaged by freezing, rainfall, or other weather conditions.

3.2 OPENING AND OPERATION OF PITS

Perform stripping, clearing, processing, and blending in the opening of new pits and operation of existing pits as necessary to obtain acceptable material. Open pits in a manner to expose the vertical faces of the deposits for suitable working depths, following which the material shall be obtained in successive vertical cuts extending through the exposed strata. Waste strata and pockets of unsuitable materials overlaying or occurring in the deposit. Change or modify the method of operating the pits, and the processing and blending of the material when necessary to obtain material conforming to the specified requirements. Upon completion of the work, condition pits to drain readily and leave in a satisfactory condition.

3.3 MIXING OF MATERIALS

Mix aggregates in a stationary or traveling plant. Proportion aggregates by weight or volume in such quantities that specified gradation, liquid limit, and plasticity index requirements are met after the base course has been placed and compacted. Incorporate, during the mixing operation, water in quantities sufficient to provide the necessary moisture content for the specified compaction. Mixing operations shall produce satisfactory uniform blending and the method of discharging into trucks shall not produce segregation.

3.4 PLACING

Do not dump mixed materials in piles, but place on prepared subgrade or subbase in layers of uniform thickness with a spreader. When a compacted course 6 inches in thickness is required, place material in a single layer. When a compacted course in excess of 6 inches is required, place material in layers of equal thickness. Do not exceed 6 inches or have less than 3 inches in thickness for any compacted layer. Place layers so that when compacted, they will be true to grades or levels required with the least possible surface disturbance. Where the base course is constructed in more than one layer, clean previously constructed layers of loose and foreign matter. Maintain material water content during the placing period to obtain the compaction specified. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to insure a satisfactory base course.

3.4.1 Stationary-Plant Method

Mix aggregates, binder material and water until a uniform homogeneous mixture is obtained. Do not dump materials in piles; place in layers of essentially uniform thickness, not to exceed 6 inches after compaction, by an approved spreader. Tail gate spreading will be acceptable only with permission, under conditions such as where space limitations prohibit use of the spreader.

3.4.2 Windrow Traveling-Plant Method

Place aggregates and binder materials in windrows of such cross section and proportions that, when picked up, mixed, and redeposited in windrows, the finished mixture shall conform to the specified requirements. Do not exceed the rated capacity of the traveling plant with the size of the windrow of the combined materials. Add water, in quantity sufficient to provide the necessary moisture content for compacting, to the aggregates at the time of mixing. Mix materials uniformly by the traveling plant, deposit in windrows of uniform cross section, and spread in a layer of uniform thickness to the required contour and grades.

3.5 COMPACTING AND FINISHING

Immediately following the placing, spread the finished mixture uniformly in a layer and bring to optimum moisture content. The loose thickness and the surface of the layer shall be such that the specified density and the required thickness shall be obtained after compaction. Compact the layer with steel-faced, vibrating or pneumatic-tired rollers, or other suitable compacting equipment or combinations thereof. Continue compacting until the layer is compacted through the full depth to a field density of at least 100 percent of the maximum density at optimum moisture content tested in accordance with ASTM D1556. In areas not accessible to rollers or compactors, compact the mixture with mechanical hand tampers. If the mixture is excessively moistened by rain, aerate by blade graders, or other suitable equipment. Aerate until the moisture content of the material is that needed to obtain the required density. Finish the surface of the layer by a combination of rolling and blading. Final surface shall be smooth and free from waves, irregularities, and ruts or soft yielding spots.

3.6 PROOF ROLLING

Make four coverages over other areas to be paved, excluding the runway over-runs, blast protection areas, and shoulders. A coverage is defined as one application of one tire print over each point in the surface of the designated area. When under the action of the proof rolling, the base course yields, pumps, or otherwise fails, remove, replace with suitable materials, and recompact materials in the base course or in the underlying layers indicated to be unsatisfactory. The speed of the roller shall not exceed 5 miles per hour. Obtain approval upon completion of the proof rolling of the base course.

3.7 FINISHING AT EDGES OF BASE COURSE

Place earth or other approved materials along the edges of the base course in such quantity that it will compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, place material to the thickness of each layer. In each operation, allow at least a one foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer.

3.8 FIELD QUALITY CONTROL

Approve materials and material sources in advance of the use of such materials in the work. Replace base where samples are removed.

3.8.1 Sampling

3.8.1.1 Aggregates at the Source

Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D75/D75M. Collect each sample by taking three incremental samples at random from the source material to make a composite sample of not less than 50 pounds. Repeat above sampling when source of material is changed or when unacceptable deficiencies or variations from specified grading of materials are found in testing.

3.8.1.2 During Construction

Take one random sample from each 1000 tons of completed course material, but not less than one random sample per day's run. Take samples in accordance with ASTM D75/D75M.

3.8.1.3 Sample Identification

Place each sample in a clean container, securely fastened to prevent loss of material. Tag each sample for identification and with the following information:

Contract No._____
Sample No._____ Quality _____
Date of Sample_____
Sampler_____
Source_____
Intended Use_____
For Testing_____

3.8.2 Testing

3.8.2.1 Aggregates

Test each sample of base course material without delay. Make gradation tests from each sample in accordance with ASTM C136. Make sieve analysis on material passing the No. 200 sieve in accordance with ASTM C117.

3.8.2.2 Smoothness Tests

Test with a 10 foot straightedge, applied parallel with and at right angles to the center line of the paved area. Correct deviations in the surface in excess of 1/2 inch by loosening, adding or removing material, reshaping, watering, and compacting. The smoothness requirements specified herein apply only to the top layer when base course is constructed in more than one layer.

3.8.2.3 Field Density Tests

ASTM D1556 . Take one test for each 500 square yards of each layer of base course or a minimum of one per work area.

3.8.2.4 Laboratory Density Tests

In accordance with ASTM D1557, Method D.

3.9 MAINTENANCE

After construction is completed, maintain the base course throughout, except where portion of the succeeding course is under construction thereon. Maintenance includes drainage, rolling, shaping, and watering, as necessary, to maintain the course in proper condition. Correct deficiencies in thickness, composition, construction, smoothness, and density, which develop during the maintenance, to conform to the requirements specified herein. Maintain sufficient moisture by light sprinkling with water at the surface to prevent a dusty condition.

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SECTION 32 12 17

HOT MIX BITUMINOUS PAVEMENT
04/08

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.

ASPHALT INSTITUTE (AI)

AI MS-02	(1997 6th Ed) Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2007) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2007a) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C188	(2009) Standard Test Method for Density of Hydraulic Cement
ASTM C29/C29M	(2009) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D1073	(2007) Fine Aggregate for Bituminous Paving Mixtures
ASTM D1188	(2007e1) Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D140/D140M	(2009) Standard Practice for Sampling

	Bituminous Materials
ASTM D1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2011) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D242/D242M	(2009) Mineral Filler for Bituminous Paving Mixtures
ASTM D2726	(2010) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D3381/D3381M	(2009a) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D3666	(2009a) Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4867/D4867M	(2009) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D546	(2010) Sieve Analysis of Mineral Filler for Bituminous Paving Mixtures
ASTM D692/D692M	(2009) Coarse Aggregate for Bituminous Paving Mixtures
ASTM D70	(2009e1) Specific Gravity and Density of Semi-Solid Bituminous Materials (Pycnometer Method)
ASTM D75/D75M	(2009) Standard Practice for Sampling Aggregates
ASTM D854	(2010) Specific Gravity of Soil Solids by Water Pycnometer
ASTM D979/D979M	(2011) Sampling Bituminous Paving Mixtures
ASTM D995	(1995b; R 2002) Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Bituminous pavement

SD-05 Design Data

Job-mix formula

Submit a job-mix formula, prepared specifically for this project, for approval prior to preparing and placing the bituminous mixture. Design mix using procedures contained in Chapter V, Marshall Method of Mix Design, of AI MS-02. Formulas shall indicate physical properties of the mixes as shown by tests made by a commercial laboratory approved by the Contracting Officer, using materials identical to those to be provided on this project. Submit formulas with material samples. Job-mix formula for each mixture shall be in effect until modified in writing by the Contractor and approved by the Contracting Officer. Provide a new job-mix formula for each source change. Submittal shall include all tests indicated in MIX DESIGN section of this specification.

Asphalt Cement Binder

Mix Design

SD-06 Test Reports

Specific gravity test of asphalt

Coarse aggregate tests

Weight of slag test

Percent of crushed pieces in gravel

Fine aggregate tests

Specific gravity of mineral filler

Bituminous mixture tests

Aggregates tests

Bituminous mix tests

Pavement courses

Submit in accordance with paragraph entitled "Mock-Up Test Section."

1.3 QUALITY ASSURANCE

1.3.1 Safety Requirements

Provide adequate and safe stairways with handrails to the mixer platform, and safe and protected ladders or other means for accessibility to plant operations. Guard equipment and exposed steam or other high temperature lines or cover with a suitable type of insulation.

1.3.2 Required Data

Job-mix formula shall show the following:

a. Source and proportions, percent by weight, of each ingredient of the mixture;

b. Correct gradation, the percentages passing each size sieve listed in the specifications for the mixture to be used, for the aggregate and mineral filler from each separate source and from each different size to be used in the mixture and for the composite mixture;

c. Amount of material passing the No. 200 sieve determined by dry sieving;

d. Number of blows of hammer compaction per side of molded specimen;

e. Temperature viscosity relationship of the asphalt cement;

f. Stability, flow, percent voids in mineral aggregate, percent air voids, unit weight;

g. Asphalt absorption by the aggregate;

h. Effective asphalt content as percent by weight of total mix;

i. Temperature of the mixture immediately upon completion of mixing;

j. Asphalt performance grade viscosity grade; and

k. Curves for the leveling binder and wearing courses.

1.3.3 Charts

Plot and submit, on a grain size chart, the specified aggregate gradation band, the job-mix gradation and the job-mix tolerance band.

1.3.4 Selection of Optimum Asphalt Content

Base selection on percent of total mix and the average of values at the following points on the curves for each mix:

a. Stability: Peak

b. Unit Weight: Peak

c. Percent Air Voids: Median

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

1.5 ENVIRONMENTAL CONDITIONS

Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the surface temperature of the underlying course is greater than 45 degrees F for course thicknesses greater than one inch and

55 degrees F for course thicknesses one inch or less.

1.6 CONSTRUCTION EQUIPMENT

Calibrated equipment, such as scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by a calibration laboratory approved by the Contracting Officer within 12 months of commencing work.

1.6.1 Mixing Plant

Design, coordinate, and operate the mixing plant to produce a mixture within the job-mix formula tolerances and to meet the requirements of ASTM D995, including additional plant requirements specified herein. The plant shall be a batch type, continuous mix type or drum-dryer mixer type, and shall have sufficient capacity to handle the new bituminous construction. Minimum plant capacity shall be 100 tons per hour. The mixing plant and equipment shall remain accessible at all times for inspecting operation, verifying weights, proportions and character of materials, and checking mixture temperatures.

1.6.1.1 Cold Aggregate Feeder

Provide plant with a feeder or feeders capable of delivering the maximum number of aggregate sizes required in their proper proportion. Provide adjustment for total and proportional feed and feeders capable of being locked in any position. When more than one cold elevator is used, feed each elevator as a separate unit and install individual controls integrated with a master control.

1.6.1.2 Dryer

Provide rotary drum-dryer which continuously agitates the mineral aggregate during the heating and drying process. When one dryer does not dry the aggregate to specified moisture requirements, provide additional dryers.

1.6.1.3 Plant Screens and Bins for Batch and Continuous Mix Plants

Use screen to obtain accurate gradation and allow no bin to contain more than 10 percent oversize or undersize. Inspect screens each day prior to commencing work for plugged, worn, or broken screens. Clean plugged screens and replace worn or broken screens with new screens prior to beginning operations. Divide hot aggregate bins into at least three compartments arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

1.6.1.4 Testing Laboratory

Provide a testing laboratory for control and acceptance testing functions during periods of mix production, sampling and testing, and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall provide adequate equipment, space, and utilities as required for the performance of the specified tests.

1.6.1.5 Surge and Storage Bins

Use for temporary storage of hot bituminous mixtures will be permitted under the following conditions:

a. When stored in surge bins for a period of time not to exceed 3 hours.

b. When stored in insulated and heated storage bins for a period of time not to exceed 12 hours. If it is determined by the Contracting Officer that there is an excessive amount of heat loss, segregation and oxidation of the mixture due to temporary storage, discontinue use of surge bins or storage bins.

1.6.1.6 Drum-Dryer Mixer

Do not use drum-dryer mixer if specified requirements of the bituminous mixture or of the completed bituminous pavement course cannot be met. If drum-dryer mixer is prohibited, use either batch or continuous mix plants meeting the specifications and producing a satisfactory mix.

1.6.2 Paving Equipment

1.6.2.1 Spreading Equipment

Self-propelled electronically controlled type, unless other equipment is authorized. Equip spreading equipment of the self-propelled electronically controlled type with hoppers, tamping or vibrating devices, distributing screws, electronically adjustable screeds, and equalizing devices. Capable of spreading hot bituminous mixtures without tearing, shoving, or gouging and to produce a finished surface of specified grade and smoothness. Operate spreaders, when laying mixture, at variable speeds between 5 and 45 feet per minute. Design spreader with a quick and efficient steering device; a forward and reverse traveling speed; and automatic devices to adjust to grade and confine the edges of the mixture to true lines. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh laid mix during operations is prohibited.

1.6.2.2 Rolling Equipment

Self-propelled pneumatic-tired rollers supplemented by three-wheel and tandem type steel wheel rollers. The number, type and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. Rollers shall be suitable for rolling hot-mix bituminous pavements and capable of reversing without backlash. Pneumatic-tired rollers shall be capable of being operated both forward and backward without turning on the mat, and without loosening the surface being rolled. Equip rollers with suitable devices and apparatus to keep the rolling surfaces wet and prevent adherence of bituminous mixture. Vibratory rollers especially designed for bituminous concrete compaction may be used provided rollers do not impair stability of pavement structure and underlying layers. Repair depressions in pavement surfaces resulting from use of vibratory rollers. Rollers shall be self-propelled, single or dual vibrating drums, and steel drive wheels, as applicable; equipped with variable amplitude and separate controls for energy and propulsion.

1.6.2.3 Hand Tampers

Minimum weight of 25 pounds with a tamping face of not more than 50 square inches.

1.6.2.4 Mechanical Hand Tampers

Commercial type, operated by pneumatic pressure or by internal combustion.

PART 2 PRODUCTS

2.1 AGGREGATES

Grade and proportion aggregates and filler so that combined mineral aggregate conforms to specified grading.

2.1.1 Coarse Aggregates

ASTM D692/D692M, except as modified herein. At least 75 percent by weight of aggregate retained on the No. 4 sieve shall have two or more fractured faces. Percentage of wear, Los Angeles test, except for slag, shall not exceed 40 in accordance with ASTM C131. Weight of slag shall not be less than 70 pounds per cubic foot. Soundness test is required in accordance with ASTM C88; after 5 cycles, loss shall not be more than 12 percent when tested with sodium sulfate or 18 percent when tested with magnesium sulfate.

2.1.2 Fine Aggregate

ASTM D1073, except as modified herein. Fine aggregate shall be produced by crushing stone, slag or gravel that meets requirements for wear and soundness specified for coarse aggregate. Where necessary to obtain the gradation of aggregate blend or workability, natural sand may be used. Quantity of natural sand to be added shall be approved and shall not exceed 15 percent of weight of coarse and fine aggregate and material passing the No. 200sieve.

2.1.3 Mineral Filler

Nonplastic material meeting the requirements of ASTM D242/D242M.

2.1.4 Aggregate Gradation

The combined aggregate gradation shall conform to gradations specified in Table I, when tested in accordance with ASTM C136 and ASTM C117, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

Table I. Aggregate Gradations

	Gradation 1	Gradation 2	Gradation 3
Sieve Size, inch	Percent Passing by Mass	Percent Passing by Mass	Percent Passing by Mass
1	100	---	---
3/4	76-96	100	---
1/2	68-88	76-96	100
3/8	60-82	69-89	76-96
No. 4	45-67	53-73	58-78
No. 8	32-54	38-60	40-60
No. 16	22-44	26-48	28-48
No. 30	15-35	18-38	18-38
No. 50	9-25	11-27	11-27
No. 100	6-18	6-18	6-18
No. 200	3-6	3-6	3-6

2.2 ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to ASTM D3381/D3381M Table 2. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting OfficerEngineer. The supplier is defined as the last source of any modification to the binder. The Contracting OfficerEngineer may sample and test the binder at the mix plant at any time before or during mix production. Samples for this verification testing shall be obtained by the Contractor in accordance with ASTM D140/D140M and in the presence of the Contracting OfficerEngineer. These samples shall be furnished to the Contracting OfficerEngineer for the verification testing, which shall be at no cost to the Contractor. Samples of the asphalt cement specified shall be submitted for approval not less than 14 days before start of the test section.

2.3 MIX DESIGN

The Contractor shall develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a JMF has been approved. The hot-mix asphalt shall be designed using procedures contained in AI MS-02 and the criteria shown in Table II. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost.

2.3.1 JMF Requirements

The job mix formula shall be submitted in writing by the Contractor for approval at least 14 days prior to the start of the test section and shall include as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt cement.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt viscosity grade, penetration grade, or performance grade.

e. Number of blows of hammer per side of molded specimen.

f. Laboratory mixing temperature.

g. Lab compaction temperature.

h. Temperature-viscosity relationship of the asphalt cement.

i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

j. Graphical plots of stability, flow, air voids, voids in the mineral

aggregate, and unit weight versus asphalt content as shown in AI MS-02.

k. Specific gravity and absorption of each aggregate.

l. Percent natural sand.

m. Percent particles with two or more fractured faces (in coarse aggregate).

n. Fine aggregate angularity.

o. Percent flat or elongated particles (in coarse aggregate).

p. Tensile Strength Ratio.

q. Antistrip agent (if required) and amount.

r. List of all modifiers and amount.

s. Percentage and properties (asphalt content, binder properties, and aggregate properties) of RAP in accordance with paragraph "Recycled Hot-Mix Asphalt," if RAP is used.

Table II. Marshall Design Criteria

Test Property	75 Blow Mix	50 Blow Mix
Stability, pounds minimum	*2150	*1350
Flow, 0.01 inch	8-16	8-18
Air voids, percent	3-5	3-5
Percent Voids in mineral aggregate (minimum)	See Table III	See Table III
TSR, minimum percent	75	75

* This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.

Table III. Minimum Percent Voids in Mineral Aggregate (VMA)**

Aggregate (See Table 2)	Minimum VMA, percent
Gradation 1	13.0
Gradation 2	14.0
Gradation 3	15.0

** Calculate VMA in accordance with AI MS-02, based on ASTM D2726 bulk specific gravity for the aggregate.

2.3.2 Adjustments to JMF

The JMF for each mixture shall be in effect until a new formula is approved in writing by the Contracting Officer. Should a change in sources of any materials be made, a new mix design shall be performed and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the JMF within the limits specified below to optimize mix volumetric properties. Adjustments to the JMF shall be limited to plus or minus 3 percent on the 1/2 inch, No. 4, and No. 8 sieves; plus or minus 1.0 percent on the No. 200 sieve; and plus or minus 0.40 percent binder content. If adjustments are needed that exceed these limits, a new mix design shall be developed. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table I; this is acceptable.

2.4 RECYCLED HOT MIX ASPHALT

Recycled HMA shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. The RAP shall be of a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP chunk size shall not exceed 2 inches. The recycled HMA mix shall be designed using procedures contained in AI MS-02. The job mix shall meet the requirements of paragraph MIX DESIGN. RAP should only be used for shoulder surface course mixes and for any intermediate courses. The amount of RAP shall be limited to 30 percent.

2.4.1 RAP Aggregates and Asphalt Cement

The blend of aggregates used in the recycled mix shall meet the requirements of paragraph "Aggregates." The percentage of asphalt in the RAP shall be established for the mixture design according to ASTM D2172/D2172M using the appropriate dust correction procedure.

2.4.2 RAP Mix

The blend of new asphalt cement and the RAP asphalt binder shall meet the viscosity requirements in paragraph "Asphalt Cement Binder." The virgin asphalt cement shall not be more than two standard asphalt material grades different than that specified in paragraph "Asphalt Cement Binder."

2.5 SOURCE QUALITY CONTROL

Employ a commercial laboratory approved by the Contracting Officer to perform testing. The laboratory used to develop the JMF and the laboratory used to perform all sampling and testing shall meet the requirements of ASTM D3666. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The certification shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

2.5.1 Tests

Perform testing in accordance with the following:

a. Specific Gravity Test of Asphalt: ASTM D70

b. Coarse Aggregate Tests:

(1) Bulk Specific Gravity: ASTM C127

(2) Abrasion Loss: ASTM C131

(3) Soundness Loss: ASTM C88

c. Weight of Slag Test: ASTM C29/C29M

d. Percent of Crushed Pieces in Gravel: Count by observation and weight

e. Fine Aggregate Tests:

(1) Bulk Specific Gravity: ASTM C128

(2) Soundness Loss: ASTM C88

f. Specific Gravity of Mineral Filler: ASTM C188 or ASTM D854

g. Bituminous Mixture Tests:

(1) Bulk Specific Gravity: ASTM D1188 or ASTM D2726

(2) Theoretical Maximum Specific Gravity: ASTM D2041/D2041M

(3) Tensile Strength Ratio: ASTM D4867/D4867M

2.5.2 Specimens

ASTM D1559 for the making and testing of bituminous specimens with the following exceptions:

a. Compaction: Apply 75 blows of the hammer to each flat face of the specimens.

b. Curves: Plot curves for the wearing course to show the effect on the test properties of at least four different percentages of asphalt on the unit weight, stability, flow, air voids, and voids in mineral aggregate; each point on the curves shall represent the average of at least four specimens.

c. Cooling of Specimen: After compaction is completed, allow the specimen to cool in air to the same temperature approximately as that of the water, 77 degrees F, to be used in the specific gravity determination.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Preparation of Asphalt Binder Material

The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than (160 degrees C) 325 degrees F when added to the aggregates. Modified asphalts shall be no more than (174 degrees C) 350 degrees F when added to the aggregate.

3.1.2 Preparation of Mineral Aggregates

Store different size aggregate in separate stockpiles so that different sizes will not mix. Stockpile different-sized aggregates in uniform layers by use of a clam shell or other approved method so as to prevent segregation. The use of bulldozers in stockpiling of aggregate or in feeding aggregate to the dryer is prohibited. Feed aggregates into the cold elevator by means of separate mechanical feeders so that aggregates are graded within requirements of the job-mix formulas and tolerances specified. Regulate rates of feed of the aggregates so that moisture content and temperature of aggregates are within tolerances specified herein. Dry and heat aggregates to the temperature necessary to achieve the mixture determined by the job mix formula within the job tolerance specified. Provide adequate dry storage for mineral filler.

3.1.3 Preparation of Bituminous Mixture

Accurately weigh aggregates and dry mineral filler and convey into the mixer in the proportionate amounts of each aggregate size required to meet the job-mix formula. In batch mixing, after aggregates and mineral filler have been introduced into the mixer and mixed for not less than 15 seconds, add asphalt by spraying or other approved methods and continue mixing for a period of not less than 20 seconds, or as long as required to obtain a homogeneous mixture. The time required to add or spray asphalt into the mixer will not be added to the total wet-mixing time provided the operation does not exceed 10 seconds and a homogeneous mixture is obtained. When a continuous mixer is employed, mixing time shall be more than 35 seconds to obtain a homogeneous mixture. Additional mixing time, when required, will be as directed by the Contracting Officer. When mixture is prepared in a twin-pugmill mixer, volume of the aggregates, mineral filler, and asphalt shall not extend above tips of mixer blades when blades are in a vertical position. Overheated and carbonized mixtures, or mixtures that foam or show indication of free moisture, will be rejected. When free moisture is detected in batch or continuous mix plant produced mixtures, waste the mix and withdraw the aggregates in the hot bins immediately and return to the respective stockpiles; for drum-dryer mixer plants, waste the mix, including that in surge or storage bins that is affected by free moisture.

3.1.4 Transportation of Bituminous Mixtures

Transport bituminous material from the mixing plant to the paving site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of concentrated solution of hydrated lime and water or other approved coating to prevent adhesion of the mixture to the truck. Petroleum products will not be permitted for coating truck. If air temperature is less than 60 degrees F or if haul time is greater than 30

minutes, cover each load with canvas or other approved material of ample size to protect the mixture from the loss of heat. Make deliveries so that the spreading and rolling of all the mixture prepared for one day's run can be completed during daylight, unless adequate approved artificial lighting is provided. Deliver mixture to area to be paved so that the temperature at the time of dumping into the spreader is within the range specified herein. Reject loads that are below minimum temperature, that have crusts of cold unworkable material, or that have been wet excessively by rain. Hauling over freshly laid material is prohibited.

3.1.5 Surface Preparation of Underlying Course

Prior to the laying of the asphalt concrete, clean underlying course of foreign or objectionable matter with power blowers or power brooms, supplemented by hand brooms and other cleaning methods where necessary. During the placement of multiple lifts of bituminous concrete, each succeeding lift of bituminous concrete shall have its underlying lift cleaned and provided with a bituminous tack coat if the time period between the placement of each lift of bituminous concrete exceeds 14 days, or the underlying bituminous concrete has become dirty. Remove grass and other vegetative growth from existing cracks and surfaces.

3.1.6 Spraying of Contact Surfaces

Spray contact surfaces of previously constructed pavement with a thin coat of bituminous materials to act as an anti-stripping agent. Paint contact surfaces of structures with a thin coat of emulsion or other approved bituminous material prior to placing the bituminous mixture. Tack coat the previously placed primed coats on base courses when surface has become excessively dirty and cannot be cleaned or when primed surface has cured to the extent that it has lost all bonding effect.

3.2 PLACEMENT

3.2.1 Machine Spreading

The range of temperatures of the mixtures at the time of spreading shall be between 250 degrees F and 300 degrees F. Bituminous concrete having temperatures less than minimum spreading temperature when dumped into the spreader will be rejected. Adjust spreader and regulate speed so that the surface of the course is smooth and continuous without tears and pulling, and of such depth that, when compacted, the surface conforms with the cross section, grade, and contour indicated. Unless otherwise directed, begin the placing along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope. Place mixture in consecutive adjacent strips having a minimum width of 10 feet, except where the edge lanes require strips less than 10 feet to complete the area. Construct longitudinal joints and edges to true line markings. Establish lines parallel to the centerline of the area to be paved, and place string lines coinciding with the established lines for the spreading machine to follow. Provide the number and location of the lines needed to accomplish proper grade control. When specified grade and smoothness requirements can be met for initial lane construction by use of an approved long ski-type device of not less than 30 feet in length and for subsequent lane construction by use of a short ski or shoe, in-place string lines for grade control may be omitted. Place mixture as nearly continuous as possible and adjust the speed of placing as needed to permit proper rolling.

3.2.2 Shoveling, Raking, and Tamping After Machine-Spreading

Shovelers and rakers shall follow the spreading machine. Add or remove hot mixture and rake the mixture as required to obtain a course that when completed will conform to requirements specified herein. Broadcasting or fanning of mixture over areas being compacted is prohibited. When segregation occurs in the mixture during placing, suspend spreading operation until the cause is determined and corrected. Correct irregularities in alignment left by the spreader by trimming directly behind the machine. Immediately after trimming, compact edges of the course by tamping laterally with a metal lute or by other approved methods. Distortion of the course during tamping is prohibited.

3.2.3 Hand-Spreading in Lieu of Machine-Spreading

In areas where the use of machine spreading is impractical, spread mixture by hand. The range of temperatures of the mixtures when dumped onto the area to be paved shall be between 250 and 300 degrees F. Mixtures having temperatures less than minimum spreading temperature when dumped onto the area to be paved will be rejected. Spread hot mixture with rakes in a uniformly loose layer of a thickness that, when compacted, will conform to the required grade, thickness, and smoothness. During hand spreading, place each shovelful of mixture by turning the shovel over in a manner that will prevent segregation. Do not place mixture by throwing or broadcasting from a shovel. Do not dump loads any faster than can be properly handled by the shovelers and rakers.

3.3 COMPACTION OF MIXTURE

Compact mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the extreme sides of the lanes and proceed toward center of pavement, or toward high side of pavement with a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least one foot. Alternate trips of the roller shall be of slightly different lengths. Conduct tests for conformity with the specified crown, grade and smoothness immediately after initial rolling. Before continuing rolling, correct variations by removing or adding materials as necessary. If required, subject course to diagonal rolling with the steel wheeled roller crossing the lines of the previous rolling while mixture is hot and in a compactible condition. Speed of the rollers shall be slow enough to avoid displacement of hot mixture. Correct displacement of mixture immediately by use of rakes and fresh mixture, or remove and replace mixture as directed. Continue rolling until roller marks are eliminated and course has a density of at least 95 percent but not more than 100 percent of that attained in a laboratory specimen of the same mixture prepared in accordance with ASTM D1559. During rolling, moisten wheels of the rollers enough to prevent adhesion of mixture to wheels, but excessive water is prohibited. Operation of rollers shall be by competent and experienced operators. Provide sufficient rollers for each spreading machine in operation on the job and to handle plant output. In places not accessible to the rollers, compact mixture thoroughly with hot hand tampers. Skin patching of an area after compaction is prohibited. Remove mixture that becomes mixed with foreign materials or is defective and replace with fresh mixture compacted to the density specified herein. Roller shall pass over unprotected edge of the course only when laying of course is to be discontinued for such length of time as to permit mixture to become cold.

3.4 JOINTS

Joints shall present the same texture and smoothness as other portions of the course, except permissible density at the joint may be up to 2 percent less than the specified course density. Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture.

3.4.1 Transverse

Roller shall pass over unprotected end of freshly laid mixture only when laying of course is to be discontinued. Except when an approved bulkhead is used, cut back the edge of previously laid course to expose an even, vertical surface for the full thickness of the course. When required, rake fresh mixture against joints, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll. Transverse joints in adjacent lanes shall be offset a minimum of 2 feet.

3.4.2 Longitudinal Joints

Space 6 inches apart. Do not allow joints to coincide with joints of existing pavement or previously placed courses. Spreader screed shall overlap previously placed lanes 2 to 3 inches and be of such height to permit compaction to produce a smooth dense joint. With a lute, push back mixture placed on the surface of previous lanes to the joint edge. Do not scatter mix. Remove and waste excess material. When edges of longitudinal joints are irregular, honeycombed, or poorly compacted, cut back unsatisfactory sections of joint and expose an even vertical surface for the full thickness of the course. When required, rake fresh mixture against joint, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll while hot.

3.5 FIELD QUALITY CONTROL

3.5.1 Sampling

3.5.1.1 Aggregates At Source

Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D75/D75M at the source. Collect each sample by taking three incremental samples at random from the source material to make a composite sample of not less than 50 pounds. Repeat the sampling when the material source changes or when testing reveals unacceptable deficiencies or variations from the specified grading of materials.

3.5.1.2 Cold Feed Aggregate Sampling

Take two samples daily from the belt conveying materials from the cold feed. Collect materials in three increments at random to make a representative composite sample of not less than 50 pounds. Take samples in accordance with ASTM D75/D75M.

3.5.1.3 Coarse and Fine Aggregates

Take a 50 pound sample from the cold feed at least once daily for sieve

analyses and specific gravity tests. Additional samples may be required to perform more frequent tests when analyses show deficiencies, or unacceptable variances or deviations. The method of sampling is as specified herein for aggregates.

3.5.1.4 Mineral Filler

ASTM D546. Take samples large enough to provide ample material for testing.

3.5.1.5 Pavement and Mixture

Take plant samples for the determination of mix properties and field samples for thickness and density of the completed pavements. Furnish tools, labor and material for samples, and satisfactory replacement of pavement. Take samples and tests at not less than frequency specified hereinafter and at the beginning of plant operations; for each day's work as a minimum; each change in the mix or equipment; and as often as directed. Accomplish sampling in accordance with ASTM D979/D979M.

3.5.2 Testing

3.5.2.1 Aggregates Tests

a. Gradation: ASTM C136.

b. Mineral Filler Content: ASTM D546.

c. Abrasion: ASTM C131 for wear (Los Angeles test). Perform one test initially prior to incorporation into the work and each time the source is changed.

3.5.2.2 Bituminous Mix Tests

Test one sample for each 500 tons, or fraction thereof, of the uncompacted mix for extraction in accordance with ASTM D2172/D2172M; perform a sieve analysis on each extraction sample in accordance with ASTM C136 and ASTM C117. Test one sample for each 500 tons or fraction thereof for stability and flow in accordance with ASTM D1559. Test one sample for each material blend for Tensile Strength Ratio in accordance with ASTM D4867/D4867M.

3.5.2.3 Pavement Courses

Perform the following tests:

a. Density: For each 1000 tons of bituminous mixture placed, determine the representative laboratory density by averaging the density of four laboratory specimens prepared in accordance with ASTM D1559. Samples for laboratory specimens shall be taken from trucks delivering mixture to the site; record in a manner approved by the Contracting Officer the project areas represented by the laboratory densities. From each representative area recorded, determine field density of pavement by averaging densities of 4 inch diameter cores obtained from leveling, binder, and wearing courses; take one core for each 2000 square yards or fraction thereof of course placed. Determine density of laboratory prepared specimens and cored samples in accordance with ASTM D1188 or ASTM D2726, as applicable. Separate pavement layers by sawing or other approved means. Maximum allowable deficiency at any point, excluding joints, shall not be more than 2 percent less than the specified

density for any course. The average density of each course, excluding joints, shall be not less than the specified density. Joint densities shall not be more than 2 percent less than specified course densities and are not included when calculating average course densities. When the deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

b. Thickness: Determine thickness of wearing courses from samples taken for the field density test. The maximum allowable deficiency at any point shall not be more than 1/4 inch less than the thickness for the indicated course. Average thickness of course or of combined courses shall be not less than the indicated thickness. Where a deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

c. Smoothness: Straightedge test the compacted surface of wearing course as work progresses. Apply straightedge parallel with and at right angles to the centerline after final rolling. Variations in the wearing course shall not vary more than 1/8 inch in 10 feet. Correct each portion of the pavement showing irregularities greater than that specified.

d. Finished Grades: Finish grades of each course placed shall not vary from the finish elevations, profiles, and cross sections indicated by more than 1/2 inch. Finished surface of the final wearing course will be tested by running lines of levels at intervals of 25 feet longitudinally and transversely to determine elevations of completed pavement. Within 45 days after completion of final placement, perform a level survey at the specified grid spacing and plot the results on a plan drawn to the same scale as the drawings. Elevations not in conformance with the specified tolerance shall be noted on the plan in an approved manner. The survey shall be performed by a registered land surveyor. The Contracting Officer will inform the Contractor in writing of paved areas that fail to meet the final grades indicated within the specified tolerances. Correct deficient paved areas by removing existing work and replacing with new materials that meet the specifications. Skin patching for correcting low areas is prohibited.

e. Finish Surface Texture of Wearing Course: Visually check final surface texture for uniformity and reasonable compactness and tightness. Final wearing course with a surface texture having undesirable irregularities such as segregation, cavities, pulls or tears, checking, excessive exposure of coarse aggregates, sand streaks, indentations, ripples, or lack of uniformity shall be removed and replaced with new materials.

3.6 PROTECTION

Do not permit vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 120 degrees F. Measure surface temperature by approved surface thermometers or other satisfactory methods.

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SECTION 32 13 13.06

PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES
11/11

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 CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 301	(2010) Specifications for Structural Concrete
ACI 305R	(2010) Specification for Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C215	(2010) Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2006e1) Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615/A615M	(2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A966/A966M	(2008) Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM C1077	(2011b) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C1260	(2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C143/C143M	(2010a) Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C150/C150M	(2011) Standard Specification for Portland Cement
ASTM C1567	(2011) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2006) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2010) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2010) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2011a) Standard Specification for Concrete Aggregates
ASTM C494/C494M	(2011) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2008a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C78/C78M	(2010) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2011b) Standard Specification for Ready-Mixed Concrete
ASTM C989	(2010) Standard Specification for Slag Cement for Use in Concrete and Mortars

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Curing materials

Admixtures

Dowel

Submit a complete list of materials including type, brand and applicable reference specifications.

Cementitious Materials

Aggregate

Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

SD-05 Design Data

Concrete mix design

Thirty days minimum prior to concrete placement, submit a mix design, with applicable tests, for each strength and type of concrete for approval. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, slag, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required. Submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted. Obtain acknowledgement of approvals prior to concrete placement. Submit a new mix design for each material source change.

SD-06 Test Reports

Aggregate tests

Concrete slump tests

Air content tests

Flexural strength tests

Cementitious materials

SD-07 Certificates

Ready-mixed concrete plant

Batch tickets

Cementitious materials

1.3 DELIVERY, STORAGE, AND HANDLING

ASTM C94/C94M.

1.4 QUALITY ASSURANCE

1.4.1 Ready-mixed Concrete Plant Certification

Unless otherwise approved by the Contracting Officer, ready mixed concrete shall be produced and provided by a National Ready-Mix Concrete Association (NRMCA) certified plant. If a volumetric mobile mixer is used to produce the concrete, rather than ready-mixed concrete, the mixer(s) must conform to the standards of the Volumetric Mixer Manufacturers Bureau (VMMB). Verification shall be made by a current VMMB conformance plate affixed to the volumetric mixer equipment.

1.4.2 Contractor Qualifications

Unless waived by the Contracting Officer, the Contractor shall meet one of the following criteria:

a. Contractor shall have at least one National Ready Mixed Concrete Association (NMRCA) certified concrete craftsman on site, overseeing each placement crew during all concrete placement.

b. Contractor shall have no less than three NRMCA certified concrete installers, who shall be on site working as members of each placement crew during all concrete placement.

1.4.3 Required Information

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix will be suitable for the job conditions. The laboratory test reports shall include mill test and all other test for cementitious materials, aggregates, and admixtures. Provide maximum nominal aggregate size, combined aggregate gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Test reports shall be submitted along with the concrete mix design. Sampling and testing of materials, concrete mix design, sampling and testing in the field shall be performed by a commercial testing laboratory which conforms to ASTM C1077. The laboratory shall be approved in writing by the Government.

1.4.4 Batch Tickets

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.5 SUSTAINABLE DESIGN REQUIREMENTS

1.5.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mileradius from the project site, if available from a minimum of three sources. Pavement materials may be locally available.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials in concrete mix shall be 50 percent non-portland cement pozzolanic materials by weight. Provide test data demonstrating compatibility and performance of concrete satisfactory to Contracting Officer.

2.1.1.1 Cement

ASTM C150/C150M, Type I or II or V.

2.1.1.2 Fly Ash and Pozzolan

ASTM C618, Type F. Fly ash certificates shall include test results in accordance with ASTM C618.

2.1.1.3 Slag

ASTM C989, Slag Cement (formerly Ground Granulated Blast Furnace Slag) Grade 120. Certificates shall include test results in accordance with ASTM C989.

2.1.2 Water

Water shall conform to ASTM C1602/C1602M. Hot water shall not be used unless approved by the Contracting Officer.

2.1.3 Aggregate

Coarse aggregate shall consist of crushed or uncrushed gravel, crushed stone, or a combination thereof. Aggregates, as delivered to the mixers, shall consist of clean, hard, uncoated particles. Coarse aggregate shall be washed. Washing shall be sufficient to remove dust and other coatings. Fine aggregate shall consist of natural sand, manufactured sand, or a combination of the two, and shall be composed of clean, hard, durable particles. Both coarse and fine aggregates shall meet the requirements of ASTM C33/C33M.

2.1.3.1 Alkali Reactivity Test

Aggregates to be used in all concrete in projects over 50,000 SFin size shall be evaluated and tested by the Contractor for alkali-aggregate reactivity in accordance with ASTM C1260. The types of aggregates shall be evaluated in a combination which matches the contractors' proposed mix design (including Class F fly ash or GGBF slag), utilizing ASTM C1567. Test results of the combination shall have a measured expansion of less than 0.08 percent at 28 days. Should the test data indicate an expansion of greater than 0.08%, the aggregate(s) shall be rejected and the contractor shall submit new aggregate sources for retesting or may submit additional test results incorporating Lithium Nitrate for consideration.

ASTM C1260 shall be modified as follows to include one of the following options:

a. Utilize the contractor's proposed low alkali Portland cement and Class

F fly ash in combination for the test proportioning. The laboratory shall use the contractor's proposed percentage of cement and fly ash.

b. Utilize the contractor's proposed low alkali Portland cement and ground granulated blast furnace (GGBF) slag in combination for the test proportioning. The laboratory shall use the contractor's proposed percentage of cement and GGBF.

c. Utilize the contractor's proposed low alkali Portland cement and Class F fly ash and ground granulated blast furnace (GGBF) slag in combination for the test proportioning. The laboratory shall use the contractor's proposed percentage of cement, fly ash and GGBF.

2.1.3.2 Fine Aggregates

ASTM C33/C33M.

2.1.3.3 Coarse Aggregates

ASTM C33/C33M.

2.1.4 Admixtures

ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures. Where not shown or specified, the use of admixtures is subject to written approval of the Contracting Officer.

ASTM C260/C260M: Air-entraining.

2.1.5 Reinforcement

2.1.5.1 Dowel Bars

Bars shall conform to ASTM A615/A615M, Grade 60 for plain billet-steel bars of the size and length indicated. Remove all burrs and projections from the bars.

2.1.5.2 Coated Dowel Bars

Bars shall conform to ASTM A615/A615M, Grade 60 for plain billet-steel bars of the size and length indicated. Remove all burrs or projections from the dowel bars. Coating system shall conform to AWWA C215, Type 2. Coat the bars with a double coat system or an epoxy coating system for resistance to penetration of oil and salt solutions. The systems shall be in accordance with manufacturer's recommendation for coatings which are not bondable to concrete. Bond the coating to the dowel bar to resist laps or folds during movement of the joint. Coating thickness shall be 7 mils minimum and 20 mils maximum.

2.1.5.3 Tie Bars

Bars shall be billet or axle steel deformed bars and conform to ASTM A615/A615M or ASTM A966/A966M Grade 60.

2.1.5.4 Reinforcement

Deformed steel bar mats shall conform to ASTM A184/A184M. Bar

reinforcement shall conform to ASTM A966/A966M, Grade 60.

2.1.6 Curing Materials

2.1.6.1 White-Burlap-Polyethylene Sheet

ASTM C171, 0.004 inch thick white opaque polyethylene bonded to 10 oz/linear yard (40 inch) wide burlap.

2.1.6.2 Liquid Membrane-Forming Compound

ASTM C309, white pigmented, Type 2, Class B, free of paraffin or petroleum.

2.1.6.3 Liquid Chemical Sealer-Hardener Compound

Compound shall be magnesium fluosilicate which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Compound shall not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.2 CONCRETE PAVEMENT

2.2.1 Joint Layout Drawings

If jointing requirements on the project drawings are not compatible with the contractor's placement sequence, the contractor shall submit a joint layout plan shop drawing to the Contracting Officer for approval. No work shall be allowed to start until the joint layout plan is approved. The joint layout plan shall indicate and describe in the detail the proposed jointing plan for contraction joints, expansion joints, and construction joints, in accordance with the following:

a. Indicate locations of contraction joints, construction joints, and expansion joints. Spacing between contraction joints shall not exceed 15 feet unless noted otherwise or approved by the Contracting Officer.

b. The larger dimension of a panel shall not be greater than 125% of the smaller dimension.

c. The minimum angle between two intersecting joints shall be 80 degrees, unless noted otherwise or approved by the Contracting Officer.

d. Joints shall intersect pavement-free edges at a 90 degree angle the pavement edge and shall extend straight for a minimum of 1.5 feet from the pavement edge, where possible.

e. Align joints of adjacent panels.

f. Align joints in attached curbs with joints in pavement when possible.

g. Ensure joint depth, widths, and dimensions are specified.

h. Minimum contraction joint depth shall be 1/4 of the pavement thickness. The minimum joint width shall be 1/8 inch.

i. Use expansion joints only where pavement abuts buildings, foundations, manholes, and other fixed objects.

2.3 CONTRACTOR-FURNISHED MIX DESIGN

Contractor-furnished mix design concrete shall be designed in accordance with ACI 211.1 except as modified herein, and the mix design shall be as specified herein under paragraph entitled "Submittals." The concrete shall have a minimum flexural strength of 650 pounds per square inch at 28 days. The concrete may be air entrained. If air entrainment is used the air content shall be 5.0 plus or minus 1.5 percent. Maximum size aggregate for slip forming shall be 1.5 inches. The minimum cementitious factor is 564 lbs per cubic yard and slump shall be 1 to 3 inches (or less when slip form is used).

If the cementitious material is not sufficient to produce concrete of the flexural strength required it shall be increased as necessary, without additional compensation under the contract. The cementitious factor shall be calculated using cement, Class F fly ash, and or GGBF slag. The mix shall use a cement replacement (by weight) of 25 percent - 35 percent Class F fly ash, or 40 percent - 50 percent GGBF slag, or a combination of the two. In the combination, each 5 percent of Class F fly ash shall be replaced by 8 percent GGBF slag.

PART 3 EXECUTION

3.1 FORMS

3.1.1 Construction

Construct forms to be removable without damaging the concrete.

3.1.2 Coating

Before placing the concrete, coat the contact surfaces of forms -except existing pavement sections where bonding is required,- with a non-staining mineral oil, non-staining form coating compound, or two coats of nitro-cellulose lacquer. When using existing pavement as a form, clean existing concrete and then coat with asphalt emulsion bondbreaker before concrete is placed.

3.1.3 Grade and Alignment

Check and correct grade elevations and alignment of the forms immediately before placing the concrete.

3.2 REINFORCEMENT

3.2.1 Dowel Bars

Install bars accurately aligned, vertically and horizontally, at indicated locations and to the dimensions and tolerances indicated. Before installation thoroughly grease the sliding portion of each dowel. Dowels must remain in position during concrete placement and curing.

3.2.2 Coated Dowel Bars

Install bars, accurately aligned vertically and horizontally, at indicated locations and to the dimensions and tolerances indicated. Reject coatings which are perforated, cracked or otherwise damaged. While handling avoid scuffing or gouging of the coatings.

3.2.3 Tie Bars

Install bars, accurately aligned horizontally and vertically, at indicated locations.

3.2.4 Setting Slab Reinforcement

Reinforcement shall be positioned on suitable chairs prior to concrete placement. At expansion, contraction and construction joints, place the reinforcement as indicated. Reinforcement, when placed in concrete, shall be free of mud, oil, scale or other foreign materials. Place reinforcement accurately and wire securely. The laps at splices shall be 12 inches minimum and the distances from ends and sides of slabs and joints shall be as indicated.

3.3 MEASURING, MIXING, CONVEYING, AND PLACING CONCRETE

3.3.1 Measuring

ASTM C94/C94M.

3.3.2 Mixing

ASTM C94/C94M, except as modified herein. Begin mixing within 30 minutes after cement has been added to aggregates. When the air temperature is greater than 85 degrees F, place concrete within 60 minutes. With the approval of the Contracting Officer, a hydration stabilizer admixture meeting the requirements of ASTM C494/C494M Type D, may be used to extend the placement time to 90 minutes. Additional water may be added to bring slump within required limits as specified in Section 11.7 of ASTM C94/C94M, provided that the specified water-cement ratio is not exceeded.

3.3.3 Conveying

ASTM C94/C94M.

3.3.4 Placing

Follow guidance of ACI 301, except as modified herein. Do not exceed a free vertical drop of 5 feet from the point of discharge. Deposit concrete either directly from the transporting equipment or by conveyor on to the pre-wetted subgrade or subbase, unless otherwise specified. Do not place concrete on frozen subgrade or subbase. Deposit the concrete between the forms to an approximately uniform height. Place concrete continuously at a uniform rate, with minimum amount of segregation, without damage to the grade and without unscheduled stops except for equipment failure or other emergencies. If this occurs within 10 feet of a previously placed expansion joint, remove concrete back to joint, repair any damage to grade, install a construction joint and continue placing concrete only after cause of the stop has been corrected.

3.3.5 Vibration

Immediately after spreading concrete, consolidate concrete with internal type vibrating equipment along the boundaries of all slabs regardless of slab thickness, and interior of all concrete slabs 6 inches or more in thickness. Limit duration of vibration to that necessary to produce consolidation of concrete. Excessive vibration will not be permitted. Vibrators shall not be operated in concrete at one location for more than

15 seconds. At the option of the Contractor, vibrating equipment of a type approved by the Contracting Officer may be used to consolidate concrete in unreinforced pavement slabs less than 6 inches thick.

3.3.5.1 Vibrating Equipment

Operate equipment, except hand-manipulated equipment, ahead of the finishing machine. Select the number of vibrating units and power of each unit to properly consolidate the concrete. Mount units on a frame that is capable of vertical movement and, when necessary, radial movement, so vibrators may be operated at any desired depth within the slab or be completely withdrawn from the concrete. Clear distance between frame-mounted vibrating units that have spuds that extend into the slab at intervals across the paving lane shall not exceed 30 inches. Distance between end of vibrating tube and side form shall not exceed 2 inches. For pavements less than 10 inches thick, operate vibrators at mid-depth parallel with or at a slight angle to the subbase. For thicker pavements, angle vibrators toward the vertical, with vibrator tip preferably about 2 inches from subbase, and top of vibrator a few inches below pavement surface. Vibrators may be pneumatic, gas driven, or electric, and shall be operated at frequencies within the concrete of not less than 8,000 vibrations per minute. Amplitude of vibration shall be such that noticeable vibrations occur at 1.5 foot radius when the vibrator is inserted in the concrete to the depth specified.

3.3.6 Cold Weather

Except with authorization, do not place concrete when ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. When authorized, when concrete is likely to be subjected to freezing within 24 hours after placing, heat concrete materials so that temperature of concrete when deposited is between 65 and 80 degrees F. Methods of heating materials are subject to approval of the Contracting Officer. Do not heat mixing water above 165 degrees F. Remove lumps of frozen material and ice from aggregates before placing aggregates in mixer. Follow practices found in ACI 306.1.

3.3.7 Hot Weather

Maintain required concrete temperature in accordance with Figure 2.1.5 in ACI 305R to prevent evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. After placement, use fog spray, apply monomolecular film, or use other suitable means to reduce the evaporation rate. Start curing when surface of fresh concrete is sufficiently hard to permit curing without damage. Cool underlying material by sprinkling lightly with water before placing concrete. Follow practices found in ACI 305R.

3.4 PAVING

Pavement shall be constructed with paving and finishing equipment utilizing fixed forms or slipforms.

3.4.1 Consolidation

The paver vibrators shall be inserted into the concrete not closer to the underlying material than 2 inches. The vibrators or any tamping units in

front of the paver shall be automatically controlled so that they shall be stopped immediately as forward motion ceases. Excessive vibration shall not be permitted. Concrete in small, odd-shaped slabs or in locations inaccessible to the paver mounted vibration equipment shall be vibrated with a hand-operated immersion vibrator. Vibrators shall not be used to transport or spread the concrete.

3.4.2 Operation

When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provisions shall be made to prevent damage to the previously constructed pavement, including keeping the existing pavement surface free of any debris, and placing rubber mats beneath the paver tracks. Transversely oscillating screeds and extrusion plates shall overlap the existing pavement the minimum possible, but in no case more than 8 inches.

3.4.3 Required Results

The paver-finisher shall be operated to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The paver-finishing operation shall produce a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities. It shall produce only a very minimum of paste at the surface. Multiple passes of the paver-finisher shall not be permitted. The equipment and its operation shall produce a finished surface requiring no hand finishing, other than the use of cutting straightedges, except in very infrequent instances. No water, other than true fog sprays (mist), shall be applied to the concrete surface during paving and finishing.

3.4.4 Fixed Form Paving

Forms shall be steel, except that wood forms may be used for curves having a radius of 150 feet or less, and for fillets. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. The base width of the form shall be not less than eight-tenths of the vertical height of the form, except that forms 8 inches or less in vertical height shall have a base width not less than the vertical height of the form. Wood forms for curves and fillets shall be adequate in strength and rigidly braced. Forms shall be set on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Forms shall not be set on blocks or on built-up spots of underlying material. Forms shall remain in place at least 12 hours after the concrete has been placed. Forms shall be removed without injuring the concrete.

3.4.5 Slipform Paving

The slipform paver shall shape the concrete to the specified and indicated cross section in one pass, and shall finish the surface and edges so that only a very minimum amount of hand finishing is required. Dowels shall not be installed by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete.

3.4.6 Placing Reinforcing Steel

Reinforcement shall be positioned on suitable chairs securely fastened to the subgrade prior to concrete placement.

3.4.7 Placing Dowels and Tie Bars

Dowels shall be installed with alignment not greater than 1/8 inch per ft. Except as otherwise specified below, location of dowels shall be within a horizontal tolerance of plus or minus 5/8 inch and a vertical tolerance of plus or minus 3/16 inch. The portion of each dowel intended to move within the concrete or expansion cap shall be painted with one coat of rust inhibiting primer paint, and then oiled just prior to placement. Dowels and tie bars in joints shall be omitted when the center of the dowel or tie bar is located within a horizontal distance from an intersecting joint equal to or less than one-fourth of the slab thickness.

3.4.7.1 Contraction Joints

Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place by means of rigid metal basket assemblies. The dowels and tie bars shall be welded to the assembly or held firmly by mechanical locking arrangements that will prevent them from becoming distorted during paving operations. The basket assemblies shall be held securely in the proper location by means of suitable anchors.

3.4.7.2 Construction Joints-Fixed Form Paving

Installation of dowels and tie bars shall be by the bonded-in-place method, supported by means of devices fastened to the forms. Installation by removing and replacing in preformed holes will not be permitted.

3.4.7.3 Dowels Installed in Hardened Concrete

Installation shall be by bonding the dowels into holes drilled into the hardened concrete. Holes approximately 1/8 inch greater in diameter than the dowels shall be drilled into the hardened concrete. Dowels shall be bonded in the drilled holes using epoxy resin injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel shall not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic collar fitted around the dowel. The vertical alignment of the dowels shall be checked by placing the straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel.

3.4.7.4 Expansion Joints

Dowels in expansion joints shall be installed by the bonded-in-place method or by bonding into holes drilled in hardened concrete, using procedures specified above.

3.5 FINISHING CONCRETE

Start finishing operations immediately after placement of concrete. Use finishing machine, except hand finishing may be used in emergencies and for concrete slabs in inaccessible locations or of such shapes or sizes that machine finishing is impracticable. Finish pavement surface on both sides of a joint to the same grade. Finish formed joints from a securely supported transverse bridge. Provide hand finishing equipment for use at

all times. Transverse and longitudinal surface tolerances shall be 1/4 inch in 10 feet.

3.5.1 Side Form Finishing

Strike off and screed concrete to the required slope and cross-section by a power-driven transverse finishing machine. Transverse rotating tube or pipe shall not be permitted unless approved by the Contracting Officer. Elevation of concrete shall be such that, when consolidated and finished, pavement surface will be adequately consolidated and at the required grade. Equip finishing machine with two screeds which are readily and accurately adjustable for changes in pavement slope and compensation for wear and other causes. Make as many passes over each area of pavement and at such intervals as necessary to give proper compaction, retention of coarse aggregate near the finished surface, and a surface of uniform texture, true to grade and slope. Do not permit excessive operation over an area, which will result in an excess of mortar and water being brought to the surface.

3.5.1.1 Equipment Operation

Maintain the travel of machine on the forms without lifting, wobbling, or other variation of the machine which tend to affect the precision of concrete finish. Keep the tops of the forms clean by a device attached to the machine. During the first pass of the finishing machine, maintain a uniform ridge of concrete ahead of the front screed for its entire length.

3.5.1.2 Joint Finish

Before concrete is hardened, correct edge slump of pavement, exclusive of edge rounding, in excess of 0.02 foot. Finish concrete surface on each side of construction joints to the same plane, and correct deviations before newly placed concrete has hardened.

3.5.1.3 Hand Finishing

Strike-off and screed surface of concrete to elevations slightly above finish grade so that when concrete is consolidated and finished pavement surface is at the indicated elevation. Vibrate entire surface until required compaction and reduction of surface voids is secured with a strike-off template.

3.5.1.4 Longitudinal Floating

After initial finishing, further smooth and consolidate concrete by means of hand-operated longitudinal floats. Use floats that are not less than 12 feet long and 6 inches wide and stiffened to prevent flexing and warping.

3.5.2 Texturing

Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement shall be given a texture as described herein. Following initial texturing on the first day of placement, the Placing Foreman, Contracting Officer representative, and a representative of the Using Agency shall inspect the texturing for compliance with design requirements. After curing is complete, all textured surfaces shall be thoroughly power broomed to remove all debris. The concrete in areas of recesses for tie-down anchors, lighting fixtures, and other outlets in the pavement shall be finished to provide a surface of the same texture as the

surrounding area.

3.5.2.1 Burlap Drag Finish

Before concrete becomes non-plastic, finish the surface of the slab by dragging on the surface a strip of clean, wet burlap measuring from 3 to 10 feet long and 2 feet wider than the width of the pavement. Select dimension of burlap drag so that at least 3 feet of the material is in contact with the pavement. Drag the surface so as to produce a finished surface with a fine granular or sandy texture without leaving disfiguring marks.

3.5.2.2 Brooming

Finish the surface of the slab by brooming the surface with a new wire broom at least 18 inches wide. Gently pull the broom over the surface of the pavement from edge to edge just before the concrete becomes non-plastic. Slightly overlap adjacent strokes of the broom. Broom perpendicular to centerline of pavement so that corrugations produced will be uniform in character and width, and not more than 1/16 inch in depth. Broomed surface shall be free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidentally disturbing particles of coarse aggregate embedded near the surface.

3.5.3 Edging

At the time the concrete has attained a degree of hardness suitable for edging, carefully finish slab edges, including edges at formed joints, with an edge having a maximum radius of one-eighth inch. When brooming is specified for the final surface finish, edge transverse joints before starting brooming, then operate broom to obliterate as much as possible the mark left by the edging tool without disturbing the rounded corner left by the edger. Clean by removing loose fragments and soupy mortar from corners or edges of slabs which have crumbled and areas which lack sufficient mortar for proper finishing. Refill voids solidly with a mixture of suitable proportions and consistency and refinish. Remove unnecessary tool marks and edges. Remaining edges shall be smooth and true to line.

3.5.4 Repair of Surface Defects

Follow guidance of ACI 301.

3.6 CURING AND PROTECTION

Protect concrete adequately from injurious action by sun, rain, flowing water, mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein. Use White-Burlap-Polyethylene Sheet or liquid membrane-forming compound, except as specified otherwise herein. Do not use membrane-forming compound on surfaces where its appearance would be objectionable, on surfaces to be painted, where coverings are to be bonded to concrete, or on concrete to which other concrete is to be bonded. Maintain temperature of air next to concrete above 40 degrees F for the full curing periods.

3.6.1 White-Burlap-Polyethylene Sheet

Wet entire exposed surface thoroughly with a fine spray of water, saturate

burlap but do not have excessive water dripping off the burlap and then cover concrete with White-Burlap-Polyethylene Sheet, burlap side down. Lay sheets directly on concrete surface and overlap 12 inches. Make sheeting not less than 18 inches wider than concrete surface to be cured, and weight down on the edges and over the transverse laps to form closed joints. Repair or replace sheets when damaged during curing. Check daily to assure burlap has not lost all moisture. If moisture evaporates, resaturate burlap and re-place on pavement (re-saturation and re-placing shall take no longer than 10 minutes per sheet). Leave sheeting on concrete surface to be cured for at least 7 days.

3.6.2 Liquid Membrane-Forming Compound Curing

Apply compound immediately after surface loses its water sheen and has a dull appearance and before joints are sawed. Agitate curing compound thoroughly by mechanical means during use and apply uniformly in a two-coat continuous operation by suitable power-spraying equipment. Total coverage for the two coats shall be at least one gallon of undiluted compound per 200 square feet. Compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. Apply an additional coat of compound immediately to areas where film is defective. Respray concrete surfaces that are subject to heavy rainfall within 3 hours after curing compound has been applied in the same manner.

3.6.2.1 Protection of Treated Surfaces

Keep concrete surfaces to which liquid membrane-forming compounds have been applied free from vehicular traffic and other sources of abrasion for not less than 72 hours. Foot traffic is allowed after 24 hours for inspection purposes. Maintain continuity of coating for entire curing period and repair damage to coating immediately.

3.6.3 Liquid Chemical Sealer-Hardener

Apply sealer-hardener to interior floors not receiving floor covering and floors located under access flooring. Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. The sealer-hardener shall not be applied until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

3.7 FIELD QUALITY CONTROL

3.7.1 Sampling

The Contractor's approved laboratory shall collect samples of fresh concrete in accordance with ASTM C172/C172M during each working day as required to perform tests specified herein. Make test specimens in accordance with ASTM C31/C31M.

3.7.2 Consistency Tests

The Contractor's approved laboratory shall perform concrete slump tests in accordance with ASTM C143/C143M. Take samples for slump determination from concrete during placement. Perform tests at the beginning of a concrete placement operation and and for each batch (minimum) or every 20 cubic yards (maximum) of concrete to ensure that specification requirements are met.

In addition, perform tests each time test beams and cylinders are made.

3.7.3 Flexural Strength Tests

The Contractor's approved laboratory shall test for flexural strength in accordance with ASTM C78/C78M. Make four test specimens for each set of tests. Test two specimens at 14 days, and the other two at 28 days. Concrete strength will be considered satisfactory when the minimum of the 28-day test results equals or exceeds the specified 28-day flexural strength, and no individual strength test is less than 550 pounds per square inch. If the ratio of the 28-day strength test to the specified 28-day strength is less than 65 percent, make necessary adjustments for conformance. Frequency of flexural tests on concrete beams shall be not less than four test beams for each 50 cubic yards of concrete, or fraction thereof, placed. Concrete which is determined to be defective, based on the strength acceptance criteria therein, shall be removed and replaced with acceptable concrete.

3.7.4 Air Content Tests

Test air-entrained concrete for air content at the same frequency as specified for slump tests. Determine percentage of air in accordance with ASTM C231/C231M on samples taken during placement of concrete in forms.

3.7.5 Surface Testing

Surface testing for surface smoothness and plan grade shall be performed as indicated below by the Testing Laboratory. The measurements shall be properly referenced in accordance with paving lane identification and stationing, and a report given to the Government within 24 hours after measurement is made. A final report of surface testing, signed by a Registered Engineer, containing all surface measurements and a description of all actions taken to correct deficiencies, shall be provided to the Government upon conclusion of surface testing.

3.7.5.1 Surface Smoothness Requirements

The finished surfaces of the pavements shall have no abrupt change of 1/8 inch or more, and all pavements shall be within the tolerances specified when checked with a 12 foot straightedge: 1/5 inch longitudinal and 1/4 inch transverse directions for roads and streets and 1/4 inch for both directions for other concrete surfaces, such as parking areas.

3.7.6 Reinforcement

Inspect reinforcement prior to installation to assure it is free of loose flaky rust, loose scale, oil, mud, or other objectionable material.

3.7.7 Dowels

Inspect dowel placement prior to placing concrete to assure that dowels are of the size indicated, and are spaced, aligned and painted and oiled as specified. Dowels shall not deviate from vertical or horizontal alignment after concrete has been placed by more than 1/8 inch per foot.

3.8 WASTE MANAGEMENT

In accordance with the Waste Management Plan. Protect excess material from contamination and return to manufacturer, or reuse on-site for walkways, patching, ditch beds, speed bumps, or curbs.

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SECTION 32 16 13

CONCRETE SIDEWALKS AND CURBS AND GUTTERS
04/08

PART 1 GENERAL

1.1 MEASUREMENT FOR PAYMENT

1.1.1 Sidewalks

The quantities of sidewalks to be paid for will be the number of square yards of each depth of sidewalk constructed as indicated.

1.1.2 Curbs and Gutters

The quantities of curbs and gutters to be paid for will be the number of linear feet of each cross section constructed as indicated, measured along the face of the curb at the gutter line.

1.2 BASIS FOR PAYMENT

1.2.1 Sidewalks

Payment of the quantities of sidewalks measured as specified will be at the contract unit price per square yard of the thickness specified.

1.2.2 Curbs and Gutters

Payment of the quantities of curbs and gutters measured as specified will be at the contract unit price per linear foot of each cross section.

1.3 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A615/A615M	(2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C143/C143M	(2010a) Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2010) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2010b) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2010) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM D1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D5893/D5893M	(2010) Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

1.4 SYSTEM DESCRIPTION

1.4.1 General Requirements

Provide plant, equipment, machines, and tools used in the work subject to approval and maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete

SD-06 Test Reports

Field Quality Control

1.6 ENVIRONMENTAL REQUIREMENTS

1.6.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.6.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed95 degrees F at any time.

PART 2 PRODUCTS

2.1 CONCRETE

Provide concrete conforming to the applicable requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE except as otherwise specified. Concrete shall have a minimum compressive strength of 3500 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches. Submit copies of certified delivery tickets for all concrete used in the construction.

2.1.1 Air Content

Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

The concrete slump shall be 2 inches plus or minus 1 inch where determined in accordance with ASTM C143/C143M.

2.1.3 Reinforcement Steel

Reinforcement bars shall conform to ASTM A615/A615M. Wire mesh reinforcement shall conform to ASTM A185/A185M.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C171, type optional, except that polyethylene film, if used, shall be white opaque.

2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C309, Type 2.

2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.4.2 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D1751 or ASTM D1752, 1/2 inch thick, unless otherwise indicated.

2.5 JOINT SEALANTS

Joint sealant, cold-applied shall conform to ASTM C920 or ASTM D5893/D5893M.

2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and

self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted as directed.

3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces

shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment shall be checked with a 10 foot straightedge. Forms shall have a transverse slope of 1/4 inch per foot with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated by tamping and spading or with an approved vibrator, and the surface shall be finished to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

3.5.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Expansion joints shall be formed with 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D1752 or building paper. Joint filler shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with cold-applied joint sealant. Joint sealant shall be gray or stone in color.

3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length.

a. Contraction joints (except for slip forming) shall be constructed by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

b. When slip forming is used, the contraction joints shall be cut in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb and gutter, using a power-driven saw. The depth of cut shall be at least one-fourth of the gutter/curb depth and 1/8 inch in width.

3.6.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least 1/2 inch in width shall be provided at intervals not less than 30

feet nor greater than 120 feet. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit.

3.7 CURING AND PROTECTION

3.7.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 6 inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18-inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet/gallon for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where

the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Completed concrete shall be protected from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

3.7.4 Protective Coating

3.7.4.1 Application

Curing and backfilling operation shall be completed prior to applying two coats of protective coating. Concrete shall be surface dry and clean before each application. Coverage shall be by spray application at not more than 50 square yards/gallon for first application and not more than 70 square yards/gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.

3.7.4.2 Precautions

Protective coating shall not be heated by direct application of flame or electrical heaters and shall be protected from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Material shall not be applied at ambient or material temperatures lower than 50 degrees F.

3.8 FIELD QUALITY CONTROL

Submit copies of all test reports within 24 hours of completion of the test.

3.8.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

Provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 250 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C172/C172M. Cylinders for acceptance shall be molded in conformance with ASTM C31/C31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

3.8.2.2 Air Content

Determine air content in accordance with ASTM C173/C173M or ASTM C231/C231M. ASTM C231/C231M shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be

uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

-- End of Section --

SECTION 32 17 23.00 20

PAVEMENT MARKINGS
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 in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2240	(2005; R 2010) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2621	(1987; R 2011) Infrared Identification of Vehicle Solids from Solvent-Reducible Paints
ASTM D2697	(2003; R 2008) Volume Nonvolatile Matter in Clear or Pigmented Coatings
ASTM D3335	(1985a; R 2009) Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
ASTM D3718	(1985a; R 2010) Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
ASTM D3924	(1980; R 2011) Standard Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials
ASTM D3960	(2005) Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4280	(2008) Extended Life Type, Nonplowable, Raised, Retroreflective Pavement Markers
ASTM D4505	(2005) Preformed Retroflective Pavement Marking Tape for Extended Service Life
ASTM D4541	(2009e1) Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D471	(2010) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D522	(1993a; R 2008) Mandrel Bend Test of Attached Organic Coatings
ASTM D711	(2010) No-Pick-Up Time of Traffic Paint

ASTM D792	(2008) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D823	(1995; R 2007) Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels.
ASTM E28	(1999; R 2009) Softening Point of Resins Derived from Naval Stores by Ring and Ball Apparatus
ASTM G 154	(2006) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI 03732	(1997) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-2886	(Rev A) Paint, Traffic, Solvent Based
FED-STD-595	(Rev C) Colors Used in Government Procurement
FS TT-B-1325	(Rev D) Beads (Glass Spheres) Retro-Reflective (Metric)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. 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

Reflective media for roads and streets

Paints for roads and streets

High Build Acrylic Coating (HBAC); G

Thermoplastic compound

Raised Pavement Markers and Adhesive

Equipment; G

Lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range,

tank and flow capacities, and safety precautions required for the equipment operation.

Qualifications

Documentation on personnel qualifications, as specified.

SD-06 Test Reports

Reflective media for roads and streets

Paints for roads and streets

High Build Acrylic Coating (HBAC); G

Thermoplastic compound

Raised Pavement Markers and Adhesive

Certified reports from sampling and testing made in accordance with paragraph entitled "Sampling and Testing" prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

SD-07 Certificates

Reflective media for roads and streets

Paints for roads and streets

Volatile Organic Compound, (VOC)

Certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located.

Thermoplastic compound

Construction equipment list

SD-08 Manufacturer's Instructions

Paints for roads and streets

Thermoplastic compound

Submit manufacturer's Material Safety Data Sheets.

1.3 DELIVERY AND STORAGE

Deliver paints, paint materials and thermoplastic compound materials in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer. Provide storage facilities at the job site for maintaining materials at temperatures recommended by the manufacturer.

1.4 WEATHER LIMITATIONS

Apply paint to clean, dry surfaces, and unless otherwise approved, only when the air and pavement surface temperature is at least 5 degrees above the dew point and the air and pavement temperatures are above 40 degrees F and less than 95 degrees F for oil-based materials; above 50 degrees F and less than 110 degrees F for water-based materials. Maintain paint temperature within these same limits.

1.5 EQUIPMENT

Machines, tools, and equipment used in the performance of the work shall be approved by the Contracting Officer and maintained in satisfactory operating condition. Submit construction equipment list for approval by the Contracting Officer.

1.5.1 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

1.5.2 Paint Application Equipment

1.5.2.1 Hand-Operated, Push-Type Machines

Provide hand-operated push-type applicator machine of a type commonly used for application of paint to pavement surfaces. Paint applicator machine shall be acceptable for marking small street and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Applicator for water-based markings shall be equipped with non-stick coated hoses; metal parts in contact with the paint material shall be constructed of grade 302, 304, 316, or equal stainless steel.

1.5.2.2 Self-Propelled or Mobile-Drawn Pneumatic Spraying Machines

Provide self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges. Provide paint applicator with paint reservoirs or tanks of sufficient capacity and suitable gages to apply paint in accordance with requirements specified. Equip tanks with suitable air-driven mechanical agitators. Equip spray mechanism with quick-action valves conveniently located, and include necessary pressure regulators and gages in full view and reach of the operator. Install paint strainers in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Provide pneumatic spray guns for hand application of paint in areas where the mobile paint applicator cannot be used. Applicator for water-based markings shall be equipped with non-stick coated hoses; metal parts in contact with the paint material shall be constructed of grade 302, 304, 316, or equal stainless steel.

1.5.3 Thermoplastic Application Equipment

1.5.3.1 Thermoplastic Material

Thermoplastic material shall be applied to the primed pavement surface by spray techniques or by the extrusion method, wherein one side of the shaping die is the pavement and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material. By either method, the markings shall be applied with equipment that is capable of providing continuous uniformity in the dimensions of the stripe.

1.5.3.2 Application Equipment

a. Application equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment which come into contact with the material shall be easily accessible and exposable for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns shall maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. The application equipment shall be constructed to ensure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying "skiplines". The equipment shall be capable of applying varying widths of traffic markings.

c. The applicator shall be equipped with a drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser shall be automatically operated and shall begin flow prior to the flow of composition to assure that the strip is fully reflectorized.

1.5.3.3 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. The equipment used for the placement of thermoplastic pavement markings shall be of two general types: mobile applicator and portable applicator.

1.5.3.4 Mobile Application Equipment

The mobile applicator shall be defined as a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method. The unit shall be equipped to apply the thermoplastic marking material at temperatures exceeding 375 degrees F, at widths varying from 3 to 12 inches and in thicknesses varying from 0.040 to 0.200 inch and shall have an automatic drop-on bead system. The mobile unit shall be capable of operating continuously and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.

The mobile unit shall be equipped with a melting kettle which holds a minimum of 6000 pounds of molten thermoplastic material. The kettle shall be capable of heating the thermoplastic composition to temperatures of 375 to 425 degrees F. A thermostatically controlled heat transfer liquid shall

be used. Heating of the composition by direct flame shall not be allowed. Oil and material temperature gauges shall be visible at both ends of the kettle. The mobile unit shall be equipped with a minimum of two extrusion shoes located one on each side of the truck, and shall be capable of marking simultaneous edgeline and centerline stripes. Each extrusion shoe shall be a closed, oil-jacketed unit; shall hold the molten thermoplastic at a temperature of 375 to 425 degrees F; and shall be capable of extruding a line of 3 to 8 inches in width; and at a thickness of not less than 0.120 inch nor more than 0.190 inch, and of generally uniform cross section.

The mobile unit shall be equipped with an electronic programmable line pattern control system. The control system shall be capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, the mobile unit shall be equipped with an automatic counting mechanism capable of recording the number of lineal feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

1.5.3.5 Portable Application Equipment

The portable applicator shall be defined as hand-operated equipment, specifically designed for placing special markings such as crosswalks, stopbars, legends, arrows, and short lengths of lane, edge and centerlines. The portable applicator shall be capable of applying thermoplastic pavement markings by the extrusion method. The portable applicator shall be loaded with hot thermoplastic composition from the melting kettles on the mobile applicator. The portable applicator shall be equipped with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature of 375 to 425 degrees F, of extruding a line of 3 to 12 inches in width, and in thickness of not less than 0.120 inch nor more than 0.190 inch and of generally uniform cross section.

1.5.4 Reflective Media Dispenser

The dispenser for applying the reflective media shall be attached to the paint dispenser and shall operate automatically and simultaneously with the applicator through the same control mechanism. The dispenser shall be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph "Application," at all operating speeds of the applicator to which it is attached.

1.5.5 Preformed Tape Application Equipment

Mechanical application equipment shall be used for the placement of preformed marking tape. Mechanical application equipment shall be defined as a mobile pavement marking machine specifically designed for use in applying precoated, pressure-sensitive pavement marking tape of varying widths, up to 12 inches. The applicator shall be equipped with rollers, or other suitable compactive device, to provide initial adhesion of the preformed, pressure-sensitive marking tape with the pavement surface. Additional hand-operated rollers shall be used as required to properly seat the thermoplastic tape.

1.5.6 Surface Preparation Equipment

1.5.6.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1.5.6.2 Waterblast Equipment

The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.

1.5.7 Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

1.5.7.1 Shotblasting Equipment

Shotblasting equipment shall be capable of producing an adjustable depth of removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.

1.5.7.2 Chemical Equipment

Chemical equipment shall be capable of application and removal of chemicals from the pavement surface, and shall leave only non-toxic biodegradable residue.

1.5.8 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

1.6 MAINTENANCE OF TRAFFIC

1.6.1 Lighting

When night operations are necessary, all necessary lighting and equipment shall be provided. Lighting shall be directed or shaded to prevent interference with aircraft, the air traffic control tower, and other base operations. All lighting and related equipment shall be capable of being removed from the runway within 15 minutes of notification of an emergency. Night work must be coordinated with the Airfield Manager and approved in advance by the Contracting Officer or authorized representative. The

Government reserves the right to accept or reject night work on the day following night activities by the Contractor.

1.6.2 Roads, Streets, and Parking Areas

When traffic must be rerouted or controlled to accomplish the work, the necessary warning signs, flagpersons, and related equipment for the safe passage of vehicles shall be provided.

1.7 WEATHER LIMITATIONS FOR REMOVAL

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

1.8 QUALIFICATIONS

The Contractor shall submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of chemicals.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials conforming to the requirements specified herein.

2.1.1 Paints for Roads and Streets

CID A-A-2886 High Build Acrylic Coating (HBAC), color to match existing.

2.1.2 Reflective Media for Roads and Streets

FS TT-B-1325, Type I, Gradation A.

2.1.3 Thermoplastic Compound

The thermoplastic reflectorized pavement marking compound shall be extruded or sprayed in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement temperatures, the marking shall be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.

2.1.3.1 Composition Requirements

The binder component shall be formulated as a hydrocarbon resin. The pigment, beads and filler shall be uniformly dispersed in the binder resin. The thermoplastic composition shall be free from all skins, dirt, and foreign objects and shall comply with the following requirements:

	Percent by Weight	
Component	White	Yellow
Binder	17 min	17 min
Titanium dioxide	10 min	-

Component	Percent by Weight White	Yellow
Glass beads	20 min	20 min
Calcium carbonate and inert fillers	49 min	*
Yellow pigments	-	*

*Amount and type of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, providing the other composition requirements of this specification are met.

2.1.3.2 Physical Properties

a. Drying time: When installed at 70 degrees F and in thicknesses between 0.120 and 0.190 inch, the composition shall be completely solid and shall show no damaging effect from traffic after curing 15 minutes.

b. Softening point: The composition shall have a softening point of not less than 194 degrees F when tested in accordance with ASTM E28.

c. Specific gravity: The specific gravity of the composition shall be between 1.9 and 2.2 as determined in accordance with ASTM D792.

2.1.3.3 Primer

a. Asphalt concrete primer: The primer for asphalt concrete pavements shall be a thermosetting adhesive with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved or dispersed in a volatile organic solvent. The solids content shall not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch, plus or minus 0.001 inch, shall dry to a tack-free condition in less than 5 minutes.

b. Portland cement concrete primer: The primer for Portland cement concrete pavements shall be an epoxy resin primer. The primer shall be of the type recommended by the manufacturer of the thermoplastic composition.

2.1.4 PREFORMED TAPE

The preformed tape shall be an adherent reflectorized strip in accordance with ASTM D4505 Type I or IV, Class optional.

2.1.5 Raised Pavement Markers

Either metallic or nonmetallic markers of the button or prismatic reflector type may be used. Markers shall be of permanent colors as specified for pavement marking, and shall retain the color and brightness under the action of traffic. Button markers shall have a diameter of not less than 4 inches, and shall be spaced not more than 40 feet apart on solid longitudinal lines. Broken centerline marker spacings shall be in segments of 10 feet with gaps of 30 feet between segments. Button markers shall have rounded surfaces presenting a smooth contour to traffic and shall not project more than 3/4 inch above level of pavement. Pavement markers and adhesive epoxy shall conform to ASTM D4280

2.1.6 High Build Acrylic Coating (HBAC)

Formulate High Build Acrylic Coating (HBAC) to meet the requirements of

Table I.

2.1.6.1 Preapproved HBAC Vendors and Materials

Table II presents a partial list of HBAC vendors and materials. Up to specifications's date of issue, preapproved materials met specification requirements. It is the user's responsibility to confirm preapproved material formulations have not changed and specification requirements will be met. Other products may meet HBAC requirements.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Allow new pavement surfaces to cure for a period of not less than 30 days before application of marking materials. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove residual curing compounds, and other coatings adhering to the pavement by water blasting. For Portland Cement Concrete pavement, grinding, light shot blasting, and light scarification, to a resulting profile equal to ICRI 03732 CSP 2, CSP 3, and CSP 4, respectively, can be used in addition to water blasting, to either remove existing coatings or for surface preparation on most pavements: shot blasting shall not be used on airfield pavements due to the potential of Foreign Object Damage (FOD) to aircraft. Scrub affected areas, where oil or grease is present on old pavements to be marked, with several applications of trisodium phosphate solution or other approved detergent or degreaser and rinse thoroughly after each application. After cleaning oil-soaked areas, seal with shellac or primer recommended by the manufacturer to prevent bleeding through the new paint. Do not commence painting in any area until pavement surfaces are dry and clean.

3.1.1 Early Painting of Rigid Pavements

Pretreat rigid pavements that require early painting with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride. Apply the solution to the areas to be marked.

3.1.2 Early Painting of Asphalt Pavements

For asphalt pavement systems requiring painting application at less than 30 days, apply the paint and beads at half the normal application rate, followed by a second application at the normal rate after 30 days.

3.2 APPLICATION

3.2.1 Testing for Moisture

Apply pavement markings to dry pavement only. The Contractor shall test the pavement surface for moisture before beginning work after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the CO or authorized representative. Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a (300 mm by 300 mm) 12 inch by 12 inch section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap

for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap.

3.2.2 Rate of Application

3.2.2.1 Reflective Markings

Apply paint evenly to the pavement area to be coated at a rate of 105 plus or minus 5 square feet per gallon. Collect and record readings for white and yellow retroreflective markings at the rate of one reading per 1000 linear feet. The minimum acceptable average for white markings is 200 millicandelas per square meter per lux (mcd/m2/lx) (measured with Mirolux 12 Retroreflectometer or similar instrument as agreed). The minimum acceptable average for yellow markings is 175 millicandelas per square meter per lux (mcd/m2/lx). Readings shall be computed by averaging a minimum of 10 readings taken within the area at random locations. Areas not meeting the retroreflective requirements stated above shall be re-marked.

3.2.2.2 Nonreflective Markings

Apply paint evenly to the pavement surface to be coated at a rate of 105 plus or minus 5 square feet per gallon. Apply High Build Acrylic Coating (HBAC) at a rate of 50 square feet per gallon.

3.2.2.3 Thermoplastic Compound

After surface preparation has been completed, prime the asphalt or concrete pavement surface with spray equipment. Allow primer materials to "set-up" prior to applying the thermoplastic composition. Allow the asphalt concrete primer to dry to a tack-free condition, usually occurring in less than 10 minutes. Allow the Portland Cement concrete primer to dry in accordance with the thermoplastic manufacturer recommendations. To shorten the curing time of the epoxy resins, an infrared heating device may be used on the concrete primer. Apply asphalt concrete primer to all asphalt concrete pavements at a wet film thickness of 0.005 inch, plus or minus 0.001 inch 265 to 400 square feet per gallon. Apply Portland cement concrete primer to all concrete pavements (including concrete bridge decks) at a wet film thickness of between 0.04 to 0.05 inch 320 to 400 square feet per gallon. After the primer has "set-up", apply the thermoplastic at temperatures no lower than 375 degrees F nor higher than 425 degrees F at the point of deposition. Immediately after installation of the marking, apply drop-on reflective glass spheres mechanically at the rate of one pound per 20 square feet such that the spheres are held by and imbedded in the surface of the molten material. Apply all extruded thermoplastic markings at the specified width and at a thickness of not less than 0.125 inch nor more than 0.190 inch. Apply all sprayed thermoplastic markings at the specified width and the thickness designated in the contract plans. If the plans do not specify a thickness, apply centerline markings at a wet thickness of 0.090 inch, plus or minus 0.005 inch, and edgeline markings at a wet thickness of 0.060 inch, plus or minus 0.005 inch.

3.2.3 Painting

Apply paint pneumatically with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply

outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. Discontinue painting operations if there is a deficiency in drying of the markings until cause of the slow drying is determined and corrected.

3.2.4 Reflective Media

Application of reflective media shall immediately follow the application of paint. Accomplish drop-on application of the glass spheres to ensure even distribution at the specified rate of coverage. Should there be malfunction of either paint applicator or reflective media dispenser, discontinue operations until deficiency is corrected.

3.2.5 Thermoplastic Compound

Place thermoplastic pavement markings upon dry pavement. At the time of installation the pavement surface temperature shall be a minimum of 40 degrees F and rising. Thermoplastics, as placed, shall be free from dirt or tint. Apply all centerline, skipline, edgeline, and other longitudinal type markings with a mobile applicator. Place all special markings, crosswalks, stop bars, legends, arrows, and similar patterns with a portable applicator, using the extrusion method.

3.2.6 Raised Pavement Markers

Prefabricated markers shall be aligned carefully at the required spacing or as directed and permanently fixed in place by means of epoxy adhesives. To ensure good bond, areas where markers will be set shall be thoroughly cleaned by water blasting and use of compressed air prior to applying adhesive.

3.3 FIELD TESTING, INSPECTION, AND DEMONSTRATIONS

3.3.1 Sampling and Testing

As soon as the paint and reflective and thermoplastic materials are available for sampling, obtain by random selection from the sealed containers, two quart samples of each batch in the presence of the Contracting Officer. Accomplish adequate mixing prior to sampling to ensure a uniform, representative sample. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Clearly identify samples by designated name, specification number, batch number, project contract number, intended use, and quantity involved. At the discretion of the Contracting Officer, samples provided may be tested by the Government for verification.

3.3.2 Inspection

Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. A certificate of compliance shall be accompanied by test results substantiating conformance to the specified requirements.

3.3.3 Surface Preparations and Application Procedures

Surface preparations and application procedures will be examined by the Contracting Officer to determine conformance with the requirements specified. Approve each separate operation prior to initiation of

subsequent operations.

3.3.3.1 Surface Preparation Demonstration

Prior to surface preparation, demonstrate surface preparation using the proposed materials, methods and equipment. Prepare areas large enough to determine cleanliness and rate of cleaning.

3.3.3.2 Test Stripe Demonstration

Prior to paint application, demonstrate test stripe application within the work area using the proposed materials and equipment. Apply separate test stripes in each of the line widths and configurations required herein using the proposed equipment. The test stripes shall be long enough to determine the proper speed and operating pressures for the vehicle(s) and machinery, but not less than 50 feet long.

3.3.3.3 Application Rate Demonstration

During the Test Stripe Demonstration, demonstrate compliance with the application rates specified herein. Document the equipment speed and operating pressures required to meet the specified rates in each configuration of the equipment and provide a copy of the documentation to the Contracting Officer or authorized representative prior to proceeding with the work.

3.3.3.4 Retroreflective Value Demonstration

After the test stripes have cured to a "no-track" condition, demonstrate compliance with the average retroreflective values specified herein. Take a minimum of ten readings on each test stripe with a Mirolux 12 Retroreflectometer, or similar instrument with the same measuring geometry and direct readout in millicandelas per square meter per lux (mcd/m2/lx).

3.3.3.5 Level of Performance Demonstration

The Contracting Officer or authorized representative will be present the application demonstrations to observe the results obtained and to validate the operating parameters of the vehicle(s) and equipment. If accepted by the Contracting Officer or authorized representative, the test stripe shall be the measure of performance required for this project. Work shall not proceed until the demonstration results are satisfactory to the Contracting Officer or authorized representative.

3.4 TRAFFIC CONTROL AND PROTECTION

Place warning signs near the beginning of the work site and well ahead of the work site for alerting approaching traffic from both directions. Place small markers along newly painted lines to control traffic and prevent damage to newly painted surfaces. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation. Do not use foil-backed material for temporary pavement marking because of its potential to conduct electricity during accidents involving downed power lines.

3.5 QUALITY ASSURANCE

Demonstrate success of bond of reflective media, new paint marking and the pavement surface, vacuum cured surface of new marking after a seven (7) day

dry time. Inspect newly applied markings for signs of bond failure based on visual inspection and comparison to results from Test Stripe Demonstration paragraph.

3.5.1 Reflective Media and Coating Bond Verification

Within seven (7) days after pavement marking application, use industrial vacuum to sweep new markings. Visually inspect the pavement markings and the material captured by the vacuum. Verify that no significant loss of reflective media has occurred to the pavement marking due to the vacuum cleaning.

3.5.2 Reflective Media and Coating Application Verification

Use a wet film thickness gauge to measure the application of wet paint.

Use a microscope or magnifying glass to evaluate the embedment of glass beads in the paint. Verify the glass bead embedment with approximately 50 percent of the beads embedded and 50 percent of the beads exposed.

TABLE I
REQUIREMENTS FOR HIGH BUILD ACRYLIC COATINGS (HBAC)

Test	Minimum Requirement (and Maximum where indicated)
Resin System (ASTM D2621)	Waterborne 100 percent Acrylic
Percent Volume Solids (ASTM D2697)	58 percent
Volatile Organic Compound, max. (ASTM D3960)	1.25 lbs/gal
White (FED-STD-595)	37925
Yellow (FED-STD-595)	33538
Shore D Hardness (ASTM D2240)	45
1/8 inch Mandrel Bend at 5 mils Dry Film Thickness (DFT, one-week cure (ASTM D522, Method B)	No visual defects at bend (Conditions at ASTM D3924)
Adhesion to Concrete and Asphaltic Pavements (ASTM D4541)	140 psi or 100 percent cohesive failure in pavement
Accelerated Weathering, Yellow, 2500 Hours UV Exposure (ASTM G 154: see note 1)	Max. color loss to 33655 (FED-STD-595)
Water Absorption at 168 Hours Immersion Tap Water (ASTM D471)	9.0 percent max. weight increase (conditions at ASTM D3924)
Application at 65 mils Wet,One Coat, One-week Cure, (see note 2)	No visual cracking or curling (conditions at ASTM D3924)
No Pick-Up at 25 mils (ASTM D711)	Wet 10 minutes max.
Lead (ASTM D3335)	0.06 percent max.
Cadmium (ASTM D3335)	0.06 percent max.
Chromium (ASTM D3718)	0.00 percent

Notes:
(1) Properly mix and apply yellow paint at 10 mils plus or minus 2 mils DFT over a suitably sized, clean aluminum substrate (ASTM D823), and cure for a minimum of 48 hours: four individual yellow samples shall be prepared. Expose three samples to continuous Ultraviolet (UV) light for 2500 hours, without cycles condensation, in accordance to ASTM G 154: UVA-340 lamps shall be used in the testing apparatus. Following exposure, compare the three exposed samples to the "one" non-exposed sample using FED-STD-595 colors 33538 and 33655 as visual references: evaluate exposed samples for degree of visual color loss. Yellow paint shall receive a passing rating if each exposed sample appears equivalent to the non-exposed sample, and in addition,

TABLE I
REQUIREMENTS FOR HIGH BUILD ACRYLIC COATINGS (HBAC)

displays color loss no greater than FED-STD-595 color 33655.

(2) Using double-stick, foam mounting tape (or equal) with a nominal thickness of 65 mils, apply a rectangular mold with inner dimensions of 3 in by 10 in to a clean aluminum sample approximately sized at 6 in by 12 in by 1/8 in. Do not remove the tape's plastic backing. Mix and apply excess paint into mold. Remove excess paint, by squeegee or other appropriate draw down technique, to a uniform thickness equal to the tape's height. Paint application and draw down shall be performed within a period of no more than 60 seconds. Approximately one to two minutes following the draw down, remove tape from sample and allow coating to cure for a minimum period of one week ASTM D3924. Using a micrometer or other appropriate device, measure cured coating thickness (less sample thickness) to confirm resulting coating application was at or above 38 mils DFT. Inspect coating for visual signs of cracking and curling. Following a one week cure, coating shall receive a passing rating if applied greater than 38 mils DFT and visually free of both cracking and curling.

TABLE II
PREAPPROVED HBACs

Manufacturer	Products
TMT-Pathway 1021 N. Mission Road Los Angeles, CA 90033 (800) 338-7680	Legend Build, #2712A9, White Legend Build, #2713A9, Yellow
Pervo Paints 6624 Stanford Ave. Los Angeles, CA 90001 (323) 758-1147	Pervo 6050, White Pervo 6053, Yellow
Vogel Traffic Services 1920 Albany Place South PO Box 140 Orange City, IA 51041 (712) 737-4016	UC-1516, White UC-3588, Yellow

-- End of Section --

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SECTION 32 92 23

SODDING
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.

ASTM INTERNATIONAL (ASTM)

ASTM D4972	(2001; R 2007) pH of Soils

TURFGRASS PRODUCERS INTERNATIONAL (TPI)

TPI GSS	(1995) Guideline Specifications to Turfgrass Sodding

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42	(1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.2 DEFINITIONS

1.2.1 Stand of Turf

100 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK, applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

Topsoil composition tests (reports and recommendations).

SD-07 Certificates

Nursery certification for sods. Indicate type of sod in accordance with TPI GSS.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Sod Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 Fertilizer Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Sod Storage

Lightly sprinkle with water, cover with moist burlap, straw, or other approved covering; and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that internal heat will not develop. Do not store sod longer than 24 hours. Do not store directly on concrete or bituminous surfaces.

1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Sod

Place sod a maximum of thirty six hours after initial harvesting, in accordance with TPI GSS as modified herein.

PART 2 PRODUCTS

2.1 SODS

2.1.1 Classification

Nursery grown, certified as classified in the TPI GSS. Machine cut sod at a uniform thickness of 3/4 inch within a tolerance of 1/4 inch, excluding top growth and thatch. Each individual sod piece shall be strong enough to support its own weight when lifted by the ends. Broken pads, irregularly shaped pieces, and torn or uneven ends will be rejected.

2.1.2 Purity

Sod species shall be genetically pure, free of weeds, pests, and disease.

2.1.3 Composition

All sod to be Argentinean Bahia.

2.2 TOPSOIL

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be furnished by the Contractor.

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Other components shall conform to the following limits:

Silt	25-50 percent
Clay	10-30 percent
Sand	20-35 percent
pH	5.5 to 7.0
Soluble Salts	600 ppm maximum

2.3 FERTILIZER

2.3.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

10 percent available nitrogen

10 percent available phosphorus
10 percent available potassium

2.4 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation containing no element toxic to plant life.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Extent Of Work

Provide soil preparation (including soil conditioners), fertilizing, and sodding of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.2 Soil Preparation

Provide 4 inches of on-site topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.2.1 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site.

3.2 SODDING

3.2.1 Finished Grade and Topsoil

Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 31 00 00 EARTHWORK.

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove from the surface debris and stones over a minimum 5/8 inch in any dimension.

3.2.2 Placing

Place sod a maximum of 36 hours after initial harvesting, in accordance with TPI GSS as modified herein.

3.2.3 Finishing

After completing sodding, blend edges of sodded area smoothly into surrounding area. Air pockets shall be eliminated and a true and even surface shall be provided. Frayed edges shall be trimmed and holes and

missing corners shall be patched with sod.

3.2.4 Rolling

Immediately after sodding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width.

3.2.5 Watering

Start watering areas sodded as required by daily temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to minimum depth of 6 inches. Run-off, puddling, and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or plant material shall be prevented.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

-- End of Section --

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SECTION 33 05 23.13

UTILITY HORIZONTAL DIRECTIONAL DRILLING
02/10

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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2010) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.652	Safety and Health Regulations for Construction; Subpart P, Excavations; Requirements for Protective Systems

UNDERWRITERS LABORATORIES (UL)

UL 651	(2011; Reprint Mar 2012) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Statement of Qualifications and Records or previous similar jobs.

Submit Soil Test Data prior to commencement of drilling/excavation work.

SD-02 Shop Drawings

Record Drawings

SD-03 Product Data

Submit Manufacturer's Catalog Data for the polyethylene conduit.

SD-07 Certificates

Drill Rod

SD-08 Manufacturer's Instructions

Material Safety Data Sheets

SD-11 Closeout Submittals

Work Complete Logs of Guided Directional Drill Operations

1.3 COMMENCEMENT, DELIVERY, STORAGE, AND HANDLING OF MATERIALS

Prior to commencement of the work, submit the following to the Engineer of Record for review and approval:

Manufacturer's Catalog Data

Material Safety Data Sheets

Statement of Qualifications and Records

Soil Test Data

Provide written documentation of conformance with AASHTO T 180. Submit a complete list of all drilling fluids, additives, and mixtures to be used along with Material Safety Data Sheets.

Inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, surface abrasions, or other defects will be rejected. Remove defective materials from the job site.

Disposal of fluids is the responsibility of the Contractor. Dispose of fluids in a manner that is in compliance with all permits and applicable federal, state, and local regulations. The Contractor may dispose of the drilling fluids on approved land owned by the Government subject to written approval from the Contracting Officer. Spread the drilling slurry over the Government-approved disposal area and plow into the soil.

1.4 QUALIFICATIONS

Ensure that Contractor and his field supervisor assigned to this project are experienced in work of this nature and have successfully completed similar projects of similar length, pipe type, pipe size, and soil type using directional drilling in the last three (3) years. As part of the bid submission, submit a description of such project(s) which include, at a minimum, a listing of the location(s), date of project(s), owner, pipe type, size installed, length of installation, type, and manufacturer of equipment used, and other information relevant to the successful completion of the project.

1.5 SAFETY

Include in directional drilling equipment machine safety requirements a common grounding system to prevent electrical shock in the event of underground electrical cable strike. Ensure the grounding system connects all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operators booth, worker grounding mats, and any other interconnected equipment to a common ground. Equip the

drill with an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.

PART 2 PRODUCTS

2.1 DRILL ROD

Select the appropriate drill rod to be used. Submit certified statement that the drill rod has been inspected and is in satisfactory condition for its intended use.

2.2 CONDUIT

UL 651, 5-inch (nominal) diameter high density polyethylene (HDPE) conduit, with a standard dimension ratio of 13.5 (SDR 13.5).

2.3 DRILLING FLUIDS

Use a high quality bentonite drilling fluid to ensure hole stability, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Use only fluid with a composition which complies with all federal, state, and local environmental regulations.

Mix the bentonite drilling fluid with potable water (of proper pH) to ensure no contamination is introduced into the soil during the drilling, reaming, or pipe installation process. The Contractor is responsible for any required pH adjustments.

Disposal of the drilling fluids is the responsibility of the Contractor. Conduct disposal in compliance with all relative environmental regulations, right-of-way and work space agreements, and permit requirements.

Collect drilling fluid returns in the entrance pit, exit pit, or spoils recovery pit. Immediately clean up any drilling fluid spills or overflows from these pits.

PART 3 EXECUTION

3.1 DRILL SET-UP AREA

The Contractor is responsible for design and construction of the drill entrance and exit pits.

3.2 DRILL ENTRANCE AND EXIT PITS

Drill entrance and exit pits are required. Maintain at minimum size to allow only the minimum amount of drilling fluid storage prior to transfer to mud recycling or processing system or removal from the site.

Do not allow drilling mud to flow freely on the site or around the entrance or exit pits. Remove spilled mud and restore ground to original condition. Provide shore pits in compliance with OSHA Standards, 29 CFR 1926.652.

When drilling near wetlands or water courses, provide secondary containment to prevent drilling fluids from entering the wetlands, and secure written approval of secondary containment plan from the Contracting Officer.

3.3 DRILL ENTRANCE AND EXIT ANGLE

Ensure entrance and exit angles and elevation profile maintains adequate cover to reduce risk of drilling fluid breakouts and ground exit occurs as specified herein. Ensure that entrance and exit angles ensure pullback forces do not exceed 5 percent strain on the polyethylene pipe.

3.4 PILOT HOLE

The type and size of the pilot string cutting head and the diameter of the drill pipe is at the Contractor's discretion.

Drill the pilot hole along the path shown on the plan and profile drawings. Pilot hole tolerances are as follows:

a. Vertical Tolerance: Provide minimum cover below channel bottom as specified on the plans. The Contractor may go deeper if necessary to prevent breakout.

b. Horizontal Tolerance: Plus/minus - 60 inches from the centerline of the product pipe.

c. Curve Radius: No curve is acceptable with a radius less than 1,000 feet.

d. Entry Point Location: Make pilot hole entry point within plus/minus - 60 inches of the location shown on the drawings or as directed by the Contracting Officer in the field.

e. Exit Point Location: Make the exit point location within plus/minus - 60 inches of the location shown on the drawings or as directed by the Contracting Officer in the field.

f. The installed pipeline cover requirements as shown on the drawings or as specified is mandatory.

3.5 REAMING

Conduct reaming operations at the Contractor's discretion. Determine the type of back reamer to be utilized by the type of subsurface soil conditions that are encountered during the pilot hole drilling operation. The reamer type is at the Contractor's discretion.

3.6 PULL BACK

Fully assemble the entire pipeline to be installed via direction drill prior to commencement of pull back operations.

Support the pipeline during pullback operations in a manner to enable it to move freely and prevent damage. Install the pipeline in one continuous pull.

Minimize torsion stress by using a swivel to connect the pull section to the reaming assembly.

Maximum allowable tensile force imposed on the pull section is not to exceed 90 percent of the pipe manufacturer's safe pull (or tensile) strength. If the pull section is made up of multiple pipe size or materials, the lowest safe pull strength value governs and the maximum allowable tensile force is not to exceed 90 percent of this value.

Minimize external pressure during installation of the pullback section in the reamed hole. Replace damaged pipe resulting from external pressure at no cost to the Government. Buoyancy modification is at the discretion of the Contractor.

3.7 GUIDANCE SYSTEMS

Walkover guidance systems are not acceptable for this project; use a magnetic survey tool locator installed behind the pilot string cutting head and an electric grid (tru-tracker) system for this project.

3.8 DOCUMENTATION

Maintain drilling logs that accurately provide drill bit location (both horizontally and vertically) at least every 2 inches along the drill path. In addition, keep logs that record, as a minimum the following, every 15 minutes throughout each drill pass, back ream pass, or pipe installation pass:

a. Drilling Fluid Pressure

b. Drilling Fluid Flow Rate

c. Drill Thrust Pressure

d. Drill Pullback Pressure

e. Drill Head Torque

Make all instrumentation, readings, and logs available to the Contracting Officer at all times during operation.

3.9 UTILITY LOCATING AND MARKING

Locate and clearly mark all utilities prior to start of excavation or drilling. The Contractor is responsible for damage to utilities, and repairs for such damages, at no cost to the Government.

3.10 CLEANUP AND FINAL CLOSEOUT

Immediately upon completion of work of this section, remove all rubbish and debris from the job site. Remove all construction equipment and implements of service leaving the entire area involved in a neat condition acceptable of the Contracting Officer.

Immediately clean "blow holes" or "breakouts" of drilling fluid to the surface and return the surface area to its original condition. Dispose of all drilling fluids, soils, and separated materials in compliance with federal, state, and local environmental regulations.

Submit an electronic copy and three hard copies of the record drawings to the Contracting Officer within five days after completing the pull back. Include in the record drawings a plan, profile, and all information recorded during the progress of the work. Clearly tie the record drawings to the project's survey control. Maintain and submit upon completion signed final work complete logs of guided directional drill operations.

-- End of Section --

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SECTION 33 40 00

STORM DRAINAGE UTILITIES
02/10

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

1.1.1 Pipe Culverts and Storm Drains

The length of pipe installed will be measured along the centerlines of the pipe from end to end of pipe without deductions for diameter of manholes. Pipe will be paid for at the contract unit price for the number of linear feet of culverts or storm drains placed in the accepted work.

1.1.2 Storm Drainage Structures

The quantity of manholes and inlets will be measured as the total number of manholes and inlets of the various types of construction, complete with frames and gratings or covers and, where indicated, with fixed side-rail ladders. The depth of manholes and inlets will be measured from the top of grating or cover to invert of outlet pipe. Manholes and inlets constructed to depths greater than the depth specified above will be paid for as units at the contract unit price for manholes and inlets.

1.1.3 Walls and Headwalls

Walls and headwalls will be measured by the number of cubic yards of reinforced concrete, plain concrete, or masonry used in the construction of the walls and headwalls. Wall and headwalls will be paid for at the contract unit price for the number of walls and headwalls constructed in the completed work.

1.1.4 Flared End Sections

Flared end sections will be measured by the unit. Flared end sections will be paid for at the contract unit price for the various sizes in the accepted work.

1.1.5 Sheeting and Bracing

Payment will be made for that sheeting and bracing ordered to be left in place, based on the number of square feet of sheeting and bracing remaining below the surface of the ground.

1.1.6 Rock Excavation

Payment will be made for the number of cubic yards of material acceptably excavated, as specified and defined as rock excavation in Section 31 00 00 EARTHWORK, measured in the original position, and computed by allowing actual width of rock excavation with the following limitations: maximum rock excavation width, 30 inches for pipe of 12 inch or less nominal diameter; maximum rock excavation width, 16 inches greater than outside diameter of pipe of more than 12 inch nominal diameter. Measurement will include authorized overdepth excavation. Payment will also include all necessary drilling and blasting, and all incidentals necessary for

satisfactory excavation and disposal of authorized rock excavation. No separate payment will be made for backfill material required to replace rock excavation; this cost shall be included in the Contractor's unit price bid per cubic yard for rock excavation. In rock excavation for manholes and other appurtenances, 1 foot will be allowed outside the wall lines of the structures.

1.1.7 Backfill Replacing Unstable Material

Payment will be made for the number of cubic yards of select granular material required to replace unstable material for foundations under pipes or drainage structures, which will constitute full compensation for this backfill material, including removal and disposal of unstable material and all excavating, hauling, placing, compacting, and all incidentals necessary to complete the construction of the foundation satisfactorily.

1.1.8 Pipe Placed by Jacking

Payment will be made for the number of linear feet of jacked pipe accepted in the completed work measured along the centerline of the pipe in place.

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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges
AASHTO M 167M/M 167	(2009) Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M 190	(2004; R 2008) Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 198	(2010) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
AASHTO M 243	(1996; R 2008) Standard Specification for Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M 294	(2011) Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 346	(2009) Specification for Cast-in-Place Concrete Pipe

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2010) Manual for Railway Engineering

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2008; Errata 2010) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C150/A21.50	(2008) Thickness Design of Ductile-Iron Pipe
AWWA C151/A21.51	(2009) Ductile-Iron Pipe, Centrifugally Cast, for Water

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A48/A48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM A742/A742M	(2003; R 2008) Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
ASTM A760/A760M	(2010) Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A762/A762M	(2008) Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A798/A798M	(2007) Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM A807/A807M	(2002; R 2008) Standard Practice for Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
ASTM A849	(2010) Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe

ASTM A929/A929M	(2001; R 2007) Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM B26/B26M	(2009) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B745/B745M	(1997; R 2005) Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C1103	(2003; R 2009) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C139	(2010) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C14	(2011) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C1433	(2010) Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
ASTM C150/C150M	(2011) Standard Specification for Portland Cement
ASTM C231/C231M	(2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C270	(2010) Standard Specification for Mortar for Unit Masonry
ASTM C32	(2011) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C425	(2004; R 2009) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C443	(2011) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C478	(2009) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C506	(2011) Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	(2011) Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

ASTM C55	(2011) Concrete Brick
ASTM C62	(2010) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C700	(2011) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C76	(2011) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C828	(2011) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C877	(2008) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C923	(2008) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C924	(2002; R 2009) Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM D1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1171	(1999; R 2007) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2167	(2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2321	(2011) Standard Practice for Underground

	Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D3034	(2008) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	(2007) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3350	(2010a) Polyethylene Plastics Pipe and Fittings Materials
ASTM D6938	(2010) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM F 1417	(2011a) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air
ASTM F 477	(2010) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	(2008) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 714	(2010) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(2003; R 2009) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(2007) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(2010) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Placing Pipe

SD-04 Samples

Pipe for Culverts and Storm Drains

SD-07 Certificates

Resin Certification
Pipeline Testing
Hydrostatic Test on Watertight Joints
Determination of Density
Frame and Cover for Gratings

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.4.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Concrete Pipe

Manufactured in accordance with and conforming to ASTM C76, Class III.

2.1.1.1 Reinforced Arch Culvert and Storm Drainpipe

Manufactured in accordance with and conforming to ASTM C506, Class A-III.

2.1.1.2 Reinforced Elliptical Culvert and Storm Drainpipe

Manufactured in accordance with and conforming to ASTM C507. Horizontal elliptical pipe shall be Class HE-III. Vertical elliptical pipe shall be Class VE-III.

2.1.1.3 Nonreinforced Pipe

Manufactured in accordance with and conforming to ASTM C14, Class 3.

2.1.1.4 Cast-In-Place Nonreinforced Conduit

ACI 346, except that testing shall be the responsibility of and at the expense of the Contractor. In the case of other conflicts between ACI 346 and project specifications, requirements of ACI 346 shall govern.

2.1.2 Clay Pipe

Standard or extra strength, as indicated, conforming to ASTM C700.

2.1.3 Corrugated Steel Pipe

ASTM A760/A760M, zinc or aluminum (Type 2) coated pipe of either:

a. Type II pipe with helical 2-2/3 by 1/2 inch corrugations.

b. Type IIR pipe with helical 3/4 by 3/4 by 7-1/2 inch corrugations.

2.1.3.1 Fully Bituminous Coated

AASHTO M 190 Type A and ASTM A760/A760M zinc or aluminum (Type 2) coated pipe of either:

a. Type II pipe with helical 2-2/3 by 1/2 inch corrugations.

b. Type IIR pipe with helical 3/4 by 3/4 by 7-1/2 inch corrugations.

2.1.3.2 Half Bituminous Coated, Part Paved

AASHTO M 190 Type B and ASTM A760/A760M zinc or aluminum (Type 2) coated Type II pipe with helical 2-2/3 by 1/2 inch corrugations.

2.1.3.3 Fully Bituminous Coated, Part Paved

AASHTO M 190 Type C and ASTM A760/A760M zinc or aluminum (Type 2) coated Type II pipe with helical 2-2/3 by 1/2 inch corrugations.

2.1.3.4 Fully Bituminous Coated, Fully Paved

AASHTO M 190 Type D and ASTM A760/A760M zinc or aluminum (Type 2) coated Type II pipe with helical 2-2/3 by 1/2 inch corrugations.

2.1.3.5 Concrete-Lined

ASTM A760/A760M zinc coated Type I corrugated steel pipe with helical 2-2/3 by 1/2 inch corrugations and a concrete lining in accordance with ASTM A849.

2.1.3.6 Polymer Precoated

ASTM A762/A762M corrugated steel pipe fabricated from ASTM A742/A742M Grade 10/10 polymer precoated sheet of either:

a. Type II pipe with helical 2-2/3 by 1/2 inch corrugations.

b. Type IIR pipe with helical 3/4 by 3/4 by 7-1/2 inch corrugations.

2.1.3.7 Polymer Precoated, Part Paved

ASTM A762/A762M Type II corrugated steel pipe and AASHTO M 190 Type B

(modified), paved invert only, fabricated from ASTM A742/A742M Grade 10/10 polymer precoated sheet with helical 2-2/3 by 1/2 inch corrugations.

2.1.3.8 Polymer Precoated, Fully Paved

ASTM A762/A762M Type II corrugated steel pipe and AASHTO M 190 Type D (modified), fully paved only, fabricated from ASTM A742/A742M Grade 10/10 polymer precoated sheet with helical 2-2/3 by 1/2 inch corrugations.

2.1.4 Corrugated Aluminum Alloy Pipe

ASTM B745/B745M corrugated aluminum alloy pipe of either:

a. Type II pipe with helical corrugations.

b. Type IIR pipe with helical corrugations.

2.1.4.1 Aluminum Fully Bituminous Coated

Bituminous coating shall conform to ASTM A849 Type III. Piping shall conform to AASHTO M 190 Type A and ASTM B745/B745M corrugated aluminum alloy pipe of either:

a. Type II pipe with helical corrugations.

b. Type IIR pipe with helical corrugations.

2.1.4.2 Aluminum Fully Bituminous Coated, Part Paved

Bituminous coating shall conform to ASTM A849 Type III. Piping shall conform to AASHTO M 190 Type C and ASTM B745/B745M corrugated aluminum alloy pipe of either:

a. Type II pipe with helical corrugations.

b. Type IIR pipe with helical corrugations.

2.1.5 Structural Plate, Steel Pipe, Pipe Arches and Arches

Assembled with galvanized steel nuts and bolts, from galvanized corrugated steel plates conforming to AASHTO M 167M/M 167. Pipe coating, when required, shall conform to the requirements of AASHTO M 190 Type A AASHTO M 243. Thickness of plates shall be as indicated.

2.1.6 PVC Pipe

Submit the pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, prior to installation of the pipe.

2.1.6.1 Type PSM PVC Pipe

ASTM D3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.1.6.2 Profile PVC Pipe

ASTM F 794, Series 46, produced from PVC certified by the compounder as

meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.1.6.3 Smooth Wall PVC Pipe

ASTM F 679 produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.1.6.4 Corrugated PVC Pipe

ASTM F 949 produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.1.7 Ductile Iron Pipe

Four inch through 24 inch stormwater containment piping shall be Pressure Class 350 ductile-iron pipe in accordance with AWWA C150/A21.50 and AWWA C151/A21.51.

2.1.7.1 Pipe Lining - Cement Mortar

Line pipe interior and fittings with cement-mortar per AWWA C104/A21.4. Lining thickness shall be the single thickness listed in AWWA C104/A21.4, Section 4.8. Lining material shall conform to ASTM C150/C150M, Type II.

2.1.8 PE Pipe

Submit the pipe manufacturer's resin certification, indicating the cell classification of PE used to manufacture the pipe, prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D3350.

2.1.8.1 Smooth Wall PE Pipe

ASTM F 714, maximum DR of 21 for pipes 3 to 24 inches in diameter and maximum DR of 26 for pipes 26 to 48 inches in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 335434C.

2.1.8.2 Corrugated PE Pipe

AASHTO M 294, Type S or C. For slow crack growth resistance, acceptance of resins shall be determined by using the notched constant ligament-stress (NCLS) test meeting the requirements of AASHTO M 294. Pipe walls shall have the following properties:

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in to the 4th/in)
12	1.50	0.024
15	1.91	0.053
18	2.34	0.062
24	3.14	0.116
30	3.92	0.163
36	4.50	0.222
42	4.69	0.543

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in to the 4th/in)
48	5.15	0.543
54	5.67	0.800
60	6.45	0.800

2.1.8.3 Profile Wall PE Pipe

ASTM F 894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 334433C. Pipe walls shall have the following properties:

		Minimum Moment Of Inertia of Wall Section (in to the 4th/in)	
Nominal Size (in.)	Minimum Wall Area (square in/ft)	Cell Class 334433C	Cell Class 335434C
18	2.96	0.052	0.038
21	4.15	0.070	0.051
24	4.66	0.081	0.059
27	5.91	0.125	0.091
30	5.91	0.125	0.091
33	6.99	0.161	0.132
36	8.08	0.202	0.165
42	7.81	0.277	0.227
48	8.82	0.338	0.277

2.2 DRAINAGE STRUCTURES

2.2.1 Flared End Sections

Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A929/A929M.

2.2.2 Precast Reinforced Concrete Box

Manufactured in accordance with and conforming to ASTM C1433.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 4000 psi concrete under Section 03 30 00 CAST-IN-PLACE CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C231/C231M. The concrete covering over steel reinforcing shall not be

less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground. Expansion-joint filler material shall conform to ASTM D1751, or ASTM D1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D1752.

2.3.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

2.3.3 Precast Concrete Segmental Blocks

Precast concrete segmental block shall conform to ASTM C139, not more than 8 inches thick, not less than 8 inches long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

2.3.4 Brick

Brick shall conform to ASTM C62, Grade SW; ASTM C55, Grade S-I or S-II; or ASTM C32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.

2.3.5 Precast Reinforced Concrete Manholes

Conform to ASTM C478. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure.

2.3.6 Prefabricated Corrugated Metal Manholes

Manholes shall be of the type and design recommended by the manufacturer. Manholes shall be complete with frames and cover, or frames and gratings.

2.3.7 Frame and Cover for Gratings

Submit certification on the ability of frame and cover or gratings to carry the imposed live load. Frame and cover for gratings shall be cast gray iron, ASTM A48/A48M, Class 35B; cast ductile iron, ASTM A536, Grade 65-45-12; or cast aluminum, ASTM B26/B26M, Alloy 356.0T6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans. The word "Storm Sewer" shall be stamped or cast into covers so that it is plainly visible.

2.3.8 Joints

2.3.8.1 Flexible Watertight Joints

a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C443. Factory-fabricated resilient joint materials shall conform to ASTM C425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.

b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph "Hydrostatic Test On Watertight Joints." Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C443. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

2.3.8.2 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C877.

2.3.8.3 Flexible Watertight, Gasketed Joints

a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches wide and approximately 3/8 inch thick, meeting the requirements of ASTM D1056, Type 2 A1, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D1171. Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches in diameter for pipe having 1 inch deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.

b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph "Hydrostatic Test On Watertight Joints."

2.3.8.4 PVC Plastic Pipes

Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

2.3.8.5 Smooth Wall PE Plastic Pipe

Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

2.3.8.6 Corrugated PE Plastic Pipe

Pipe joints shall be water tight and shall conform to the requirements in AASHTO M 294. Water tight joints shall be made using a PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F 477.

2.3.8.7 Profile Wall PE Plastic Pipe

Joints shall be gasketed or thermal weld type with integral bell in accordance with ASTM F 894.

2.3.8.8 Ductile Iron Pipe

Couplings and fittings shall be as recommended by the pipe manufacturer.

2.4 STEEL LADDER

Steel ladder shall be provided where the depth of the storm drainage structure exceeds 12 feet. These ladders shall be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2-1/2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A123/A123M.

2.5 DOWNSPOUT BOOTS

Boots used to connect exterior downspouts to the storm-drainage system shall be of gray cast iron conforming to ASTM A48/A48M, Class 30B or 35B. Shape and size shall be as indicated.

2.6 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923.

2.7 HYDROSTATIC TEST ON WATERTIGHT JOINTS

2.7.1 Concrete, Clay, PVC and PE Pipe

A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M 198 or ASTM C443. Test requirements for joints in clay pipe shall conform to ASTM C425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D3212.

2.7.2 Corrugated Steel and Aluminum Pipe

A hydrostatic test shall be made on the watertight joint system or coupling

band type proposed. The moment strength required of the joint is expressed as 15 percent of the calculated moment capacity of the pipe on a transverse section remote from the joint by the AASHTO HB-17 (Division II, Section 26). The pipe shall be supported for the hydrostatic test with the joint located at the point which develops 15 percent of the moment capacity of the pipe based on the allowable span in feet for the pipe flowing full or 40,000 foot-pounds, whichever is less. Performance requirements shall be met at an internal hydrostatic pressure of 10 psi, for a 10 minute period for both annular corrugated metal pipe and helical corrugated metal pipe with factory reformed ends.

2.8 EROSION CONTROL RIPRAP

Provide nonerodible rock not exceeding 15 inches in its greatest dimension and choked with sufficient small rocks to provide a dense mass with a minimum thickness of 8 inches.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK and the requirements specified below.

3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 24 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified, without any overexcavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 31 00 00 EARTHWORK.

3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph "Backfilling." When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in granular material minimum 4 inch in depth in trenches with soil foundation. Depth of granular bedding in trenches with rock foundation shall be 1/2 inch in depth per foot of depth of fill, minimum depth of bedding shall be 8 inch up to maximum depth of 24 inches. The middle third of the granular bedding shall be loosely placed. Bell holes and depressions for joints shall be removed and formed so entire barrel of pipe is uniformly supported. The bell hole and depressions for the joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

3.2.2 Corrugated Metal Pipe

Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A798/A798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A807/A807M.

3.2.3 Ductile Iron and Cast-Iron Pipe

Bedding for ductile iron and cast-iron pipe shall be as shown on the drawings.

3.2.4 Plastic Pipe

Bedding for PVC and PE pipe shall meet the requirements of ASTM D2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

3.3 PLACING PIPE

Submit printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Corrugated Steel and Aluminum Alloy	5
Concrete-Lined Corrugated Steel	3
Ductile Iron Culvert	3
Plastic (PVC & HDPE)	5

Note post installation requirements of paragraph 'Deflection Testing' in PART 3 of this specification for all pipe products including deflection testing requirements for flexible pipe.

3.3.1 Concrete, Clay, PVC, Ribbed PVC, Ductile Iron and Cast-Iron Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

3.3.2 Elliptical and Elliptical Reinforced Concrete Pipe

The manufacturer's reference lines, designating the top of the pipe, shall be within 5 degrees of a vertical plane through the longitudinal axis of the pipe, during placement. Damage to or misalignment of the pipe shall be prevented in all backfilling operations.

3.3.3 Corrugated PE Pipe

Laying shall be with the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's recommendations.

3.3.4 Corrugated Metal Pipe and Pipe Arch

Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Part paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M 190 or AASHTO M 243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During transportation and installation, pipe or pipe arch and coupling bands shall be handled with care to preclude damage to the coating, paving or lining. Damaged coatings, pavings and linings shall be repaired in accordance with the manufacturer's recommendations prior to placing backfill. Pipe on which coating, paving or lining has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

3.3.5 Structural-Plate Steel

Structural plate shall be installed in accordance with ASTM A807/A807M. Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are tightened to meet the torque requirements of 200 foot-pounds plus or minus 50 foot-pounds. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for amount of torque produced. Power wrenches shall be checked and adjusted frequently as needed, according to type or condition, to ensure proper adjustment to supply the required torque.

3.3.6 Structural-Plate Aluminum

Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are torqued to a minimum of 100 foot-pounds on aluminum alloy bolts and a minimum of 150 foot-pounds on galvanized steel bolts. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for the amount of torque produced. Power wrenches shall be checked and adjusted as frequently as needed, according to type or condition, to ensure that they are in proper adjustment to supply the required torque.

3.3.7 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 3 feet apart, whichever is less.

3.3.8 Jacking Pipe Through Fills

Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in Volume 1, Chapter 1, Part 4 of AREMA Eng Man.

3.4 JOINTING

3.4.1 Concrete and Clay Pipe

3.4.1.1 Cement-Mortar Bell-and-Spigot Joint

The first pipe shall be bedded to the established grade line, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

3.4.1.2 Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe

A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.

3.4.1.3 Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe

The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.

a. Diaper Bands: Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in lengths that extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 8 inches apart. Wires shall be cut into lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.

b. Grout: Grout shall be poured between band and pipe from the high side of band only, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be forced out by pouring, and removed.

c. Remainder of Joint: The remaining unfilled upper portion of the joint shall be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.

3.4.1.4 Cement-Mortar Tongue-and-Groove Joint

The first pipe shall be bedded carefully to the established grade line with the groove upstream. A shallow excavation shall be made underneath the

pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be thoroughly cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

3.4.1.5 Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe

The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch, thick and the width of the diaper band shall be at least 8 inches. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. Backfilling around the joints shall not be done until the joints have been fully inspected and approved.

3.4.1.6 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe

Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions shall be cut off flush with the inner surface of the pipe. If non-mastic-type sealant material is used, the "Squeeze-Out" requirement above will be waived.

3.4.1.7 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

3.4.1.8 External Sealing Band Joint for Noncircular Pipe

Surfaces to receive sealing bands shall be dry and clean. Bands shall be

installed in accordance with manufacturer's recommendations.

3.4.2 Corrugated Metal Pipe

3.4.2.1 Field Joints

Transverse field joints shall be designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A798/A798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.

3.4.2.2 Flexible Watertight, Gasketed Joints

Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket; the gasket shall seat properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

3.5 DRAINAGE STRUCTURES

3.5.1 Manholes and Inlets

Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

3.5.2 Walls and Headwalls

Construction shall be as indicated.

3.6 STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet vertically, and shall be installed to provide at least 6 inches of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

3.7 BACKFILLING

3.7.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation equal to the midpoint (spring line) of RCP or has reached an elevation of at least 12 inches above the top of the pipe for flexible pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 6 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.7.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 6 inches. Use select granular material for this entire region of backfill for flexible pipe installations.

3.7.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.7.4 Compaction

3.7.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.7.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.

b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.7.5 Determination of Density

Testing is the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D2167 or ASTM D6938. When ASTM D6938 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D6938 results in a wet unit weight of soil and ASTM D6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D6938. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

3.8 PIPELINE TESTING

3.8.1 Leakage Tests

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall conform to ASTM C828. Low pressure air testing for concrete pipes shall conform to ASTM C924. Low pressure air testing for plastic pipe shall conform to ASTM F 1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C828 or ASTM C924, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C1103. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 0.2 gallons per inch in diameter per 100 feet of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished.

3.8.2 Deflection Testing

No sooner than 30 days after completion of installation and final backfill, an initial post installation inspection shall be accomplished. Clean or flush all lines prior to inspection. Perform a deflection test on entire length of installed flexible pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed limits in paragraph "Placing Pipe" above as percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a laser profiler or mandrel.

a. Laser Profiler Inspection: If deflection readings in excess of the allowable deflection of average inside diameter of pipe are obtained, remove pipe which has excessive deflection, and replace with new pipe. Initial post installation inspections of the pipe interior with laser profiling equipment shall utilize low barrel distortion video equipment for pipe sizes 48 inches or less. Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll static or other image distortion qualities that would prevent the reviewer from evaluating the condition

of the pipe. For initial post installation inspections for pipe sizes larger than 48 inches, visual inspection shall be completed of the pipe interior.

b. Pull-Through Device Inspection: Pass the pull-through device through each run of pipe by pulling it by hand. If deflection readings in excess of the allowable deflection of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show excess allowable deflections of the average inside diameter of pipe, remove pipe which has excessive deflection, replace with new pipe, and completely retest in same manner and under same conditions. Pull-through device: The mandrel shall be rigid, nonadjustable having a minimum of 9 fins, including pulling rings at each end, engraved with the nominal pipe size and mandrel outside diameter. The mandrel shall be 5 percent less than the certified-actual pipe diameter for Plastic Pipe, 5 percent less than the certified-actual pipe diameter for Corrugated Steel and Aluminum Alloy, 3 percent less than the certified-actual pipe diameter for Concrete-Lined Corrugated Steel and Ductile Iron Culvert provided by manufacturer. When mandrels are utilized to verify deflection of flexible pipe products, the Government will verify the mandrel OD through the use of proving rings that are manufactured with an opening that is certified to be as shown above.

c. Deflection measuring device: Shall be approved by the Contracting Officer prior to use.

d. Warranty period test: Pipe found to have a deflection of greater than allowable deflection in paragraph "Placing Pipe" above, just prior to end of one-year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection. Inspect 100 percent of all pipe systems under the travel lanes, including curb and gutter. Random inspections of the remaining pipe system outside of the travel lanes shall represent at least 10 percent of the total pipe footage of each pipe size. Inspections shall be made, depending on the pipe size, with video camera or visual observations. In addition, for flexible pipe installations, perform deflection testing on 100 percent of all pipes under the travel lanes, including curb and gutter, with either a laser profiler or 9-fin mandrel. For flexible pipe, random deflection inspections of the pipe system outside of the travel lanes shall represent at least 10 percent of the total pipe footage of each pipe size. When mandrels are utilized to verify deflection of flexible pipe products during the final post installation inspection, the Government will verify the mandrel OD through the use of proving rings.

3.8.3 Post-Installation Inspection

One hundred percent of all reinforced concrete pipe installations shall be checked for joint separations, soil migration through the joint, cracks greater than 0.01 inches, settlement and alignment. One hundred percent of all flexible pipes (HDPE, PVC, CMP) shall be checked for rips, tears, joint separations, soil migration through the joint, cracks, localized bucking, bulges, settlement and alignment.

a. Replace pipes having cracks greater than 0.1 inches in width or deflection greater than 5 percent deflection. An engineer shall evaluate all pipes with cracks greater than 0.01 inches but less than 0.10 inches to determine if any remediation or repair is required. RCP with crack width less than 0.10 inches and located in a non-corrosive

environment (pH 5.5) are generally acceptable. Repair or replace any pipe with crack exhibiting displacement across the crack, exhibiting bulges, creases, tears, spalls, or delamination.

b. Reports: The deflection results and finial post installation inspection report shall include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design, grade, deviation from line, deflection and deformation of flexible pipe systems, inspector notes, condition of joints, condition of pipe wall (e.g. distress, cracking, wall damage dents, bulges, creases, tears, holes, etc.).

3.9 FIELD PAINTING

After installation, clean cast-iron frames, covers, gratings, and steps not buried in masonry or concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

-- End of Section --

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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges
AASHTO M 198	(2010) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 318M	(2008; Errata 2011) Building Code Requirements for Structural Concrete & Commentary
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C478	(2009) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C857	(2011) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2012) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60005	(Basic; Notice 2) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, Section 33 05 23.13 UTILITY HORIZONTAL DIRECTIONAL DRILLING, and Section 26 08 00 APPARATUS INSPECTION AND TESTING apply to this section, with the additions and modifications specified herein.

1.3 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 100.

b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Precast underground structures; G

SD-03 Product Data

Precast concrete structures; G

Sealing Material

Pulling-In Irons

Manhole frames and covers; G

Composite/fiberglass handholes; G

Cable racks (brackets and arms); G

1.5 QUALITY ASSURANCE

1.5.1 Precast Underground Structures

Submittal required for each type used. Provide calculations and drawings for precast manholes bearing the seal of a registered professional engineer including:

a. Material description (i.e., f'c and Fy).

b. Manufacturer's printed assembly and installation instructions.

c. Design calculations.

d. Reinforcing shop drawings in accordance with ACI SP-66.

e. Plans and elevations showing opening and pulling-in iron locations and details.

1.5.2 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.

1.5.3 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.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 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

Provide ducts, grounding, and low voltage wiring equipment in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and Section 33 05 23.13 UTILITY HORIZONTAL DIRECTIONAL DRILLING. Provide medium voltage cable, cable identification (both high and low voltage) within manholes and handholes in accordance with Section 26 05 13.00 98 MEDIUM VOLTAGE CABLE. Provide additional requirements as indicated below.

2.1 CONDUIT SEALING COMPOUND

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as (1.76 degrees C) 35 degrees F, shall neither slump at a temperature of (149 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.

2.2 BURIED WARNING AND IDENTIFICATION TAPE

Provide detectable tape in accordance with Section 31 00 00 EARTHWORK.

2.3 PULL ROPE

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

2.4 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. In addition, provide concrete for encasement of underground ducts with 3000 psi minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts shall be 4000 psi minimum 28-day compressive strength unless specified otherwise.

2.5 UNDERGROUND STRUCTURES

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C857 and ASTM C478. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers shall fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including brackets and arms, shall be adequate to accommodate the cable.

2.5.1 Cast-in-Place Concrete Structures

Concrete shall conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.5.2 Precast Concrete Structures, Risers, and Tops

In lieu of cast-in-place, Contractors, at their option, may provide precast concrete underground structures subject to the requirements specified below. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes.

2.5.2.1 General

Precast concrete structures shall have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures shall have plan area and clear heights not less than those of cast-in-place

structures. Concrete materials and methods of construction shall be the same as for cast-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work shall have a 28-day compressive strength of not less than (27279 kpa) 4000 psi. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. Structures shall be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.

2.5.2.2 Design for Precast Structures

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

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

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

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

d. Ground Water Level = 915 mm 3 feet below ground elevation

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

f. Horizontal design loads shall include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, shall be considered, along with a pulling-in iron design load of (2722 kg) 6000 pounds.

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

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

2.5.2.3 Construction

Structure top, bottom, and wall shall be of a uniform thickness of not less than 6 inches. Thin-walled knock-out panels for designed or future duct bank entrances shall not be permitted. Quantity, size, and location of duct bank entrance windows shall be as directed, and cast completely open by the precaster. Size of windows shall exceed the nominal duct bank envelope dimensions by at least (305 mm) 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows shall be a minimum of 6 inches from the inside surface of adjacent walls, floors, or

ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. Provide drain sumps a minimum of (305 mm) 12 inches in diameter and 4 inches deep for precast structures.

2.5.2.4 Joints

Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to AASHTO M 198, Type B. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

2.5.3 Manhole Frames and Covers

Provide cast iron frames and covers for manholes conforming to CID A-A-60005. Cast the words "ELECTRIC" in the top face of electrical power manhole covers.

2.5.4 Composite/Fiberglass Handholes and Covers

Provide handholes and covers of polymer concrete, reinforced with heavy weave fiberglass.

2.6 CABLE RACKS (BRACKETS AND ARMS)

Cable racks shall be as specified herein and detailed on the drawings.

2.6.1 Cable Rack Brackets

Cable rack brackets shall be UL Listed heavy-duty nonmetallic glass reinforced nylon in lengths as indicated on the drawings.

2.6.2 Cable Rack Arms

Cable rack arms shall be UL Listed heavy-duty nonmetallic glass reinforced nylon and shall be of the removable type. Cable rack arm length shall be a minimum of (305 mm) 12 inches and a maximum of (356 mm) 142 inches. Hardware (bolts, nuts, washers & lock washers) shall be Type 316 stainless steel.

PART 3 EXECUTION

3.1 INSTALLATION

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

3.2 UNDERGROUND STRUCTURE CONSTRUCTION

Provide standard type cast-in-place and precast construction as specified herein and on the drawings. Horizontal concrete surfaces of floors shall

have a smooth trowel finish. Cure concrete by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound shall conform to ASTM C309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete.

3.2.1 Precast Concrete Construction

Set commercial precast structures on (150 mm) 6 inches of level, 90 percent compacted granular fill, (19 mm) 3/4 inch to (25 mm) 1 inch size, extending (305 mm) 12 inches beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation shall additionally conform to the manufacturer's instructions.

3.2.2 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices 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) 6 inches from the edge of the sump, and in the walls the irons shall be located within (150 mm) 6 inches 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) 6 inches of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the (150 mm) 6 inch clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a (915 mm) 3 foot length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner 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) 3 inches 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) 4 inches and shall be designed to withstand a minimum pulling-in load of (2722 kg) 6000 pounds. Irons shall be hot-dipped galvanized after fabrication.

3.2.3 Cable Racks

Cable racks shall be sufficient to accommodate the cables. Contractor shall choose one of the following methods for anchoring cable racks on this project:

a. Provide a (16 mm) 5/8 inch diameter by (127 mm) 5 inch long anchor bolt with (75 mm) 3 inch foot cast in structure wall with (50 mm) 2 inch protrusion of threaded portion of bolt into structure. Provide (16 mm) 5/8 inch steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.

b. Provide concrete channel insert with a minimum load rating of (1191 kg per meter) 800 pounds per foot. Insert channel shall be steel of the same length as "vertical rack channel;" channel insert shall be cast flush in structure wall. Provide (16 mm) 5/8 inch steel nuts in channel insert to receive (16 mm) 5/8 inch diameter by (75 mm) 3 inch long steel, square head anchor bolts.

c. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert shall have minimum (363 kg) 800 pound load rating. Provide (16 mm) 5/8 inch diameter by (75 mm) 3 inch long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

3.2.4 Field Painting

Cast-iron frames and covers not buried in concrete or masonry shall be cleaned of mortar, rust, grease, dirt and other deleterious materials, and given a coat of bituminous paint.

3.3 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.3.1 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 (75 mm) 3 inches per (30.5 m) 100 feet. 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 (457 mm) 18 inches for ducts of less than (75 mm) 3 inch diameter, and (915 mm) 36 inches for ducts (75 mm) 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of (7.6 m) 25 feet 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.

3.3.2 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.

3.3.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes (75 mm) 3 inches and larger, draw a flexible testing mandrel approximately (305 mm) 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes less than (75 mm) 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.3.4 Conduit Installation Under Roads and Paved Areas

Conduits to be installed under existing roads and paved areas which are not to be disturbed, high density polyethylene (HDPE) installed via the horizontal directional drilling (HDD) process. Refer to Section 33 05 23.13 UTILITY HORIZONTAL DIRECTIONAL DRILLING for requirements.

3.3.5 Galvanized Conduit Concrete Penetrations

Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations shall be PVC coated and shall extend from at least (50 mm) 2 inches within the concrete to the first coupling or fitting outside the concrete (minimum of (150 mm) 6 inches from penetration).

3.3.6 Multiple Conduits

Separate multiple conduits by a minimum distance of (64 mm) 2 1/2 inches, except that light and power conduits shall be separated from control, signal, and telephone conduits by a minimum distance of 12 inches. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly shall consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per (3 m) 10 feet of conduit assembly.

3.3.7 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 weephole or screen to allow water drainage. Provide a plastic pull rope having (915 mm) 3 feet of slack at each end of unused or empty conduits.

3.3.8 Conduit and Duct Without Concrete Encasement

Provide not less than (75 mm) 3 inches clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional (75 mm) 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a (6 mm) 1/4 inch sieve. The first (150 mm) 6 inch 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) 3 to 6 inch layers. Provide color, type and depth of warning tape as specified in Section 31 00 00

EARTHWORK.

3.3.8.1 Encasement Under Roads and Paved Areas

Under roads and paved areas install conduits in concrete encasement of rectangular cross-section providing a minimum of (75 mm) 3 inch concrete cover around ducts. Concrete encasement shall extend at least (1.5 m) 5 feet beyond the edges of roads and paved areas.

3.3.9 Duct Encased in Concrete

Construct underground duct lines of individual conduits encased in concrete. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least (75 mm) 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of (64 mm) 2 1/2 inches, except separate light and power conduits from control, signal, and telecommunications conduits by a minimum concrete thickness of (75 mm) 3 inches. Before pouring concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete pouring. Anchoring shall be done by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.3.9.1 Connections to Manholes

Duct bank envelopes connecting to underground structures shall be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than (305 mm) 12 inches in each direction. Perimeter of the duct bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

3.3.9.2 Connections to Existing Underground Structures

For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and bend out to tie into the reinforcing of the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

3.3.9.3 Connections to Existing Concrete Pads

For duct bank connections to concrete pads, break an opening in the pad out to the dimensions required and preserve steel in pad. Cut the steel and bend out to tie into the reinforcing of the duct bank envelope. Chip out the opening in the pad to form a key for the duct bank envelope.

3.3.9.4 Connections to Existing Ducts

Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks.

3.3.9.5 Partially Completed Duct Banks

During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of (610 mm) 2 feet back into the envelope and a minimum of (610 mm) 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, (75 mm) 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately one foot apart. Restrain reinforcing assembly from moving during concrete pouring.

3.3.9.6 Removal of Ducts

Where duct lines are removed from existing underground structures, close the openings to waterproof the structure. Chip out the wall opening to provide a key for the new section of wall.

3.4 CABLE PULLING

Test existing duct lines with a flexible mandrel and thoroughly swab out to remove foreign material before pulling cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures.

3.4.1 Cable Lubricants

Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

3.5 CABLES IN UNDERGROUND STRUCTURES

Except as otherwise noted, do not install cables utilizing the shortest path between penetrations, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare arm for each cable rack in each underground structure.

3.6 CONDUCTORS INSTALLED IN PARALLEL

Conductors shall be grouped such that each conduit of a parallel run contains 1 Phase A conductor, 1 Phase B conductor, 1 Phase C conductor, and 1 neutral conductor.

3.7 LOW VOLTAGE CABLE SPLICING AND TERMINATING

Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after the splicing material has completely set. Make splices in underground distribution

systems only in accessible locations such as manholes or handholes. Where new conductors are specified to be spliced to existing conductors, field verify the size(s) of the existing conductors prior to procuring the materials to make up these splices.

3.8 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70 and Section 31 00 00 EARTHWORK.

3.8.1 Reconditioning of Surfaces

3.8.1.1 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.

3.8.1.2 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.

3.9 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.9.1 Concrete Slabs for Equipment

Unless otherwise indicated, the slab shall be at least (203 mm) 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh, placed uniformly (100 mm) 4 inches from the top of the slab. Slab shall be placed on a (150 mm) 6 inch thick, well-compacted gravel base. Top of concrete slab shall be approximately (100 mm) 4 inches above finished grade with gradual slope for drainage. Edges above grade shall have (13 mm) 1/2 inch chamfer. Slab shall be of adequate size to project at least (203 mm) 8 inches beyond the equipment.

Stub up conduits, with bushings, (50 mm) 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.9.2 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

-- End of Section --

APPENDICES

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PbO_3 INCORPORATED *ENVIRONMENTAL TESTING & SVC. CO.*

Report No: ACM -811-09-07-12-15

September 7, 2012

Client: URS Corporation
7650 W. Courtney Campbell Causeway
Tampa, FL 33607

Attn: John J. Calamari, P.E.
Senior Project Manager

Project: Limited Asbestos Survey
Project No.: **PCN 98860**
Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Processing Areas
Kennedy Space Center, FL

According to your instructions ***PbO_3*** Environmental Testing & Service Co., Inc. has completed a limited asbestos survey at the subject property (Project). The following pages of this report contain the results of this inspection. This limited asbestos inspection report presents data that describes the location of asbestos-containing material (ACM) identified only within the project scope. This report is to be used as a program-planning tool for the proposed renovation activities scheduled at this facility. This survey was conducted on site by EPA/AHERA trained professional inspector.

Suspect materials not previously identified in this report may be encountered during any renovation and/or maintenance activities. These materials should be assumed asbestos containing material until sample collection and subsequent analysis prove otherwise.

This report is intended for the exclusive use of our client. The findings are relevant to the conditions observed during the physical process of performing the Inspection. These findings should not be treated as absolute nor should they be relied upon to represent conditions at significantly later dates.

PbO_3 Environmental Testing & Service Co., Inc.

Dave Mederer
Project Manager

Unofficial without seal
Alfredo Delregato, CIH 9459CP
FLAC # AX80

Asbestos License # ZA 0000205

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1.0 EXECUTIVE SUMMARY

Sample Collection Date

August 21st 2012

Inspector:

Kevin O'Malley, Asbestos Building Inspector Certification No. 154429

Licensed Asbestos Consultant

Alfredo Delregato, CIH 9459CP
FLAC # AX80

State Licenses and/or Certifications

Asbestos License No. ZA 0000205

Limited Asbestos Sampling for the following components:

JobLocation	Sample No.	Sample Indentification	Component	Description
Rev.MV.Elec.Dist.Sys	ONC-01	Rm 1635 (1435)	Duct Mastic	White, Soft
Rev.MV.Elec.Dist.Sys	ONC-02	Rm 1635 (1435)	Duct Mastic	White, Soft
Rev.MV.Elec.Dist.Sys	ONC-03	Rm 1635 (1435)	Duct Mastic	White, Soft
Rev.MV.Elec.Dist.Sys	ONC-04	Rm 1635 (1435)	TSI-Pipe	Silver, Fibrous
Rev.MV.Elec.Dist.Sys	ONC-05	Rm 1635 (1435)	TSI-Pipe	Silver, Fibrous
Rev.MV.Elec.Dist.Sys	ONC-06	Rm 1635 (1435)	TSI-Pipe	Silver, Fibrous
Rev.MV.Elec.Dist.Sys	ONC-07	Rm 1623 (1423)	TSI-Pipe CWR	Silver, Fibrous
Rev.MV.Elec.Dist.Sys	ONC-07	Rm 1623 (1423)	Soft Material	Gray, Soft
Rev.MV.Elec.Dist.Sys	ONC-08	Rm 1623 (1423)	TSI-Pipe CWR	Green/Gray, Fibrous
Rev.MV.Elec.Dist.Sys	ONC-08	Rm 1623 (1423)	Soft Material	Gray, Soft
Rev.MV.Elec.Dist.Sys	ONC-09	Rm 1623 (1423)	TSI- Elbow CWR	White/Gray, Fibrous
Rev.MV.Elec.Dist.Sys	ONC-09	Rm 1623 (1423)	Soft Material	Gray, Soft
Rev.MV.Elec.Dist.Sys	ONC-10	Rm 1623 (1423)	TSI-Tank Small	White, Powdery/Fibrous
Rev.MV.Elec.Dist.Sys	ONC-11	Rm 1623 (1423)	TSI-Tank Small	White, Powdery/Fibrous
Rev.MV.Elec.Dist.Sys	ONC-12	Rm 1623 (1423)	TSI-Tank Small	White, Powdery/Fibrous
Rev.MV.Elec.Dist.Sys	ONC-13	Rm 1623 (1423)	TSI-Pipe HWS	White/Yellow, Fibrous
Rev.MV.Elec.Dist.Sys	ONC-13	Rm 1623 (1423)	Cover	White, Fibrous
Rev.MV.Elec.Dist.Sys	ONC-14	Rm 1623 (1423)	TSI-Pipe HWR	White, Fibrous

JobLocation	Sample No.	Sample Indentification	Component	Description
Rev.MV.Elec.Dist.Sys	ONC-15	Rm 1623 (1423)	TSI-Elbow	Gray, Powdery
Rev.MV.Elec.Dist.Sys	ONC-15	Rm 1623 (1423)	Cover	White, Fibrous
Rev.MV.Elec.Dist.Sys	IACP-16	Chiller Rm M7-407	Insulation-Wall	Yellow, Fibrous
Rev.MV.Elec.Dist.Sys	IACP-16	Chiller Rm M7-407	Cover	White, Soft
Rev.MV.Elec.Dist.Sys	IACP-17	Chiller Rm M7-407	Insulation-Wall	Yellow, Fibrous
Rev.MV.Elec.Dist.Sys	IACP-17	Chiller Rm M7-407	Cover	White, Soft
Rev.MV.Elec.Dist.Sys	IACP-18	Chiller Rm M7-407	Insulation-Wall	Yellow, Fibrous
Rev.MV.Elec.Dist.Sys	IACP-18	Chiller Rm M7-407	Cover	White, Soft

TSI =Thermal System Insulation

Overview

PbO3 Environmental Testing & Service Co., Inc. was contracted by the URS Corporation to provide limited testing services for suspect asbestos containing materials as designated by our client.

There was a total of twenty-six (26) samples (including sub-samples) analyzed by EPA Method 600/M4/82/020R-93/116.

Based upon our visual observations, bulk sampling of suspect materials, and subsequent microscopic analysis, we have determined that **Asbestos Containing Material** was detected.

2.0 SUMMARY- SAMPLE RESULTS

Asbestos Containing Material was detected in the following samples:

Sample No.	Sample Identification	LayerID	Component	MacroDescription	Asbestos Material	Asbestos Qty	Friable
ONC-08	Rm 1623 (1423)	2	TSI-Pipe CWR	Gray, Soft	CHRYSOTILE	**2%**	Yes*
ONC-09	Rm 1623 (1423)	2	TSI- Elbow CWR	Gray, Soft	CHRYSOTILE	**2%**	Yes*
ONC-15	Rm 1623 (1423)	1	TSI-Elbow	Gray, Powdery	CHRYSOTILE	**6%**	Yes*
ONC-10	Rm 1623 (1423)	triplicate samples	TSI-Tank Small	White, Powdery/Fibrous	CHRYSOTILE	**35%**	Yes*
ONC-12	Rm 1623 (1423)	triplicate samples	TSI-Tank Small	White, Powdery/Fibrous	CHRYSOTILE	**35%**	Yes*
ONC-11	Rm 1623 (1423)	triplicate samples	TSI-Tank Small	White, Powdery/Fibrous	CHRYSOTILE	**40%**	Yes*

Note: 3/4 inch insulated hot water lines to elevated heaters in room 1611 (1411) were not sampled. The insulated hot water lines are assumed to be a friable form of asbestos containing material.

*Friable asbestos-containing material (ACM), is defined by the EPA-"National Emission Standards for Hazardous Air Pollutants" (NESHAP) regulation as any material containing more than one percent (1%) asbestos when dry, can be crumbled, pulverized or reduced to powder by hand pressure.

Asbestos Containing Material was **NOT** detected in the following samples

JobLocation	Sample No.	Sample Identification	LayerID	Component	MacroDescription	Asbestos Material
Rev.MV.Elec.Dist.Sys	ONC-01	Rm 1635 (1435)	1	Duct Mastic	White, Soft	None Detected
Rev.MV.Elec.Dist.Sys	ONC-02	Rm 1635 (1435)	1	Duct Mastic	White, Soft	None Detected
Rev.MV.Elec.Dist.Sys	ONC-03	Rm 1635 (1435)	1	Duct Mastic	White, Soft	None Detected
Rev.MV.Elec.Dist.Sys	ONC-04	Rm 1635 (1435)	1	TSI-Pipe	Silver, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	ONC-05	Rm 1635 (1435)	1	TSI-Pipe	Silver, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	ONC-06	Rm 1635 (1435)	1	TSI-Pipe	Silver, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	ONC-07	Rm 1623 (1423)	1	TSI-Pipe CWR	Silver, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	ONC-07	Rm 1623 (1423)	2	Soft Material	Gray, Soft	None Detected
Rev.MV.Elec.Dist.Sys	ONC-08	Rm 1623 (1423)	1	TSI-Pipe CWR	Green/Gray, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	ONC-09	Rm 1623 (1423)	1	TSI- Elbow CWR	White/Gray, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	ONC-13	Rm 1623 (1423)	1	TSI-Pipe HWS	White/Yellow, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	ONC-13	Rm 1623 (1423)	2	Cover	White, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	ONC-14	Rm 1623 (1423)	1	TSI-Pipe HWR	White, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	ONC-15	Rm 1623 (1423)	2	Cover	White, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	IACP-16	M7-407 Chiller Rm	1	Insulation-Wall	Yellow, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	IACP-16	M7-407 Chiller Rm	2	Cover	White, Soft	None Detected
Rev.MV.Elec.Dist.Sys	IACP-17	M7-407 Chiller Rm	1	Insulation-Wall	Yellow, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	IACP-17	M7-407 Chiller Rm	2	Cover	White, Soft	None Detected
Rev.MV.Elec.Dist.Sys	IACP-18	M7-407 Chiller Rm	1	Insulation-Wall	Yellow, Fibrous	None Detected
Rev.MV.Elec.Dist.Sys	IACP-18	M7-407 Chiller Rm	2	Cover	White, Soft	None Detected

LABORATORY REPORTS

SCHNEIDER LABORATORIES GLOBAL

INCORPORATED

2512 W. Cary Street • Richmond, Virginia • 23220-5117

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LABORATORY ANALYSIS REPORT

Asbestos Identification by EPA Method[1] 600/R-93/116

Using SLI A6

ACCOUNT #:	1491-12-3156	**DATE COLLECTED:**	8/21/2012
CLIENT:	PbO3 ENV TESTING & SERVICES INC	**DATE RECEIVED:**	8/22/2012
ADDRESS:	473 N PINE MEADOW DR	**DATE ANALYZED:**	8/25/2012
	DEBARY, FL 32713	**DATE REPORTED:**	8/27/2012
PROJECT NAME:	VRS		
JOB LOCATION:	Rev.MV.Elec.Dist.Sys		
PROJECT NO.:			
PO NO.:		**SampleType:**	BULK

Client Sample No.	SLI Sample/ Layer ID	Sample Identification/ Layer Name	PLM Analysis Results: Asbestos Fibers	PLM Analysis Results: Other Materials
ONC-01	31584246	Rm 1635 (1435)		
Layer 1:	Duct Mastic White, Soft		None Detected	100% NON FIBROUS MATERIAL
ONC-02	31584247	Rm 1635 (1435)		
Layer 1:	Duct Mastic White, Soft		None Detected	100% NON FIBROUS MATERIAL
ONC-03	31584248	Rm 1635 (1435)		
Layer 1:	Duct Mastic White, Soft		None Detected	100% NON FIBROUS MATERIAL
ONC-04	31584249	Rm 1635 (1435)		
Layer 1:	TSI Silver, Fibrous		None Detected	80% CELLULOSE FIBER 5% MINERAL/GLASS WOOL 15% NON FIBROUS MATERIAL
ONC-05	31584250	Rm 1635 (1435)		
Layer 1:	TSI Silver, Fibrous		None Detected	80% CELLULOSE FIBER 5% MINERAL/GLASS WOOL 15% NON FIBROUS MATERIAL

Total Number of Pages in Report: 3

Results relate only to samples as received by the laboratory. Visit www.slabinc.com for current certifications.

Samples analyzed by the EPA Test Method are subject to the limitations of light microscopy including matrix interference. Gravimetric reduction and correlative analyses are recommended for all non-friable, organically bound materials. This method has a reporting limit of 1% or greater. Visual estimation contains an inherent range of uncertainty. This report must not be reproduced except in full with the approval of the lab, and must not be used to claim NVLAP or other gov't agency endorsement.

79K39136 REV A

Client Sample No.	SLI Sample/ Layer ID	Sample Identification/ Layer Name	PLM Analysis Results: Asbestos Fibers	PLM Analysis Results: Other Materials
ONC-06	31584251	Rm 1635 (1435)		
Layer 1:	TSI Silver, Fibrous		None Detected	80% CELLULOSE FIBER 5% MINERAL/GLASS WOOL 15% NON FIBROUS MATERIAL
ONC-07	31584252	Rm 1623 (1423)		
Layer 1:	TSI Silver, Fibrous		None Detected	65% CELLULOSE FIBER 35% NON FIBROUS MATERIAL
Layer 2:	Soft Material Gray, Soft		None Detected	100% NON FIBROUS MATERIAL
ONC-08	31584253	Rm 1623 (1423)		
Layer 1:	TSI Green/Gray, Fibrous		None Detected	35% NON FIBROUS MATERIAL 65% CELLULOSE FIBER
Layer 2:	Soft Material Gray, Soft		2% CHRYSOTILE	98% NON FIBROUS MATERIAL
ONC-09	31584254	Rm 1623 (1423)		
Layer 1:	TSI White/Gray, Fibrous		None Detected	65% CELLULOSE FIBER 5% MINERAL/GLASS WOOL 30% NON FIBROUS MATERIAL
Layer 2:	Soft Material Gray, Soft		2% CHRYSOTILE	98% NON FIBROUS MATERIAL
ONC-10	31584255	Rm 1623 (1423)		
Layer 1:	TSI White, Powdery/Fibrous, Homogenous		35% CHRYSOTILE	30% CELLULOSE FIBER 35% NON FIBROUS MATERIAL
ONC-11	31584256	Rm 1623 (1423)		
Layer 1:	TSI White, Powdery/Fibrous		40% CHRYSOTILE	30% CELLULOSE FIBER 30% NON FIBROUS MATERIAL
ONC-12	31584257	Rm 1623 (1423)		
Layer 1:	TSI White, Powdery/Fibrous		35% CHRYSOTILE	25% CELLULOSE FIBER 40% NON FIBROUS MATERIAL

Total Number of Pages in Report: 3

Results relate only to samples as received by the laboratory. Visit www.slabinc.com for current certifications.

Samples analyzed by the EPA Test Method are subject to the limitations of light microscopy including matrix interference. Gravimetric reduction and correlative analyses are recommended for all non-friable, organically bound materials. This method has a reporting limit of 1% or greater. Visual estimation contains an inherent range of uncertainty. This report must not be reproduced except in full with the approval of the lab, and must not be used to claim NVLAP or other gov't agency endorsement.

79K39136 REV A

Client Sample No.	SLI Sample/ Layer ID	Sample Identification/ Layer Name	PLM Analysis Results Asbestos Fibers	Other Materials
ONC-13	31584258	Rm 1623 (1423)		
Layer 1:	TSI White/Yellow, Fibrous		None Detected	90% MINERAL/GLASS WOOL 10% NON FIBROUS MATERIAL
Layer 2:	Cover White, Fibrous		None Detected	85% CELLULOSE FIBER 15% NON FIBROUS MATERIAL
ONC-14	31584259	Rm 1623 (1423)		
Layer 1:	TSI White, Fibrous		None Detected	85% CELLULOSE FIBER 15% NON FIBROUS MATERIAL
ONC-15	31584260	Rm 1623 (1423)		
Layer 1:	TSI Gray, Powdery		6% CHRYSOTILE	14% MINERAL/GLASS WOOL 80% NON FIBROUS MATERIAL
Layer 2:	Cover White, Fibrous		None Detected	75% CELLULOSE FIBER 25% NON FIBROUS MATERIAL
IACP-16	31584261	M7-407		
Layer 1:	Insulation Yellow, Fibrous		None Detected	90% MINERAL/GLASS WOOL 10% NON FIBROUS MATERIAL
Layer 2:	Cover White, Soft		None Detected	100% NON FIBROUS MATERIAL
IACP-17	31584262	Chiller Rm		
Layer 1:	Insulation Yellow, Fibrous		None Detected	90% MINERAL/GLASS WOOL 10% NON FIBROUS MATERIAL
Layer 2:	Cover White, Soft		None Detected	100% NON FIBROUS MATERIAL
IACP-18	31584263			
Layer 1:	Insulation Yellow, Fibrous		None Detected	90% MINERAL/GLASS WOOL 10% NON FIBROUS MATERIAL
Layer 2:	Cover White, Soft		None Detected	100% NON FIBROUS MATERIAL

Analyst: **SAMANI ABDELFADIEL** **Reviewed By:** **Hind Eldanaf, Microscopy Supervisor**

Total Number of Pages in Report: 3

Results relate only to samples as received by the laboratory. Visit www.slabinc.com for current certifications.

Samples analyzed by the EPA Test Method are subject to the limitations of light microscopy including matrix interference. Gravimetric reduction and correlative analyses are recommended for all non-friable, organically bound materials. This method has a reporting limit of 1% or greater. Visual estimation contains an inherent range of uncertainty. This report must not be reproduced except in full with the approval of the lab, and must not be used to claim NVLAP or other gov't agency endorsement.

1491-12-3156

79K39136 REV A

SAMPLE LOG

PbO3 ENVIRONMENTAL, INC.
473 N. PINE MEADOW DR.
DEBARY, FL. 32713
Phone 386-668-4545
Fax 386-668-4566
Pbo3@comcast.net

3 day TAT

PROJECT NAME: URS
JOB LOCATION: Rev. MV. Elec. Dist. Sys.
PROJECT #:
PO NO.:
DATE: 8/21/12

1 OF 1

SAMPLE LOG
ASBESTOS X LEAD ____ OTHER ____

SAMPLE NUMBER	DESCRIPTION	LOCATION
ONC-01	Duct Mastic	Rm 1635 (1435)
02		
03		
04	TSI pipe	
05		
06		
07	TSI pipe CWR	Rm 1623 (1423)
08	" CWS	
09	elbow "	
10	TSI Tank (small)	
11		
12		
13	TSI pipe HWS	Rm 1623 (1423)
14	" HWR	
15	elbow	
IACP. 16	Wall Ins.	M7-407
17		Chiller Rm
18		

[signature] 8/21/12

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4.0 RECOMMENDATIONS

The EPA's National Emission Standard for Hazardous Air Pollutants (NESHAP) regulations and the Florida Department of Environmental Protection (FDEP) Asbestos program regulate the removal and disposal of asbestos-containing building materials. The Florida Department of Environmental Protection (DEP) administers an asbestos removal program under Chapter 62-257, Florida Administrative Code. The Asbestos NESHAP has been adopted by reference in section 62-204.800, Florida Administrative Code. The program's intent is to minimize the release of asbestos fibers during activities involving the processing, handling, and disposal of asbestos-containing material.

29 CFR 1926.1101- OSHA's Asbestos Standard for the Construction Industry does apply to the demolition/renovation of all facilities identified with asbestos containing material. The contractor will need to comply with the specific **training, duties** and **responsibilities** outlined in this CFR.

All Asbestos abatement projects must in compliance with Florida Statute Title XXXII Chapter 469. Only a Florida licensed asbestos contractor using properly trained, certified, and licensed asbestos workers can perform asbestos removal projects in Florida.

The regulations of these agencies require the removal of friable asbestos-containing materials prior to extensive renovation or demolition projects, and the removal of non-friable asbestos-containing materials that may be rendered friable in the course of renovation or demolition projects.

Florida requires the submission of a 10-Day Notification for all renovations and demolitions of facilities with at least 260 linear feet of regulated asbestos-containing materials (RACM), 160 square feet of regulated asbestos containing materials on other facility components, or at least one cubic meter (35 cubic feet) off facility components. Asbestos waste requires disposal at an approved solid waste disposal facility. Local agencies may also have specific requirements for demolition/renovation projects involving asbestos-containing building materials.

OSHA 29 CFR 1910.1001 requires the communication of information concerning asbestos hazards. Employees engaged in work activities with installed ACM may be exposed to asbestos fibers. The owner or operator should take the necessary steps to reduce the potential for disturbance.

Suspect materials not previously identified in this report may be encountered during any renovation and/or maintenance activities. If encountered all work in the immediate area shall cease. These materials should be assumed asbestos containing material until sample collection and subsequent analysis prove otherwise.

Inspection Limits

PbO_3 has performed the Client requested tasks in a thorough and professional manner consistent with commonly accepted standard industry practices, using state of the art practices and best available known technology, as of the date of the assessment. ***PbO_3*** cannot guarantee and does not warrant that this limited Asbestos Survey has identified all adverse environmental factors and/or conditions affecting the subject properties on the date of the Assessment. ***PbO_3*** cannot and will not warrant that this limited Asbestos Survey that was requested by the client will satisfy the dictates of, or provide a legal defense in connection with, any environmental laws or regulations. It is the responsibility of the client to know and abide by all applicable laws, regulations, and standards. The results reported and conclusions reached by ***PbO_3*** are solely for the benefit of the client. The results and opinions in this report, based solely upon the conditions found on the property as of the date of the Assessment, will be valid only as of the date of the Assessment. This limited asbestos survey was not intended to be definitive study of the presence of asbestos on the subject property since it is limited to select areas scheduled for renovation. Other locations of asbestos may exist at the subject property, and the levels may vary from those stated in this report. There may be variations in the composition of materials which appear similar. Materials may be hidden from view and not accessible. This is an occupied structure where damage and invasive sampling needed to be minimized (such as structures not owned by our client). Hypothetical examples include floor tile hidden under carpeting, and not detected by our typical examination of the area under the carpet at a corner(s) or existing hole(s), an abandoned length of insulated pipe hidden within a finished wall, an asbestos-cement sewer vent pipe in the wall behind a toilet, asbestos paper/felt between hardwood flooring and the sub-floor or old vinyl floor tile covered over with plywood and newer flooring materials. No attempt was made to disassemble equipment or demolish structural elements and finishes as this is beyond the scope of our authorized services. Visual observations were made only at convenient locations, due to these limitations, wall voids, flooring under carpet, building cavities and mechanical equipment, and other areas may contain unreported asbestos-containing materials. This report has been prepared for the exclusive use of our client, for the expressed purpose of providing them with an understanding of the potential for the presence of asbestos at the assessed property. PbO3 has relied upon state-of-the-art information in this report, and accepts no responsibility for any deficiencies, mis-statements or inaccuracies in the report as a result of mis-statements, omissions, misrepresentations, fraudulent, or inaccurate information provided. We are not responsible for changes in applicable regulatory standards, practices, or regulations following performance of services. All fire doors should be assumed asbestos containing material since disassembly of locks and/or other work to access the door insulation is not possible. We generally assume that roofing material contains asbestos, as asbestos roofing material is very common. Location and sampling of underground items, such as asbestos-cement pipes, would have been outside of the scope.

5.0 CERTIFICATIONS

Aug 15 12 01:51p Alberto Ania 904 278 2117 p.1
Page 548

Asbestos Consulting & Training Systems

39674.5748CERT/BIR

900 N.W. 5TH Avenue, Fort Lauderdale, Florida 33311 (954) 524-7208

Processed By:

Seagull

To Authenticate Certificate:
www.seagulltraining.com
1-800-966-9933

This is to Certify that

Kevin X O'Malley

XXX-XX-Ø544

625 Merritt Ave # G , Merritt Island,FL

has successfully completed an English

Asbestos Building Inspection Refresher

14-Aug-12 TO 14-Aug-12

Individual above has completed the requsite training for accreditation under TSCA Title II

Meets state requirements of FL49-0001020/CN-0006273.

NDAAC Provider #451 Trainer(s): Alberto A. Ania

Training Address: 2233 Park Avenue Suite 406, Orange Park, FL, 32073

Successful course completion based on exam score on: 14-Aug-12

UNDER CIVIL AND CRIMINAL PENALTIES OF LAW FOR MAKING OR SUBMITTING FALSE OR FRAUDULENT STATEMENTS OR REPRESENTATIONS (18 U.S.C. [illegible] AND 15 [illegible]), I CERTIFY THAT THIS TRAINING COURSE COMPLIES WITH ALL APPLICABLE REQUIREMENTS OF TITLE II OF THE TOXIC SUBSTANCES CONTROL ACT, 40 CFR PART 763, AND ALL APPLICABLE FEDERAL, STATE OR LOCAL REQUIREMENTS AS AMENDED.

James F. Stump, Course Sponsor

Certificate Number..... 154429

This Certificate Expires:

14-Aug-13 Ø8/14/13

Course Number JE1233

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LITHO. IN U.S.A.

STATE OF FLORIDA

DEPARTMENT OF BUSINESS AND PROFESSIONAL REGULATION

79K39136 REV A

ASBESTOS LICENSING UNIT
1940 NORTH MONROE STREET
TALLAHASSEE FL 32399-0783

(850) 487-1395

PBO3 ENVIRONMENTAL TESTING & SVC COMPANY, INC
PETER C. SWARR
473 N.PINE MEADOW DR
DEBARY FL 32713

Congratulations! With this license you become one of the nearly one million Floridians licensed by the Department of Business and Professional Regulation. Our professionals and businesses range from architects to yacht brokers, from boxers to barbeque restaurants, and they keep Florida's economy strong.

Every day we work to improve the way we do business in order to serve you better. For information about our services, please log onto **www.myfloridalicense.com**. There you can find more information about our divisions and the regulations that impact you, subscribe to department newsletters and learn more about the Department's initiatives.

Our mission at the Department is: License Efficiently, Regulate Fairly. We constantly strive to serve you better so that you can serve your customers. Thank you for doing business in Florida, and congratulations on your new license!

STATE OF FLORIDA AC# 5754934
DEPARTMENT OF BUSINESS AND PROFESSIONAL REGULATION

ZA0000205 09/16/11 110104006

ASBESTOS BUSINESS ORGANIZATION
PBO3 ENVIRONMENTAL TESTING & SVC
PETER C. SWARR

IS LICENSED under the provisions of Ch.469 FS.
Expiration date: NOV 30, 2013 L11091603036

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AC# 5754934

STATE OF FLORIDA

DEPARTMENT OF BUSINESS AND PROFESSIONAL REGULATION
ASBESTOS LICENSING UNIT

SEQ# L11091603036

DATE	BATCH NUMBER	LICENSE NBR
09/16/2011	110104006	ZA0000205

The ASBESTOS BUSINESS ORGANIZATION
Named below IS LICENSED
Under the provisions of Chapter 469 FS.
Expiration date: NOV 30, 2013

PBO3 ENVIRONMENTAL TESTING & SVC COMPANY, INC
PETER C. SWARR
473 N.PINE MEADOW DR
DEBARY FL 32713

RICK SCOTT
GOVERNOR

KEN LAWSON
SECRETARY

DISPLAY AS REQUIRED BY LAW

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 101150-0

Schneider Laboratories Global, Inc.

Richmond, VA

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

BULK ASBESTOS FIBER ANALYSIS

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2012-04-01 through 2013-03-31

Effective dates

DEPARTMENT OF COMMERCE * UNITED STATES OF AMERICA *

David F. Alderman

For the National Institute of Standards and Technology

79K39136 REV A

NVLAP® National Voluntary Laboratory Accreditation Program

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

Schneider Laboratories Global, Inc.
2512 W. Cary Street
Richmond, VA 23220-5117
Mr. Raja Abouzaki, PhD
Phone: 804-353-6778 Fax: 804-359-1138
E-Mail: RAbouzaki@slabinc.com
URL: http://www.slabinc.com

BULK ASBESTOS FIBER ANALYSIS (PLM) **NVLAP LAB CODE 101150-0**

NVLAP Code	*Designation / Description*
18/A01	EPA-600/M4-82-020: Interim Method for the Determination of Asbestos in Bulk Insulation Samples

2012-04-01 through 2013-03-31
Effective dates

David F. Alderman
For the National Institute of Standards and Technology

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PbD3 INCORPORATED

Report No: MTL -811-09-07-12-14

September 7, 2012

Client: URS Corporation
7650 W. Courtney Campbell Causeway
Tampa, FL 33607

Attn: John J. Calamari, P.E.
Senior Project Manager

Project: Paint Analysis for Total Metals- Eight (8) Metals
Project No.: **PCN 98860**
Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Processing Areas
Kennedy Space Center, FL

According to your instructions □□□ Environmental Testing & Service Co., Inc. has completed a limited testing survey for metals at the subject property (Project). The following pages of this report contain the results of this testing. This report is to be used as a program-planning tool for the proposed renovation activities scheduled at this facility. This survey was conducted on site by Florida EPA Certified Lead-Based Paint Risk Assessor and EPA/AHERA trained Asbestos Inspector.

This report is intended for the exclusive use of our client. The findings are relevant to the conditions observed during the physical process of performing the Inspection. These findings should not be treated as absolute nor should they be relied upon to represent conditions at significantly later dates.

□□□ Environmental Testing & Service Co., Inc.

Dave Mederer
Project Manager

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2.0 DETAILED FINDINGS 5
3.0 LABORATORY REPORTS 12

1.0 EXECUTIVE SUMMARY

Sample Collection Dates

August 21st, 24th & 28th 2012

State Licenses and/or Certifications

U.S. EPA Certified Lead-Based Paint Activities Firm No. FL-2418-2
Asbestos License # ZA 0000205

Inspector:

Kevin O'Malley, Florida EPA Certified Lead-Based Paint Risk Assessor FL-R-345-3
Asbestos Building Inspector Certification No. 154429

Paint Chip Samples were collected from the following component(s):

Job Location	Sample No.	Sample Description
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec
Rev MV Elec Dist Sys	P-09	SS-B Transformer
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec
Rev MV Elec Dist Sys	P-10	SS-B Secondary
Rev MV Elec Dist Sys	P-06	SS-EE Transformer
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec
Rev MV Elec Dist Sys	P-13	SS-C Secondary
Rev MV Elec Dist Sys	P-22	SS-F Secondary
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec
Rev MV Elec Dist Sys	P-12	SS-C Transformer
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch
Rev MV Elec Dist Sys	P-19	SS-E Secondary
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec
Rev MV Elec Dist Sys	P-20	SS-F Primary

Job Location	Sample No.	Sample Description
Rev MV Elec Dist Sys	P-01	LBS-14
Rev MV Elec Dist Sys	P-02	LBS-57
Rev MV Elec Dist Sys	P-03	LBS-58
Rev MV Elec Dist Sys	P-04	LBS-80
Rev MV Elec Dist Sys	P-15	SS-D Transformer
Rev MV Elec Dist Sys	P-16	SS-D Secondary
Rev MV Elec Dist Sys	P-18	SS-E Transformer
Rev MV Elec Dist Sys	P-21	SS-F Transformer
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec
Rev MV Elec Dist Sys	P-24	SS-119A Transformer
Rev MV Elec Dist Sys	P-25	SS-119A Secondary
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec
Rev MV Elec Dist Sys	P-27	SS-119B Transformer
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply

Overview

According to your instructions □□□□Environmental Testing & Service Co., Inc. has collected twenty-eight (28) representative paint chip samples of exposed painted components as designated by our client.

The samples were analyzed for Total Metals by EPA Method 6010C for Barium, Cadmium, Chromium, Lead, Silver Arsenic, Selenium and EPA Method 7471B for Mercury.

Paint Analysis for Total Metals- Eight (8) Metals
Project No.: **PCN 98860**
Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Processing Areas
Kennedy Space Center, FL

2.0 DETAILED FINDINGS

Job Location	Sample No.	Sample Description	PeriodicName	PPM	Dimensions -Inches
Rev MV Elec Dist Sys	P-01	LBS-14	Silver	6	70x23x75
Rev MV Elec Dist Sys	P-01	LBS-14	Arsenic	< 6	
Rev MV Elec Dist Sys	P-01	LBS-14	Barium	32,515	
Rev MV Elec Dist Sys	P-01	LBS-14	Cadmium	< 6	
Rev MV Elec Dist Sys	P-01	LBS-14	Chromium	22	
Rev MV Elec Dist Sys	P-01	LBS-14	Mercury	< 1	
Rev MV Elec Dist Sys	P-01	LBS-14	Lead	14	
Rev MV Elec Dist Sys	P-01	LBS-14	Selenium	< 6	
Rev MV Elec Dist Sys	P-02	LBS-57	Silver	< 6	80x23x73
Rev MV Elec Dist Sys	P-02	LBS-57	Arsenic	< 6	
Rev MV Elec Dist Sys	P-02	LBS-57	Barium	6,769	
Rev MV Elec Dist Sys	P-02	LBS-57	Cadmium	21	
Rev MV Elec Dist Sys	P-02	LBS-57	Chromium	< 14	
Rev MV Elec Dist Sys	P-02	LBS-57	Mercury	< 1	
Rev MV Elec Dist Sys	P-02	LBS-57	Lead	151	
Rev MV Elec Dist Sys	P-02	LBS-57	Selenium	< 6	
Rev MV Elec Dist Sys	P-03	LBS-58	Silver	< 6	80x23x73
Rev MV Elec Dist Sys	P-03	LBS-58	Arsenic	< 6	
Rev MV Elec Dist Sys	P-03	LBS-58	Barium	18,846	
Rev MV Elec Dist Sys	P-03	LBS-58	Cadmium	10	
Rev MV Elec Dist Sys	P-03	LBS-58	Chromium	< 16	
Rev MV Elec Dist Sys	P-03	LBS-58	Mercury	< 1	
Rev MV Elec Dist Sys	P-03	LBS-58	Lead	84	
Rev MV Elec Dist Sys	P-03	LBS-58	Selenium	< 6	
Rev MV Elec Dist	P04	LBS-80	Silver	4	94x24x88
Rev MV Elec Dist	P04	LBS-80	Arsenic	< 4	
Rev MV Elec Dist	P04	LBS-80	Barium	< 4	
Rev MV Elec Dist	P04	LBS-80	Cadmium	< 4	
Rev MV Elec Dist	P04	LBS-80	Chromium	21	
Rev MV Elec Dist	P04	LBS-80	Mercury	< 1	
Rev MV Elec Dist	P04	LBS-80	Lead	29	
Rev MV Elec Dist	P04	LBS-80	Selenium	< 4	
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec	Silver	< 7	114x88x90
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec	Arsenic	< 7	
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec	Barium	2,797	
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec	Cadmium	< 7	

Job Location	Sample No.	Sample Description	PeriodicName	PPM	Dimensions -Inches
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec	Chromium	37	
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec	Mercury	2	
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec	Lead	8,532	
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec	Selenium	< 7	
Rev MV Elec Dist Sys	P-06	SS-EE Transformer	Silver	< 6	54x53x58
Rev MV Elec Dist Sys	P-06	SS-EE Transformer	Arsenic	< 6	
Rev MV Elec Dist Sys	P-06	SS-EE Transformer	Barium	667	
Rev MV Elec Dist Sys	P-06	SS-EE Transformer	Cadmium	< 6	
Rev MV Elec Dist Sys	P-06	SS-EE Transformer	Chromium	846	
Rev MV Elec Dist Sys	P-06	SS-EE Transformer	Mercury	2	
Rev MV Elec Dist Sys	P-06	SS-EE Transformer	Lead	5,106	
Rev MV Elec Dist Sys	P-06	SS-EE Transformer	Selenium	< 6	
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch	Silver	< 6	80x60x90
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch	Arsenic	< 6	
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch	Barium	278	
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch	Cadmium	16	
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch	Chromium	134	
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch	Mercury	1	
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch	Lead	2,200	
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch	Selenium	< 6	
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec	Silver	< 6	80x108x104
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec	Arsenic	< 6	
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec	Barium	51	
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec	Cadmium	< 6	
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec	Chromium	< 15	
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec	Mercury	< 1	
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec	Lead	114	
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec	Selenium	< 6	
Rev MV Elec Dist Sys	P-09	SS-B Transformer	Silver	< 6	75x60x90
Rev MV Elec Dist Sys	P-09	SS-B Transformer	Arsenic	182	
Rev MV Elec Dist Sys	P-09	SS-B Transformer	Barium	6,888	
Rev MV Elec Dist Sys	P-09	SS-B Transformer	Cadmium	253	
Rev MV Elec Dist Sys	P-09	SS-B Transformer	Chromium	883	
Rev MV Elec Dist Sys	P-09	SS-B Transformer	Mercury	< 1	
Rev MV Elec Dist Sys	P-09	SS-B Transformer	Lead	68,277	
Rev MV Elec Dist Sys	P-09	SS-B Transformer	Selenium	< 6	

Job Location	Sample No.	Sample Description	PeriodicName	PPM	Dimensions -Inches
Rev MV Elec Dist Sys	P-10	SS-B Secondary	Silver	< 6	77x63x108
Rev MV Elec Dist Sys	P-10	SS-B Secondary	Arsenic	13	
Rev MV Elec Dist Sys	P-10	SS-B Secondary	Barium	457	
Rev MV Elec Dist Sys	P-10	SS-B Secondary	Cadmium	< 6	
Rev MV Elec Dist Sys	P-10	SS-B Secondary	Chromium	308	
Rev MV Elec Dist Sys	P-10	SS-B Secondary	Mercury	< 1	
Rev MV Elec Dist Sys	P-10	SS-B Secondary	Lead	4,281	
Rev MV Elec Dist Sys	P-10	SS-B Secondary	Selenium	< 6	
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec	Silver	8	81x108x104
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec	Arsenic	182	
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec	Barium	3,790	
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec	Cadmium	171	
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec	Chromium	83	
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec	Mercury	< 1	
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec	Lead	65,129	
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec	Selenium	< 6	
Rev MV Elec Dist Sys	P-12	SS-C Transformer	Silver	< 7	75x60x90
Rev MV Elec Dist Sys	P-12	SS-C Transformer	Arsenic	< 7	
Rev MV Elec Dist Sys	P-12	SS-C Transformer	Barium	36	
Rev MV Elec Dist Sys	P-12	SS-C Transformer	Cadmium	< 7	
Rev MV Elec Dist Sys	P-12	SS-C Transformer	Chromium	60	
Rev MV Elec Dist Sys	P-12	SS-C Transformer	Mercury	< 1	
Rev MV Elec Dist Sys	P-12	SS-C Transformer	Lead	3,613	
Rev MV Elec Dist Sys	P-12	SS-C Transformer	Selenium	< 7	
Rev MV Elec Dist Sys	P-13	SS-C Secondary	Silver	10	77x63x108
Rev MV Elec Dist Sys	P-13	SS-C Secondary	Arsenic	295	
Rev MV Elec Dist Sys	P-13	SS-C Secondary	Barium	7,027	
Rev MV Elec Dist Sys	P-13	SS-C Secondary	Cadmium	224	
Rev MV Elec Dist Sys	P-13	SS-C Secondary	Chromium	581	
Rev MV Elec Dist Sys	P-13	SS-C Secondary	Mercury	< 1	
Rev MV Elec Dist Sys	P-13	SS-C Secondary	Lead	111,619	
Rev MV Elec Dist Sys	P-13	SS-C Secondary	Selenium	< 6	
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec	Silver	< 6	80x108x104
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec	Arsenic	< 6	
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec	Barium	28	
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec	Cadmium	< 6	
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec	Chromium	781	

Job Location	Sample No.	Sample Description	PeriodicName	PPM	Dimensions -Inches
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec	Mercury	< 1	
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec	Lead	14,147	
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec	Selenium	< 6	
Rev MV Elec Dist Sys	P-15	SS-D Transformer	Silver	< 6	76x61x90
Rev MV Elec Dist Sys	P-15	SS-D Transformer	Arsenic	< 6	
Rev MV Elec Dist Sys	P-15	SS-D Transformer	Barium	35	
Rev MV Elec Dist Sys	P-15	SS-D Transformer	Cadmium	< 6	
Rev MV Elec Dist Sys	P-15	SS-D Transformer	Chromium	483	
Rev MV Elec Dist Sys	P-15	SS-D Transformer	Mercury	< 1	
Rev MV Elec Dist Sys	P-15	SS-D Transformer	Lead	24	
Rev MV Elec Dist Sys	P-15	SS-D Transformer	Selenium	< 6	
Rev MV Elec Dist Sys	P-16	SS-D Secondary	Silver	< 6	77x63x108
Rev MV Elec Dist Sys	P-16	SS-D Secondary	Arsenic	< 6	
Rev MV Elec Dist Sys	P-16	SS-D Secondary	Barium	9	
Rev MV Elec Dist Sys	P-16	SS-D Secondary	Cadmium	< 6	
Rev MV Elec Dist Sys	P-16	SS-D Secondary	Chromium	737	
Rev MV Elec Dist Sys	P-16	SS-D Secondary	Mercury	< 1	
Rev MV Elec Dist Sys	P-16	SS-D Secondary	Lead	12,616	
Rev MV Elec Dist Sys	P-16	SS-D Secondary	Selenium	< 6	
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec	Silver	< 6	81x108x104
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec	Arsenic	< 6	
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec	Barium	40,214	
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec	Cadmium	< 6	
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec	Chromium	714	
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec	Mercury	< 1	
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec	Lead	15,158	
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec	Selenium	< 6	
Rev MV Elec Dist Sys	P-18	SS-E Transformer	Silver	< 6	76x60x90
Rev MV Elec Dist Sys	P-18	SS-E Transformer	Arsenic	< 6	
Rev MV Elec Dist Sys	P-18	SS-E Transformer	Barium	42,711	
Rev MV Elec Dist Sys	P-18	SS-E Transformer	Cadmium	< 6	
Rev MV Elec Dist Sys	P-18	SS-E Transformer	Chromium	438	
Rev MV Elec Dist Sys	P-18	SS-E Transformer	Mercury	< 1	
Rev MV Elec Dist Sys	P-18	SS-E Transformer	Lead	7	
Rev MV Elec Dist Sys	P-18	SS-E Transformer	Selenium	< 6	
Rev MV Elec Dist Sys	P-19	SS-E Secondary	Silver	< 5	77x63x108

Job Location	Sample No.	Sample Description	PeriodicName	PPM	Dimensions -Inches
Rev MV Elec Dist Sys	P-19	SS-E Secondary	Arsenic	< 5	
Rev MV Elec Dist Sys	P-19	SS-E Secondary	Barium	39,509	
Rev MV Elec Dist Sys	P-19	SS-E Secondary	Cadmium	< 5	
Rev MV Elec Dist Sys	P-19	SS-E Secondary	Chromium	1,262	
Rev MV Elec Dist Sys	P-19	SS-E Secondary	Mercury	< 1	
Rev MV Elec Dist Sys	P-19	SS-E Secondary	Lead	20,889	
Rev MV Elec Dist Sys	P-19	SS-E Secondary	Selenium	< 5	
Rev MV Elec Dist Sys	P-20	SS-F Primary	Silver	< 6	81x108x104
Rev MV Elec Dist Sys	P-20	SS-F Primary	Arsenic	< 6	
Rev MV Elec Dist Sys	P-20	SS-F Primary	Barium	34,178	
Rev MV Elec Dist Sys	P-20	SS-F Primary	Cadmium	< 6	
Rev MV Elec Dist Sys	P-20	SS-F Primary	Chromium	3,472	
Rev MV Elec Dist Sys	P-20	SS-F Primary	Mercury	< 1	
Rev MV Elec Dist Sys	P-20	SS-F Primary	Lead	59,830	
Rev MV Elec Dist Sys	P-20	SS-F Primary	Selenium	< 6	
Rev MV Elec Dist Sys	P-21	SS-F Transformer	Silver	< 6	76x60x90
Rev MV Elec Dist Sys	P-21	SS-F Transformer	Arsenic	< 6	
Rev MV Elec Dist Sys	P-21	SS-F Transformer	Barium	30,908	
Rev MV Elec Dist Sys	P-21	SS-F Transformer	Cadmium	< 6	
Rev MV Elec Dist Sys	P-21	SS-F Transformer	Chromium	450	
Rev MV Elec Dist Sys	P-21	SS-F Transformer	Mercury	< 1	
Rev MV Elec Dist Sys	P-21	SS-F Transformer	Lead	109	
Rev MV Elec Dist Sys	P-21	SS-F Transformer	Selenium	< 6	
Rev MV Elec Dist Sys	P-22	SS-F Secondary	Silver	< 6	77x63x108
Rev MV Elec Dist Sys	P-22	SS-F Secondary	Arsenic	< 6	
Rev MV Elec Dist Sys	P-22	SS-F Secondary	Barium	40,814	
Rev MV Elec Dist Sys	P-22	SS-F Secondary	Cadmium	< 6	
Rev MV Elec Dist Sys	P-22	SS-F Secondary	Chromium	1,660	
Rev MV Elec Dist Sys	P-22	SS-F Secondary	Mercury	< 1	
Rev MV Elec Dist Sys	P-22	SS-F Secondary	Lead	28,705	
Rev MV Elec Dist Sys	P-22	SS-F Secondary	Selenium	< 6	
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec	Silver	< 6	102x36x113
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec	Arsenic	< 6	
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec	Barium	34,337	
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec	Cadmium	< 6	
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec	Chromium	< 14	
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec	Mercury	< 1	

Job Location	Sample No.	Sample Description	PeriodicName	PPM	Dimensions -Inches
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec	Lead	< 6	
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec	Selenium	< 6	
Rev MV Elec Dist Sys	P-24	SS-119A Transformer	Silver	< 6	132x170x114
Rev MV Elec Dist Sys	P-24	SS-119A Transformer	Arsenic	< 6	
Rev MV Elec Dist Sys	P-24	SS-119A Transformer	Barium	21,119	
Rev MV Elec Dist Sys	P-24	SS-119A Transformer	Cadmium	< 6	
Rev MV Elec Dist Sys	P-24	SS-119A Transformer	Chromium	751	
Rev MV Elec Dist Sys	P-24	SS-119A Transformer	Mercury	< 1	
Rev MV Elec Dist Sys	P-24	SS-119A Transformer	Lead	774	
Rev MV Elec Dist Sys	P-24	SS-119A Transformer	Selenium	< 6	
Rev MV Elec Dist Sys	P-25	SS-119A Secondary	Silver	< 6	331x170x114
Rev MV Elec Dist Sys	P-25	SS-119A Secondary	Arsenic	< 6	
Rev MV Elec Dist Sys	P-25	SS-119A Secondary	Barium	37,675	
Rev MV Elec Dist Sys	P-25	SS-119A Secondary	Cadmium	< 6	
Rev MV Elec Dist Sys	P-25	SS-119A Secondary	Chromium	< 15	
Rev MV Elec Dist Sys	P-25	SS-119A Secondary	Mercury	< 1	
Rev MV Elec Dist Sys	P-25	SS-119A Secondary	Lead	< 6	
Rev MV Elec Dist Sys	P-25	SS-119A Secondary	Selenium	< 6	
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec	Silver	< 6	103x35x112
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec	Arsenic	< 6	
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec	Barium	47,478	
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec	Cadmium	< 6	
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec	Chromium	< 15	
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec	Mercury	< 1	
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec	Lead	< 6	
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec	Selenium	< 6	
Rev MV Elec Dist Sys	P-27	SS-119B Transformer	Silver	< 6	144x90x98
Rev MV Elec Dist Sys	P-27	SS-119B Transformer	Arsenic	< 6	
Rev MV Elec Dist Sys	P-27	SS-119B Transformer	Barium	13,317	
Rev MV Elec Dist Sys	P-27	SS-119B Transformer	Cadmium	< 6	
Rev MV Elec Dist Sys	P-27	SS-119B Transformer	Chromium	4,623	
Rev MV Elec Dist Sys	P-27	SS-119B Transformer	Mercury	< 1	
Rev MV Elec Dist Sys	P-27	SS-119B Transformer	Lead	1,541	
Rev MV Elec Dist Sys	P-27	SS-119B Transformer	Selenium	< 6	
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply	Silver	< 6	103x35x112
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply	Arsenic	< 6	

Job Location	Sample No.	Sample Description	PeriodicName	PPM	Dimensions -Inches
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply	Barium	39,798	
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply	Cadmium	< 6	
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply	Chromium	< 16	
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply	Mercury	< 1	
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply	Lead	< 6	
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply	Selenium	< 6	

Paint Analysis for Total Metals- Eight (8) Metals
Project No.: **PCN 98860**
Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Processing Areas
Kennedy Space Center, FL

3.0 LABORATORY REPORTS

SCHNEIDER LABORATORIES GLOBAL

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LABORATORY ANALYSIS REPORT

ACCOUNT #: 1491-12-3168
CLIENT: PbO3 ENV TESTING & SERVICES INC
ADDRESS: 473 N PINE MEADOW DR
DEBARY, FL 32713
PROJECT NAME: URS
JOB LOCATION: Rev MV Elec Dist Sys
PROJECT NO.:
PO NO.:

DATE COLLECTED: 8/24/2012
DATE RECEIVED: 8/29/2012
DATE ANALYZED: 8/30/2012
DATE REPORTED: 8/31/2012
Sample Type: PAINT

SLI ID: 31592375 **Client ID:** P-08 **Description:** SS-B Primary Sec
Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	327	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	327	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	327	16.8	0.005	51	EPA 6010C	2.0
Cadmium (Cd)	327	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	327	< 5.0	< 0.002	< 15	EPA 6010C	5.0
Mercury (Hg)	106	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	327	37.32	0.011	114	EPA 6010C	2.00
Selenium (Se)	327	< 2.0	< 0.001	< 6	EPA 6010C	2.0

Total Number of Pages in Report: 10

Results relate only to samples as received by the laboratory.

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SLI ID: 31592376 **Client ID:** P-09 **Description:** SS-B Transformer

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	343	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	343	62.5	0.018	182	EPA 6010C	2.0
Barium (Ba)	343	2,362.6	0.689	6,888	EPA 6010C	2.0
Cadmium (Cd)	343	86.9	0.025	253	EPA 6010C	2.0
Chromium (Cr)	343	302.9	0.088	883	EPA 6010C	5.0
Mercury (Hg)	122	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	343	23,419.06	6.828	68,277	EPA 6010C	2.00
Selenium (Se)	343	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592377 **Client ID:** P-10 **Description:** SS-B Secondary

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	310	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	310	3.9	0.001	13	EPA 6010C	2.0
Barium (Ba)	310	141.6	0.046	457	EPA 6010C	2.0
Cadmium (Cd)	310	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	310	95.3	0.031	308	EPA 6010C	5.0
Mercury (Hg)	121	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	310	1,327.16	0.428	4,281	EPA 6010C	2.00
Selenium (Se)	310	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592378 **Client ID:** P-11 **Description:** SS-C Primary Sec

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	320	2.7	< 0.001	8	EPA 6010C	2.0
Arsenic (As)	320	58.3	0.018	182	EPA 6010C	2.0
Barium (Ba)	320	1,212.9	0.379	3,790	EPA 6010C	2.0
Cadmium (Cd)	320	54.6	0.017	171	EPA 6010C	2.0
Chromium (Cr)	320	26.5	0.008	83	EPA 6010C	5.0
Mercury (Hg)	166	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	320	20,841.29	6.513	65,129	EPA 6010C	2.00
Selenium (Se)	320	< 2.0	< 0.001	< 6	EPA 6010C	2.0

Total Number of Pages in Report: 10

Results relate only to samples as received by the laboratory.

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SLI ID: 31592379 **Client ID:** P-12 **Description:** SS-C Transformer

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	303	< 2.0	< 0.001	< 7	EPA 6010C	2.0
Arsenic (As)	303	< 2.0	< 0.001	< 7	EPA 6010C	2.0
Barium (Ba)	303	11.0	0.004	36	EPA 6010C	2.0
Cadmium (Cd)	303	< 2.0	< 0.001	< 7	EPA 6010C	2.0
Chromium (Cr)	303	18.3	0.006	60	EPA 6010C	5.0
Mercury (Hg)	115	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	303	1,094.80	0.361	3,613	EPA 6010C	2.00
Selenium (Se)	303	< 2.0	< 0.001	< 7	EPA 6010C	2.0

SLI ID: 31592380 **Client ID:** P-13 **Description:** SS-C Secondary

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	314	3.1	< 0.001	10	EPA 6010C	2.0
Arsenic (As)	314	92.5	0.029	295	EPA 6010C	2.0
Barium (Ba)	314	2,206.3	0.703	7,027	EPA 6010C	2.0
Cadmium (Cd)	314	70.3	0.022	224	EPA 6010C	2.0
Chromium (Cr)	314	182.3	0.058	581	EPA 6010C	5.0
Mercury (Hg)	130	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	314	35,048.26	11.162	111,619	EPA 6010C	2.00
Selenium (Se)	314	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592381 **Client ID:** P-14 **Description:** SS-D Primary Sec

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	322	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	322	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	322	9.0	0.003	28	EPA 6010C	2.0
Cadmium (Cd)	322	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	322	251.4	0.078	781	EPA 6010C	5.0
Mercury (Hg)	124	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	322	4,555.26	1.415	14,147	EPA 6010C	2.00
Selenium (Se)	322	< 2.0	< 0.001	< 6	EPA 6010C	2.0

Total Number of Pages in Report: 10

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SLI ID: 31592382 **Client ID:** P-15 **Description:** SS-D Transformer

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	351	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	351	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	351	12.2	0.003	35	EPA 6010C	2.0
Cadmium (Cd)	351	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	351	169.6	0.048	483	EPA 6010C	5.0
Mercury (Hg)	123	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	351	8.50	0.002	24	EPA 6010C	2.00
Selenium (Se)	351	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592383 **Client ID:** P-16 **Description:** SS-D Secondary

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	308	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	308	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	308	2.9	< 0.001	9	EPA 6010C	2.0
Cadmium (Cd)	308	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	308	227.0	0.074	737	EPA 6010C	5.0
Mercury (Hg)	121	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	308	3,885.72	1.262	12,616	EPA 6010C	2.00
Selenium (Se)	308	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592384 **Client ID:** P-17 **Description:** SS-E Primary Sec

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	330	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	330	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	330	13,270.7	4.021	40,214	EPA 6010C	2.0
Cadmium (Cd)	330	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	330	235.7	0.071	714	EPA 6010C	5.0
Mercury (Hg)	159	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	330	5,002.21	1.516	15,158	EPA 6010C	2.00
Selenium (Se)	330	< 2.0	< 0.001	< 6	EPA 6010C	2.0

Total Number of Pages in Report: 10

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SLI ID: 31592385 **Client ID:** P-18 **Description:** SS-E Transformer
Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	338	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	338	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	338	14,436.4	4.271	42,711	EPA 6010C	2.0
Cadmium (Cd)	338	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	338	148.0	0.044	438	EPA 6010C	5.0
Mercury (Hg)	146	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	338	2.31	< 0.001	7	EPA 6010C	2.00
Selenium (Se)	338	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592386 **Client ID:** P-19 **Description:** SS-E Secondary
Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	375	< 2.0	< 0.001	< 5	EPA 6010C	2.0
Arsenic (As)	375	< 2.0	< 0.001	< 5	EPA 6010C	2.0
Barium (Ba)	375	14,815.8	3.951	39,509	EPA 6010C	2.0
Cadmium (Cd)	375	< 2.0	< 0.001	< 5	EPA 6010C	2.0
Chromium (Cr)	375	473.2	0.126	1,262	EPA 6010C	5.0
Mercury (Hg)	162	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	375	7,833.56	2.089	20,889	EPA 6010C	2.00
Selenium (Se)	375	< 2.0	< 0.001	< 5	EPA 6010C	2.0

SLI ID: 31592387 **Client ID:** P-20 **Description:** SS-F Primary
Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	355	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	355	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	355	12,133.3	3.418	34,178	EPA 6010C	2.0
Cadmium (Cd)	355	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	355	1,232.5	0.347	3,472	EPA 6010C	5.0
Mercury (Hg)	124	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	355	21,239.82	5.983	59,830	EPA 6010C	2.00
Selenium (Se)	355	< 2.0	< 0.001	< 6	EPA 6010C	2.0

Total Number of Pages in Report: 10

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SLI ID: 31592388 **Client ID:** P-21 **Description:** SS-F Transformer

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	359	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	359	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	359	11,095.9	3.091	30,908	EPA 6010C	2.0
Cadmium (Cd)	359	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	359	161.6	0.045	450	EPA 6010C	5.0
Mercury (Hg)	139	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	359	39.17	0.011	109	EPA 6010C	2.00
Selenium (Se)	359	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592389 **Client ID:** P-22 **Description:** SS-F Secondary

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	338	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	338	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	338	13,795.3	4.081	40,814	EPA 6010C	2.0
Cadmium (Cd)	338	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	338	561.0	0.166	1,660	EPA 6010C	5.0
Mercury (Hg)	149	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	338	9,702.27	2.870	28,705	EPA 6010C	2.00
Selenium (Se)	338	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592390 **Client ID:** P-05 **Description:** SS-EE Primary Sec

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	306	< 2.0	< 0.001	< 7	EPA 6010C	2.0
Arsenic (As)	306	< 2.0	< 0.001	< 7	EPA 6010C	2.0
Barium (Ba)	306	855.7	0.280	2,797	EPA 6010C	2.0
Cadmium (Cd)	306	< 2.0	< 0.001	< 7	EPA 6010C	2.0
Chromium (Cr)	306	11.5	0.004	37	EPA 6010C	5.0
Mercury (Hg)	108	0.264	< 0.001	2	EPA 7471B	0.075
Lead (Pb)	306	2,610.72	0.853	8,532	EPA 6010C	2.00
Selenium (Se)	306	< 2.0	< 0.001	< 7	EPA 6010C	2.0

Total Number of Pages in Report: 10

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SLI ID: 31592391 **Client ID:** P-06 **Description:** SS-EE Transformer

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	317	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	317	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	317	211.4	0.067	667	EPA 6010C	2.0
Cadmium (Cd)	317	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	317	268.0	0.085	846	EPA 6010C	5.0
Mercury (Hg)	110	0.167	< 0.001	2	EPA 7471B	0.075
Lead (Pb)	317	1,618.69	0.511	5,106	EPA 6010C	2.00
Selenium (Se)	317	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592392 **Client ID:** P-07 **Description:** SS-EE Secondary Switch

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	310	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	310	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	310	86.0	0.028	278	EPA 6010C	2.0
Cadmium (Cd)	310	4.9	0.002	16	EPA 6010C	2.0
Chromium (Cr)	310	41.6	0.013	134	EPA 6010C	5.0
Mercury (Hg)	134	0.089	< 0.001	1	EPA 7471B	0.075
Lead (Pb)	310	682.08	0.220	2,200	EPA 6010C	2.00
Selenium (Se)	310	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592393 **Client ID:** P-01 **Description:** LBS-14

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	355	2.0	< 0.001	6	EPA 6010C	2.0
Arsenic (As)	355	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	355	11,542.9	3.252	32,515	EPA 6010C	2.0
Cadmium (Cd)	355	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	355	7.7	0.002	22	EPA 6010C	5.0
Mercury (Hg)	107	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	355	5.03	0.001	14	EPA 6010C	2.00
Selenium (Se)	355	< 2.0	< 0.001	< 6	EPA 6010C	2.0

Total Number of Pages In Report: 10

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SLI ID: 31592394 **Client ID:** P-02 **Description:** LBS-57
Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	359	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	359	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	359	2,430.0	0.677	6,769	EPA 6010C	2.0
Cadmium (Cd)	359	7.6	0.002	21	EPA 6010C	2.0
Chromium (Cr)	359	< 5.0	< 0.001	< 14	EPA 6010C	5.0
Mercury (Hg)	170	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	359	54.26	0.015	151	EPA 6010C	2.00
Selenium (Se)	359	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592395 **Client ID:** P-03 **Description:** LBS-58
Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	312	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	312	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	312	5,880.0	1.885	18,846	EPA 6010C	2.0
Cadmium (Cd)	312	3.0	< 0.001	10	EPA 6010C	2.0
Chromium (Cr)	312	< 5.0	< 0.002	< 16	EPA 6010C	5.0
Mercury (Hg)	147	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	312	26.12	0.008	84	EPA 6010C	2.00
Selenium (Se)	312	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592396 **Client ID:** P-23 **Description:** SS-119A Primary Sec
Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	347	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	347	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	347	11,915.0	3.434	34,337	EPA 6010C	2.0
Cadmium (Cd)	347	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	347	< 5.0	< 0.001	< 14	EPA 6010C	5.0
Mercury (Hg)	114	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	347	< 2.00	< 0.001	< 6	EPA 6010C	2.00
Selenium (Se)	347	< 2.0	< 0.001	< 6	EPA 6010C	2.0

Total Number of Pages in Report: 10

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SLI ID: 31592397 **Client ID:** P-24 **Description:** SS-119A Transformer

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	344	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	344	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	344	7,265.0	2.112	21,119	EPA 6010C	2.0
Cadmium (Cd)	344	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	344	258.5	0.075	751	EPA 6010C	5.0
Mercury (Hg)	113	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	344	266.25	0.077	774	EPA 6010C	2.00
Selenium (Se)	344	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592398 **Client ID:** P-25 **Description:** SS-119A Secondary

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	342	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	342	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	342	12,885.0	3.768	37,675	EPA 6010C	2.0
Cadmium (Cd)	342	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	342	< 5.0	< 0.001	< 15	EPA 6010C	5.0
Mercury (Hg)	119	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	342	< 2.00	< 0.001	< 6	EPA 6010C	2.00
Selenium (Se)	342	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592399 **Client ID:** P-26 **Description:** SS-119B Primary Sec

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	339	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	339	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	339	16,095.0	4.748	47,478	EPA 6010C	2.0
Cadmium (Cd)	339	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	339	< 5.0	< 0.001	< 15	EPA 6010C	5.0
Mercury (Hg)	165	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	339	< 2.00	< 0.001	< 6	EPA 6010C	2.00
Selenium (Se)	339	< 2.0	< 0.001	< 6	EPA 6010C	2.0

Total Number of Pages in Report: 10

Results relate only to samples as received by the laboratory.

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SLI ID: 31592400 **Client ID:** P-27 **Description:** SS-119B Transformer

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	309	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	309	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	309	4,115.0	1.332	13,317	EPA 6010C	2.0
Cadmium (Cd)	309	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	309	1,428.5	0.462	4,623	EPA 6010C	5.0
Mercury (Hg)	137	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	309	476.30	0.154	1,541	EPA 6010C	2.00
Selenium (Se)	309	< 2.0	< 0.001	< 6	EPA 6010C	2.0

SLI ID: 31592401 **Client ID:** P-28 **Description:** SS-119B DC Power Supply

Date Collected: 8/24/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	322	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Arsenic (As)	322	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Barium (Ba)	322	12,815.0	3.980	39,798	EPA 6010C	2.0
Cadmium (Cd)	322	< 2.0	< 0.001	< 6	EPA 6010C	2.0
Chromium (Cr)	322	< 5.0	< 0.002	< 16	EPA 6010C	5.0
Mercury (Hg)	121	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	322	< 2.00	< 0.001	< 6	EPA 6010C	2.00
Selenium (Se)	322	< 2.0	< 0.001	< 6	EPA 6010C	2.0

Analyst: ABISOLA O. KASALI

Total Number of Pages in Report: 10

Results relate only to samples as received by the laboratory.

Reviewed By **Derek L. Jackson, Analyst**

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*Soil samples are tested as received unless noted as "Dried before analysis." Equivalent units: PPM = mg/kg. **MRL=Minimum Reporting Limit. Quality Control data available upon request. Unusual sample conditions, if any, are described. All testing is performed in strict accordance with Schneider Laboratories, Inc. protocol.*

SCHNEIDER LABORATORIES GLOBAL

INCORPORATED

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LABORATORY ANALYSIS REPORT

ACCOUNT #: 1491-12-3155
CLIENT: PbO3 ENV TESTING & SERVICES INC
ADDRESS: 473 N PINE MEADOW DR
DEBARY, FL 32713
PROJECT NAME: URS
JOB LOCATION: Rev MV Elec Dist
PROJECT NO.: NASA
PO NO.:

DATE COLLECTED: 8/21/2012
DATE RECEIVED: 8/22/2012
DATE ANALYZED: 8/23/2012
DATE REPORTED: 8/23/2012
Sample Type: BULK

SLI ID: 31583160 **Client ID:** P04 **Description:** LBS-80
Date Collected: 8/21/2012

Analyte	Sample Wt(mg)	Total (µg)*	Conc. (% by wt)	Conc. PPM	Analysis Method	MRL** (µg)
Silver (Ag)	531	2.1	< 0.001	4	EPA 6010C	2.0
Arsenic (As)	531	< 2.0	< 0.001	< 4	EPA 6010C	2.0
Barium (Ba)	531	< 2.0	< 0.001	< 4	EPA 6010C	2.0
Cadmium (Cd)	531	< 2.0	< 0.001	< 4	EPA 6010C	2.0
Chromium (Cr)	531	11.0	0.002	21	EPA 6010C	5.0
Mercury (Hg)	153	< 0.075	< 0.001	< 1	EPA 7471B	0.075
Lead (Pb)	531	15.3	0.003	29	EPA 6010C	2.0
Selenium (Se)	531	< 2.0	< 0.001	< 4	EPA 6010C	2.0

Analyst: MARTI H. BAIRD

Total Number of Pages in Report: 1

Results relate only to samples as received by the laboratory.

Reviewed By **Derek L. Jackson, Analyst**

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*Soil samples are tested as received unless noted as "Dried before analysis." Equivalent units: PPM = mg/kg. **MRL=Minimum Reporting Limit. Quality Control data available upon request. *Data precision justifies 2 significant figures. Unusual sample conditions, if any, are described. All testing is performed in strict accordance with Schneider Laboratories, Inc. protocol.*

1491-12-3154

79K39136 REV A

SAMPLE LOG

PbO3 ENVIRONMENTAL, INC.
473 N. PINE MEADOW DR.
DEBARY, FL. 32713
Phone 386-668-4545
Fax 386-668-4566
Pbo3@comcast.net

5 day TAT

PROJECT NAME: URS
JOB LOCATION: Rev. MV. Elec. Dist. Sys.
PROJECT #: NASA
PO NO.:
DATE: 8/21/12

RCRA 8 Totals & PCBs 1 OF ___
SAMPLE LOG
ASBESTOS ____ LEAD ____ OTHER X

SAMPLE NUMBER	DESCRIPTION	LOCATION
P04	WBS-80	94" x 24" x 88"
	Kpm 8/21/12	

WorkOrderKey
V: \ 905 \ 905274

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AUG 22 2012
BY: [illegible] 9:50

URS

5059

1491-12-3166

SAMPLE LOG

79K39136 REV A

PbO3 ENVIRONMENTAL, INC.
473 N. PINE MEADOW DR.
DEBARY, FL. 32713
Phone 386-668-4545
Fax 386-668-4566
Pbo3@comcast.net

5 day TAT

PROJECT NAME: URS
JOB LOCATION: Rev. MV. Elec. Dist. Sys.
PROJECT #:
PO NO.:
DATE: 8/24/12

RCRA8 & PCB's 1 OF 2
SAMPLE LOG
ASBESTOS _____ LEAD _____ OTHER X

SAMPLE NUMBER	DESCRIPTION	LOCATION
P-08	SS-B Primary Sec.	80X108X104
P-09	SS-B Transformer	75X60X90
P-10	SS-B Secondary	77X63X108
P-11	SS-C Primary Sec.	81X108X104
P-12	SS-C Transformer	75X60X90
P-13	SS-C Secondary	77X63X108
P-14	SS-D Primary Sec	80X108X104
P-15	SS-D Transformer	76X61X90
P-16	SS-D Secondary	77X63X108
P-17	SS-E Primary Sec	81X108X104
P-18	SS-E Transformer	76X60X90
P-19	SS-E Secondary	77X63X108
P-20	SS-F Primary	81X108X104
P-21	SS-F Transformer	76X60X90
P-22	SS-F Secondary	77X63X108
P-05	SS-EE Primary Sec.	114X88X90
P-06	SS-EE Transformer	54X63X58
P-07	SS-EE Secondary switchgear	80X60X90
P-01	LBS-14	70X23X75
P-02	LBS-57	80X23X73
P-03	LBS-58	80X23X73

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URS

1491-12-31666

SAMPLE LOG

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PbO3 ENVIRONMENTAL, INC.
473 N. PINE MEADOW DR.
DEBARY, FL. 32713
Phone 386-668-4545
Fax 386-668-4566
Pbo3@comcast.net

5day TAT

PROJECT NAME: URS
JOB LOCATION: Rev. MV. Elec. Dist. System
PROJECT #:
PO NO.:
DATE: 8/28/12

RCRA & Total & PCBs 2 OF 2
SAMPLE LOG
ASBESTOS _____ LEAD _____ OTHER X

SAMPLE NUMBER	DESCRIPTION	LOCATION Inches
P-23	SS-119A Primary Sec.	102 x 36 x 113
P-24	SS-119A Transformer	132 x 144 x 96
P-25	SS-119A Secondary	331 x 170 x 114
P-26	SS-119B Primary Sec.	103 x 35 x 112
P-27	SS-119B Transformer	144 x 90 x 98
P-28	SS-119B DC Power Supply	103 x 35 x 112
	[signature] 8/28/12	

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BY: [signature] 10:39

UPS

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PbO_3 INCORPORATED *ENVIRONMENTAL TESTING & SVC. CO.*

Report No: PCB -811-09-04-12-12

September 4, 2012

Client: URS Corporation
7650 W. Courtney Campbell Causeway
Tampa, FL 33607

Attn: John J. Calamari, P.E.
Senior Project Manager

Project: Polychlorinated Biphenyl (PCB) Testing – Paint Chip Samples
Project No.: **PCN 98860**
Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Processing Areas
Kennedy Space Center, FL

According to your instructions ***PbO_3*** Environmental Testing & Service Co., Inc. has completed a limited PCB testing survey at the subject property (Project). The following pages of this report contain the results of this testing. This limited PCB testing report presents data that describes the location of the Polychlorinated Biphenyl's (PCB's) identified only within the project scope. This report is to be used as a program-planning tool for the proposed renovation activities scheduled at this facility. This survey was conducted on site by Florida EPA Certified Lead-Based Paint Risk Assessor and EPA/AHERA trained Asbestos Inspector.

This report is intended for the exclusive use of our client. The findings are relevant to the conditions observed during the physical process of performing the Inspection. These findings should not be treated as absolute nor should they be relied upon to represent conditions at significantly later dates.

PbO_3 Environmental Testing & Service Co., Inc.

Dave Mederer
Project Manager

473 N. PINE MEADOW DR. DeBARY, FL 32713 386.668.4545 Fax 386.668.4566

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1.0 EXECUTIVE SUMMARY

Sample Collection Dates

August 21st, 24th & 28th 2012

State Licenses and/or Certifications

U.S. EPA Certified Lead-Based Paint Activities Firm No. FL-2418-2
Asbestos License # ZA 0000205

Inspector:

Kevin O'Malley, Florida EPA Certified Lead-Based Paint Risk Assessor FL-R-345-3
Asbestos Building Inspector Certification No. 154429

Polychlorinated Biphenyl (PCB) paint chip samples were collected from the following component(s):

Job Location	Sample No.	Sample Description
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec
Rev MV Elec Dist Sys	P-09	SS-B Transformer
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec
Rev MV Elec Dist Sys	P-10	SS-B Secondary
Rev MV Elec Dist Sys	P-06	SS-EE Transformer
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec
Rev MV Elec Dist Sys	P-13	SS-C Secondary
Rev MV Elec Dist Sys	P-22	SS-F Secondary
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec
Rev MV Elec Dist Sys	P-12	SS-C Transformer
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch
Rev MV Elec Dist Sys	P-19	SS-E Secondary
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec

Job Location	Sample No.	Sample Description
Rev MV Elec Dist Sys	P-20	SS-F Primary
Rev MV Elec Dist Sys	P-01	LBS-14
Rev MV Elec Dist Sys	P-02	LBS-57
Rev MV Elec Dist Sys	P-03	LBS-58
Rev MV Elec Dist Sys	P-04	LBS-80
Rev MV Elec Dist Sys	P-15	SS-D Transformer
Rev MV Elec Dist Sys	P-16	SS-D Secondary
Rev MV Elec Dist Sys	P-18	SS-E Transformer
Rev MV Elec Dist Sys	P-21	SS-F Transformer
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec
Rev MV Elec Dist Sys	P-24	SS-119A Transformer
Rev MV Elec Dist Sys	P-25	SS-119A Secondary
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec
Rev MV Elec Dist Sys	P-27	SS-119B Transformer
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply

Overview

According to your instructions PbO_3 Environmental Testing & Service Co., Inc. has collected twenty-eight (28) representative paint chip samples of exposed painted components as designated by our client.

The samples were analyzed by Method SW846 8082 for Polychlorinated Biphenyls (PCBs).

Based upon our visual observations, bulk sampling of suspect materials, and subsequent laboratory analysis, we have determined that PCB's were detected in seven (7) component paint chip samples.

Job Location	Sample No.	Sample Description	Dimensions -Inches	Aroclor-1254	PCBs ≥ 50 ppm
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec	80x108x104	1,434.032 ppm	Yes
Rev MV Elec Dist Sys	P-09	SS-B Transformer	75x60x90	3,697.446 ppm	Yes
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec	81x108x104	4,083.373 ppm	Yes
Rev MV Elec Dist Sys	P-10	SS-B Secondary	77x63x108	5,322.713 ppm	Yes
Rev MV Elec Dist Sys	P-06	SS-EE Transformer	54x53x58	53.393 ppm	Yes
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec	114x88x90	67.689 ppm	Yes
Rev MV Elec Dist Sys	P-13	SS-C Secondary	77x63x108	8,044.810 ppm	Yes

All materials with PCB concentrations greater than or equal to 50 ppm are regulated by and shall be managed in accordance with the requirements specified in 40 CFR 761. Requirements for managing and disposing of PCBs are found in Kennedy NASA Procedural Requirements (KNPR) 8500.1 Chapter 19.

2.0 DETAILED FINDINGS

Job Location	Sample No.	Sample Description	Dimensions - Inches	Aroclor-1254	PCBs ≥ 50 ppm
Rev MV Elec Dist Sys	P-08	SS-B Primary Sec	80x108x104	1,434.032 ppm	Yes
Rev MV Elec Dist Sys	P-09	SS-B Transformer	75x60x90	3,697.446 ppm	Yes
Rev MV Elec Dist Sys	P-11	SS-C Primary Sec	81x108x104	4,083.373 ppm	Yes
Rev MV Elec Dist Sys	P-10	SS-B Secondary	77x63x108	5,322.713 ppm	Yes
Rev MV Elec Dist Sys	P-06	SS-EE Transformer	54x53x58	53.393 ppm	Yes
Rev MV Elec Dist Sys	P-05	SS-EE Primary Sec	114x88x90	67.689 ppm	Yes
Rev MV Elec Dist Sys	P-13	SS-C Secondary	77x63x108	8,044.810 ppm	Yes
Rev MV Elec Dist Sys	P-22	SS-F Secondary	77x63x108	0.644 ppm	No
Rev MV Elec Dist Sys	P-14	SS-D Primary Sec	80x108x104	11.407 ppm	No
Rev MV Elec Dist Sys	P-12	SS-C Transformer	75x60x90	13.335 ppm	No
Rev MV Elec Dist Sys	P-07	SS-EE Secondary Switch	80x60x90	23.351 ppm	No
Rev MV Elec Dist Sys	P-19	SS-E Secondary	77x63x108	3.513 ppm	No
Rev MV Elec Dist Sys	P-17	SS-E Primary Sec	81x108x104	9.536 ppm	No
Rev MV Elec Dist Sys	P-20	SS-F Primary	81x108x104	9.889 ppm	No
Rev MV Elec Dist Sys	P-01	LBS-14	70x23x75	BQL	No
Rev MV Elec Dist Sys	P-02	LBS-57	80x23x73	BQL	No
Rev MV Elec Dist Sys	P-03	LBS-58	80x23x73	BQL	No
Rev MV Elec Dist Sys	P-04	LBS-80	94x24x88	BQL	No
Rev MV Elec Dist Sys	P-15	SS-D Transformer	76x61x90	BQL	No
Rev MV Elec Dist Sys	P-16	SS-D Secondary	77x63x108	BQL	No
Rev MV Elec Dist Sys	P-18	SS-E Transformer	76x60x90	BQL	No
Rev MV Elec Dist Sys	P-21	SS-F Transformer	76x60x90	BQL	No
Rev MV Elec Dist Sys	P-23	SS-119A Primary Sec	102x36x113	BQL	No
Rev MV Elec Dist Sys	P-24	SS-119A Transformer	132x170x114	BQL	No
Rev MV Elec Dist Sys	P-25	SS-119A Secondary	331x170x114	BQL	No
Rev MV Elec Dist Sys	P-26	SS-119B Primary Sec	103x35x112	BQL	No
Rev MV Elec Dist Sys	P-27	SS-119B Transformer	144x90x98	BQL	No
Rev MV Elec Dist Sys	P-28	SS-119B DC Power Supply	103x35x112	BQL	No

BQL =Below Quantitation Limit

3.0 LABORATORY REPORTS

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-B Primary Sec	**SLI Sample No.:**	31592335	
		Client Sample No.:	P-08	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	87298	µg/kg	200	8/31/2012	THN
Aroclor - 1221	BQL	87298	µg/kg	200	8/31/2012	THN
Aroclor - 1232	BQL	87298	µg/kg	200	8/31/2012	THN
Aroclor - 1242	BQL	87298	µg/kg	200	8/31/2012	THN
Aroclor - 1248	BQL	87298	µg/kg	200	8/31/2012	THN
Aroclor - 1254	1434032	87298	µg/kg	200	8/31/2012	THN
Aroclor - 1260	BQL	87298	µg/kg	200	8/31/2012	THN
Aroclor - 1268	BQL	87298	µg/kg	200	8/31/2012	THN
Aroclor - 1262	BQL	87298	µg/kg	200	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	36%
TCMX	99%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-B Transformer	**SLI Sample No.:**	31592336	
		Client Sample No.:	P-09	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	481928	µg/kg	1000	8/31/2012	THN
Aroclor - 1221	BQL	481928	µg/kg	1000	8/31/2012	THN
Aroclor - 1232	BQL	481928	µg/kg	1000	8/31/2012	THN
Aroclor - 1242	BQL	481928	µg/kg	1000	8/31/2012	THN
Aroclor - 1248	BQL	481928	µg/kg	1000	8/31/2012	THN
Aroclor - 1254	3697446	481928	µg/kg	1000	8/31/2012	THN
Aroclor - 1260	BQL	481928	µg/kg	1000	8/31/2012	THN
Aroclor - 1268	BQL	481928	µg/kg	1000	8/31/2012	THN
Aroclor - 1262	BQL	481928	µg/kg	1000	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	D
TCMX	D

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-B Secondary	**SLI Sample No.:**	31592337	
		Client Sample No.:	P-10	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	464468	µg/kg	1000	8/31/2012	THN
Aroclor - 1221	BQL	464468	µg/kg	1000	8/31/2012	THN
Aroclor - 1232	BQL	464468	µg/kg	1000	8/31/2012	THN
Aroclor - 1242	BQL	464468	µg/kg	1000	8/31/2012	THN
Aroclor - 1248	BQL	464468	µg/kg	1000	8/31/2012	THN
Aroclor - 1254	5322713	464468	µg/kg	1000	8/31/2012	THN
Aroclor - 1260	BQL	464468	µg/kg	1000	8/31/2012	THN
Aroclor - 1268	BQL	464468	µg/kg	1000	8/31/2012	THN
Aroclor - 1262	BQL	464468	µg/kg	1000	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	D
TCMX	D

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-C Primary Sec	**SLI Sample No.:**	31592338	
		Client Sample No.:	P-11	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	388440	µg/kg	1000	8/31/2012	THN
Aroclor - 1221	BQL	388440	µg/kg	1000	8/31/2012	THN
Aroclor - 1232	BQL	388440	µg/kg	1000	8/31/2012	THN
Aroclor - 1242	BQL	388440	µg/kg	1000	8/31/2012	THN
Aroclor - 1248	BQL	388440	µg/kg	1000	8/31/2012	THN
Aroclor - 1254	4082373	388440	µg/kg	1000	8/31/2012	THN
Aroclor - 1260	BQL	388440	µg/kg	1000	8/31/2012	THN
Aroclor - 1268	BQL	388440	µg/kg	1000	8/31/2012	THN
Aroclor - 1262	BQL	388440	µg/kg	1000	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	D
TCMX	97%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-C Transformer	**SLI Sample No.:**	31592339	
		Client Sample No.:	P-12	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	11547	µg/kg	20	8/31/2012	THN
Aroclor - 1221	BQL	11547	µg/kg	20	8/31/2012	THN
Aroclor - 1232	BQL	11547	µg/kg	20	8/31/2012	THN
Aroclor - 1242	BQL	11547	µg/kg	20	8/31/2012	THN
Aroclor - 1248	BQL	11547	µg/kg	20	8/31/2012	THN
Aroclor - 1254	13335	11547	µg/kg	20	8/31/2012	THN
Aroclor - 1260	BQL	11547	µg/kg	20	8/31/2012	THN
Aroclor - 1268	BQL	11547	µg/kg	20	8/31/2012	THN
Aroclor - 1262	BQL	11547	µg/kg	20	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	D
TCMX	D

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-C Secondary	**SLI Sample No.:**	31592340	
		Client Sample No.:	P-13	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	377758	µg/kg	1000	8/31/2012	THN
Aroclor - 1221	BQL	377758	µg/kg	1000	8/31/2012	THN
Aroclor - 1232	BQL	377758	µg/kg	1000	8/31/2012	THN
Aroclor - 1242	BQL	377758	µg/kg	1000	8/31/2012	THN
Aroclor - 1248	BQL	377758	µg/kg	1000	8/31/2012	THN
Aroclor - 1254	8044810	377758	µg/kg	1000	8/31/2012	THN
Aroclor - 1260	BQL	377758	µg/kg	1000	8/31/2012	THN
Aroclor - 1268	BQL	377758	µg/kg	1000	8/31/2012	THN
Aroclor - 1262	BQL	377758	µg/kg	1000	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	D
TCMX	101%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				

Sample Description: SS-D Primary Sec

SLI Sample No.: 31592341
Client Sample No.: P-14

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	4352	µg/kg	10	8/31/2012	THN
Aroclor - 1221	BQL	4352	µg/kg	10	8/31/2012	THN
Aroclor - 1232	BQL	4352	µg/kg	10	8/31/2012	THN
Aroclor - 1242	BQL	4352	µg/kg	10	8/31/2012	THN
Aroclor - 1248	BQL	4352	µg/kg	10	8/31/2012	THN
Aroclor - 1254	11407	4352	µg/kg	10	8/31/2012	THN
Aroclor - 1260	BQL	4352	µg/kg	10	8/31/2012	THN
Aroclor - 1268	BQL	4352	µg/kg	10	8/31/2012	THN
Aroclor - 1262	BQL	4352	µg/kg	10	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	D
TCMX	D

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				

Sample Description: SS-D Transformer

SLI Sample No.: 31592342

Client Sample No.: P-15

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	426	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	426	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	426	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	426	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	426	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	426	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	426	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	426	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	426	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	133%
TCMX	80%

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-D Secondary	**SLI Sample No.:**	31592343	
		Client Sample No.:	P-16	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	485	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	485	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	485	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	485	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	485	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	485	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	485	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	485	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	485	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	78%
TCMX	94%

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				

Sample Description: SS-E Primary Sec

SLI Sample No.: 31592344

Client Sample No.: P-17

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	3725	µg/kg	10	8/31/2012	THN
Aroclor - 1221	BQL	3725	µg/kg	10	8/31/2012	THN
Aroclor - 1232	BQL	3725	µg/kg	10	8/31/2012	THN
Aroclor - 1242	BQL	3725	µg/kg	10	8/31/2012	THN
Aroclor - 1248	BQL	3725	µg/kg	10	8/31/2012	THN
Aroclor - 1254	9536	3725	µg/kg	10	8/31/2012	THN
Aroclor - 1260	BQL	3725	µg/kg	10	8/31/2012	THN
Aroclor - 1268	BQL	3725	µg/kg	10	8/31/2012	THN
Aroclor - 1262	BQL	3725	µg/kg	10	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	113%
TCMX	97%

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-E Transformer	**SLI Sample No.:**	31592345	
		Client Sample No.:	P-18	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	406	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	406	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	406	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	406	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	406	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	406	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	406	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	406	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	406	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	129%
TCMX	87%

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-E Secondary	**SLI Sample No.:**	31592346	
		Client Sample No.:	P-19	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	403	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	403	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	403	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	403	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	403	µg/kg	1	8/31/2012	THN
Aroclor - 1254	3513	403	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	403	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	403	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	403	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	117%
TCMX	103%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				

Sample Description: SS-F Primary

SLI Sample No.: 31592347

Client Sample No.: P-20

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	6867	µg/kg	20	8/31/2012	THN
Aroclor - 1221	BQL	6867	µg/kg	20	8/31/2012	THN
Aroclor - 1232	BQL	6867	µg/kg	20	8/31/2012	THN
Aroclor - 1242	BQL	6867	µg/kg	20	8/31/2012	THN
Aroclor - 1248	BQL	6867	µg/kg	20	8/31/2012	THN
Aroclor - 1254	9889	6867	µg/kg	20	8/31/2012	THN
Aroclor - 1260	BQL	6867	µg/kg	20	8/31/2012	THN
Aroclor - 1268	BQL	6867	µg/kg	20	8/31/2012	THN
Aroclor - 1262	BQL	6867	µg/kg	20	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	128%
TCMX	105%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-F Transformer	**SLI Sample No.:**	31592348	
		Client Sample No.:	P-21	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	405	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	405	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	405	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	405	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	405	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	405	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	405	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	405	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	405	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	127%
TCMX	103%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				

Sample Description: SS-F Secondary

SLI Sample No.: 31592349
Client Sample No.: P-22

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	448	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	448	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	448	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	448	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	448	µg/kg	1	8/31/2012	THN
Aroclor - 1254	644	448	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	448	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	448	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	448	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	130%
TCMX	108%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-EE Primary Sec	**SLI Sample No.:**	31592350	
		Client Sample No.:	P-05	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	8997	µg/kg	20	8/31/2012	THN
Aroclor - 1221	BQL	8997	µg/kg	20	8/31/2012	THN
Aroclor - 1232	BQL	8997	µg/kg	20	8/31/2012	THN
Aroclor - 1242	BQL	8997	µg/kg	20	8/31/2012	THN
Aroclor - 1248	BQL	8997	µg/kg	20	8/31/2012	THN
Aroclor - 1254	67689	8997	µg/kg	20	8/31/2012	THN
Aroclor - 1260	BQL	8997	µg/kg	20	8/31/2012	THN
Aroclor - 1268	BQL	8997	µg/kg	20	8/31/2012	THN
Aroclor - 1262	BQL	8997	µg/kg	20	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	96%
TCMX	112%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-EE Transformer	**SLI Sample No.:**	31592351	
		Client Sample No.:	P-06	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	51546	µg/kg	100	8/31/2012	THN
Aroclor - 1221	BQL	51546	µg/kg	100	8/31/2012	THN
Aroclor - 1232	BQL	51546	µg/kg	100	8/31/2012	THN
Aroclor - 1242	BQL	51546	µg/kg	100	8/31/2012	THN
Aroclor - 1248	BQL	51546	µg/kg	100	8/31/2012	THN
Aroclor - 1254	53393	51546	µg/kg	100	8/31/2012	THN
Aroclor - 1260	BQL	51546	µg/kg	100	8/31/2012	THN
Aroclor - 1268	BQL	51546	µg/kg	100	8/31/2012	THN
Aroclor - 1262	BQL	51546	µg/kg	100	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	83%
TCMX	70%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				

Sample Description: SS-EE Secondary Switch

SLI Sample No.: 31592352

Client Sample No.: P-07

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	7046	µg/kg	20	8/31/2012	THN
Aroclor - 1221	BQL	7046	µg/kg	20	8/31/2012	THN
Aroclor - 1232	BQL	7046	µg/kg	20	8/31/2012	THN
Aroclor - 1242	BQL	7046	µg/kg	20	8/31/2012	THN
Aroclor - 1248	BQL	7046	µg/kg	20	8/31/2012	THN
Aroclor - 1254	23351	7046	µg/kg	20	8/31/2012	THN
Aroclor - 1260	BQL	7046	µg/kg	20	8/31/2012	THN
Aroclor - 1268	BQL	7046	µg/kg	20	8/31/2012	THN
Aroclor - 1262	BQL	7046	µg/kg	20	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	118%
TCMX	109%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	LBS-14	**SLI Sample No.:**	31592353	
		Client Sample No.:	P-01	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	488	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	488	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	488	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	488	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	488	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	488	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	488	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	488	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	488	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	39%
TCMX	58%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				

Sample Description: LBS-57

SLI Sample No.: 31592354
Client Sample No.: P-02

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	283	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	283	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	283	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	283	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	283	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	283	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	283	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	283	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	283	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	51%
TCMX	52%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

All samples for organics testing should be shipped in cool conditions, 1 to 6°C. Quality Control Data available upon request. *Data precision justifies 2 significant figures. Sample concentrations below the Quantitation Limit are noted as BQL (Below Quantitation Limit) or ND (None Detected) or with a "less than" (<) sign. Values designated with a "B" indicate presence of the analyte in the laboratory blank at a concentration above the Quantitation Limit. Surrogate Spike results designated with "D" indicate that the analyte was diluted out. "MI" indicates matrix interference. Soil results are reported on a dry weight basis. Results relate only to samples as received by the laboratory. Unusual sample conditions, if any, are described. All testing is done in strict accordance with SLI. protocol. Visit www.slabinc.com for current certifications.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	LBS-58	**SLI Sample No.:**	31592355	
		Client Sample No.:	P-03	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	316	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	316	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	316	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	316	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	316	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	316	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	316	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	316	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	316	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	55%
TCMX	53%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3154	**Date/Time Collected:**	8/21/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/22/2012	9:20 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	8/29/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	BULK	
Project No.:	NASA			
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	**LBS-80**	**SLI Sample No.:**	31583120	
		Client Sample No.:	P04	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1221	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1232	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1242	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1248	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1254	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1260	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1268	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1262	BQL	486	µg/kg	1	8/29/2012	APS

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	26%
TCMX	52%

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				

Sample Description: SS-119A Primary Sec

SLI Sample No.: 31592356

Client Sample No.: P-23

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	420	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	420	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	420	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	420	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	420	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	420	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	420	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	420	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	420	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	50%
TCMX	50%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-119A Transformer	**SLI Sample No.:**	31592357	
		Client Sample No.:	P-24	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	393	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	393	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	393	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	393	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	393	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	393	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	393	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	393	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	393	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	46%
TCMX	49%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-119A Secondary	**SLI Sample No.:**	31592358	
		Client Sample No.:	P-25	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	467	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	467	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	467	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	467	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	467	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	467	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	467	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	467	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	467	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	38%
TCMX	48%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-119B Primary Sec	**SLI Sample No.:**	31592359	
		Client Sample No.:	P-26	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	340	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	340	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	340	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	340	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	340	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	340	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	340	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	340	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	340	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	38%
TCMX	52%

Reviewed By: Mandapi Mishra, Organics QC Rep.

All samples for organics testing should be shipped in cool conditions, 1 to 6°C. Quality Control Data available upon request. *Data precision justifies 2 significant figures. Sample concentrations below the Quantitation Limit are noted as BQL (Below Quantitation Limit) or ND (None Detected) or with a "less than" (<) sign. Values designated with a "B" indicate presence of the analyte in the laboratory blank at a concentration above the Quantitation Limit. Surrogate Spike results designated with "D" indicate that the analyte was diluted out. "MI" indicates matrix interference. Soil results are reported on a dry weight basis. Results relate only to samples as received by the laboratory. Unusual sample conditions, if any, are described. All testing is done in strict accordance with SLI. protocol. Visit www.slabinc.com for current certifications.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-119B Transformer	**SLI Sample No.:**	31592360	
		Client Sample No.:	P-27	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	370	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	370	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	370	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	370	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	370	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	370	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	370	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	370	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	370	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	38%
TCMX	43%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3166	**Date/Time Collected:**	8/24/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/29/2012	10:30 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	9/5/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	SOLID	
Project No.:				
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	SS-119B DC Power Supply	**SLI Sample No.:**	31592361	
		Client Sample No.:	P-28	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	386	µg/kg	1	8/31/2012	THN
Aroclor - 1221	BQL	386	µg/kg	1	8/31/2012	THN
Aroclor - 1232	BQL	386	µg/kg	1	8/31/2012	THN
Aroclor - 1242	BQL	386	µg/kg	1	8/31/2012	THN
Aroclor - 1248	BQL	386	µg/kg	1	8/31/2012	THN
Aroclor - 1254	BQL	386	µg/kg	1	8/31/2012	THN
Aroclor - 1260	BQL	386	µg/kg	1	8/31/2012	THN
Aroclor - 1268	BQL	386	µg/kg	1	8/31/2012	THN
Aroclor - 1262	BQL	386	µg/kg	1	8/31/2012	THN

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	45%
TCMX	52%

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

All samples for organics testing should be shipped in cool conditions, 1 to 6°C. Quality Control Data available upon request. *Data precision justifies 2 significant figures. Sample concentrations below the Quantitation Limit are noted as BQL (Below Quantitation Limit) or ND (None Detected) or with a "less than" (<) sign. Values designated with a "B" indicate presence of the analyte in the laboratory blank at a concentration above the Quantitation Limit. Surrogate Spike results designated with "D" indicate that the analyte was diluted out. "MI" indicates matrix interference. Soil results are reported on a dry weight basis. Results relate only to samples as received by the laboratory. Unusual sample conditions, if any, are described. All testing is done in strict accordance with SLI. protocol. Visit www.slabinc.com for current certifications.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3154	**Date/Time Collected:**	8/21/2012	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/22/2012	9:20 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	8/29/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	URS	**Sample Matrix:**	BULK	
Project No.:	NASA			
Job Location:	Rev MV Elec Dist Sys			
P.O.#:				
Sample Description:	LBS-80	**SLI Sample No.:**	31583120	
		Client Sample No.:	P04	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1221	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1232	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1242	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1248	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1254	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1260	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1268	BQL	486	µg/kg	1	8/29/2012	APS
Aroclor - 1262	BQL	486	µg/kg	1	8/29/2012	APS

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	26%
TCMX	52%

Reviewed By: Mandapi Mishra, Organics QC Rep.

All samples for organics testing should be shipped in cool conditions, 1 to 6°C. Quality Control Data available upon request. *Data precision justifies 2 significant figures. Sample concentrations below the Quantitation Limit are noted as BQL (Below Quantitation Limit) or ND (None Detected) or with a "less than" (<) sign. Values designated with a "B" indicate presence of the analyte in the laboratory blank at a concentration above the Quantitation Limit. Surrogate Spike results designated with "D" indicate that the analyte was diluted out. "MI" indicates matrix interference. Soil results are reported on a dry weight basis. Results relate only to samples as received by the laboratory. Unusual sample conditions, if any, are described. All testing is done in strict accordance with SLI. protocol. Visit www.slabinc.com for current certifications.

1491-12-3154

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SAMPLE LOG

PbO3 ENVIRONMENTAL, INC.
473 N. PINE MEADOW DR.
DEBARY, FL. 32713
Phone 386-668-4545
Fax 386-668-4566
Pbo3@comcast.net

5dayTAT

PROJECT NAME: URS
JOB LOCATION: Rev. MV. Elec. Dist. Sys.
PROJECT #: NASA
PO NO.:
DATE: 8/21/12

RCRA 8 Totals & PCBs 1 OF ___

SAMPLE LOG

ASBESTOS ____ LEAD ____ OTHER X

SAMPLE NUMBER	DESCRIPTION	LOCATION
P04	WBS-80	94" x 24" x 88"
	Kpm 8/21/12	

WorkOrderKey
V: \ 905 \ 905274

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BY

URS

5 of 9

1491-12-3166

SAMPLE LOG

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PbO3 ENVIRONMENTAL, INC.
473 N. PINE MEADOW DR.
DEBARY, FL. 32713
Phone 386-668-4545
Fax 386-668-4566
Pbo3@comcast.net

5 day TAT

PROJECT NAME: URS
JOB LOCATION: Rev. MV. Elec. Dist. Sys.
PROJECT #:
PO NO.:
DATE: 8/24/12

RCRA8 & PCB's 1 OF 2
SAMPLE LOG
ASBESTOS _____ LEAD _____ OTHER X

SAMPLE NUMBER	DESCRIPTION	LOCATION
P-08	SS-B Primary Sec.	80 X 108 X 104
P-09	SS-B Transformer	75 X 60 X 90
P-10	SS-B Secondary	77 X 63 X 108
P-11	SS-C Primary Sec.	81 X 108 X 104
P-12	SS-C Transformer	75 X 60 X 90
P-13	SS-C Secondary	77 X 63 X 108
P-14	SS-D Primary Sec	80 X 108 X 104
P-15	SS-D Transformer	76 X 61 X 90
P-16	SS-D Secondary	77 X 63 X 108
P-17	SS-E Primary Sec	81 X 108 X 104
P-18	SS-E Transformer	76 X 60 X 90
P-19	SS-E Secondary	77 X 63 X 108
P-20	SS-F Primary	81 X 108 X 104
P-21	SS-F Transformer	76 X 60 X 90
P-22	SS-F Secondary	77 X 63 X 108
P-05	SS-EE Primary Sec.	114 X 88 X 90
P-06	SS-EE Transformer	54 X 63 X 58
P-07	SS-EE Secondary switchgear	80 X 60 X 90
P-01	LBS-14	70 X 23 X 75
P-02	LBS-57	80 X 23 X 73
P-03	LBS-58	80 X 23 X 73

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URS

1491-12-31666

SAMPLE LOG

PbO3 ENVIRONMENTAL, INC.
473 N. PINE MEADOW DR.
DEBARY, FL. 32713
Phone 386-668-4545
Fax 386-668-4566
Pbo3@comcast.net

5day TAT

79K39136 REV A

PROJECT NAME: URS
JOB LOCATION: Rev. MV. Elec. Dist. System
PROJECT #:
PO NO.:
DATE: 8/28/12

RCRA 8 Total + PCBs 2 OF 2
SAMPLE LOG
ASBESTOS _____ LEAD _____ OTHER X

SAMPLE NUMBER	DESCRIPTION	LOCATION Inches
P-23	SS-119A Primary Sec.	102 x 36 x 113
P-24	SS-119A Transformer	132 x 144 x 96
P-25	SS-119A Secondary	331 x 170 x 114
P-26	SS-119B Primary Sec.	103 x 35 x 112
P-27	SS-119B Transformer	144 x 90 x 98
P-28	SS-119B DC Power Supply	103 x 35 x 112
	[signature] 8/28/12	

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BY: [signature] 10:39

UPS

PbO_3 INCORPORATED *ENVIRONMENTAL TESTING & SVC. CO.*

Report No: PCB -811-09-04-12-11

September 4, 2012

Client: URS Corporation
7650 W. Courtney Campbell Causeway
Tampa, FL 33607

Attn: John J. Calamari, P.E.
Senior Project Manager

Project: Polychlorinated Biphenyl (PCB) Testing – Transformer Oil
Project No.: **PCN 98860**
Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Processing Areas
Kennedy Space Center, FL

According to your instructions ***PbO_3*** Environmental Testing & Service Co., Inc. has completed a limited PCB testing survey at the subject property (Project). The following pages of this report contain the results of this testing. This limited PCB testing report presents data that describes the location of the Polychlorinated Biphenyl's (PCB's) identified only within the project scope. This report is to be used as a program-planning tool for the proposed renovation activities scheduled at this facility. This survey was conducted on site by Florida EPA Certified Lead-Based Paint Risk Assessor and EPA/AHERA trained Asbestos Inspector.

This report is intended for the exclusive use of our client. The findings are relevant to the conditions observed during the physical process of performing the Inspection. These findings should not be treated as absolute nor should they be relied upon to represent conditions at significantly later dates.

PbO_3 Environmental Testing & Service Co., Inc.

Dave Mederer
Project Manager

79K39136 REV A

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2.0 DETAILED FINDINGS 4
3.0 LABORATORY REPORTS 5

1.0 EXECUTIVE SUMMARY

Sample Collection Date

August 08, 2012

State Licenses and/or Certifications

U.S. EPA Certified Lead-Based Paint Activities Firm No. FL-2418-2
Asbestos License # ZA 0000205

Inspector:

Kevin O'Malley, Florida EPA Certified Lead-Based Paint Risk Assessor FL-R-345-3
Asbestos Building Inspector Certification No. 154429

Polychlorinated Biphenyl (PCB) Oil samples were collected from the following component(s):

Transformer Equip No.	Transformer Serial No.	Location
SS-C	E-688749	O&C(M7-355) SE Pad
SS-B	E-689245A	O&C(M7-355) SE Pad
SS-F	E-689242	O&C(M7-355) SE Pad
SS-EE	EE-4GR-43901	O&C(M7-355) Rm 1410
SS-E	E694831	O&C(M7-355) SE Pad
SS-119A	H-BT0911-0101	S. IACP (M7-407)
SS-D	E6892408	O&C(M7-355) SE Pad
SS-119B	HBB1199	S. IACP (M7-407)

Overview

According to your instructions ***PbO_3*** Environmental Testing & Service Co., Inc. collected eight (8) samples of transformer oil for analysis.

The samples were analyzed by Method SW846 8082 for Polychlorinated Biphenyls (PCBs).

Based on subsequent laboratory analysis, we have determined that PCB's were not detected in the eight (8) samples analyzed.

All materials with PCB concentrations greater than or equal to 50 ppm are regulated by and shall be managed in accordance with the requirements specified in 40 CFR 761. Requirements for managing and disposing of PCBs are found in Kennedy NASA Procedural Requirements (KNPR) 8500.1 Chapter 19.

2.0 DETAILED FINDINGS

Equip No.	Serial No.	Location	Aroclor-1254	Quantitation Limit	PCBs ≥ 50 ppm
SS-C	E-688749	O&C(M7-355) SE Pad	**0.461 ppm**	414	No
SS-B	E-689245A	O&C(M7-355) SE Pad	**0.629 ppm**	423	No
SS-F	E-689242	O&C(M7-355) SE Pad	**1.278 ppm**	458	No
SS-EE	EE-4GR-43901	O&C(M7-355) Rm 1410	**1.958 ppm**	439	No
SS-E	E694831	O&C(M7-355) SE Pad	**7.657 ppm**	464	No
SS-119A	H-BT0911-0101	S. IACP (M7-407)	BQL	496	No
SS-D	E6892408	O&C(M7-355) SE Pad	BQL	394	No
SS-119B	HBB1199	S. IACP (M7-407)	BQL	436	No

BQL =Below Quantitation Limit

Polychlorinated Biphenyl (PCB) Testing – Transformer Oil
Project No.: **PCN 98860**
Revitalize Medium Voltage Electrical Distribution Systems, Industrial and Payload Processing Areas
Kennedy Space Center, FL

3.0 LABORATORY REPORTS

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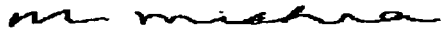
LABORATORY ANALYSIS REPORT

Account:	1491-12-3137	**Date/Time Collected:**	Not available	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/14/2012	9:50 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	8/20/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	Rev MV Elec Dist	**Sample Matrix:**	OIL	
Project No.:				
Job Location:	NASA KSC			
P.O.#:	PCN 98860			
Sample Description:	E-688749	**SLI Sample No.:**	31573445	
		Client Sample No.:	SS-C	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	414	µg/kg	1	8/16/2012 8:48:00 PM	APS
Aroclor - 1221	BQL	414	µg/kg	1	8/16/2012 8:48:00 PM	APS
Aroclor - 1232	BQL	414	µg/kg	1	8/16/2012 8:48:00 PM	APS
Aroclor - 1242	BQL	414	µg/kg	1	8/16/2012 8:48:00 PM	APS
Aroclor - 1248	BQL	414	µg/kg	1	8/16/2012 8:48:00 PM	APS
Aroclor - 1254	461	414	µg/kg	1	8/16/2012 8:48:00 PM	APS
Aroclor - 1260	BQL	414	µg/kg	1	8/16/2012 8:48:00 PM	APS
Aroclor - 1268	BQL	414	µg/kg	1	8/16/2012 8:48:00 PM	APS
Aroclor - 1262	BQL	414	µg/kg	1	8/16/2012 8:48:00 PM	APS

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	MI
TCMX	MI



Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3137	**Date/Time Collected:**	Not available	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/14/2012	9:50 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	8/20/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	Rev MV Elec Dist	**Sample Matrix:**	OIL	
Project No.:				
Job Location:	NASA KSC			
P.O.#:	PCN 98860			
Sample Description:	E-689245A	**SLI Sample No.:**	31573446	
		Client Sample No.:	SS-B	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	423	µg/kg	1	8/16/2012 9:04:00 PM	APS
Aroclor - 1221	BQL	423	µg/kg	1	8/16/2012 9:04:00 PM	APS
Aroclor - 1232	BQL	423	µg/kg	1	8/16/2012 9:04:00 PM	APS
Aroclor - 1242	BQL	423	µg/kg	1	8/16/2012 9:04:00 PM	APS
Aroclor - 1248	BQL	423	µg/kg	1	8/16/2012 9:04:00 PM	APS
Aroclor - 1254	629	423	µg/kg	1	8/16/2012 9:04:00 PM	APS
Aroclor - 1260	BQL	423	µg/kg	1	8/16/2012 9:04:00 PM	APS
Aroclor - 1268	BQL	423	µg/kg	1	8/16/2012 9:04:00 PM	APS
Aroclor - 1262	BQL	423	µg/kg	1	8/16/2012 9:04:00 PM	APS

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	MI
TCMX	MI

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3137	**Date/Time Collected:**	Not available	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/14/2012	9:50 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	8/20/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	Rev MV Elec Dist	**Sample Matrix:**	OIL	
Project No.:				
Job Location:	NASA KSC			
P.O.#:	PCN 98860			
Sample Description:	E-689242	**SLI Sample No.:**	31573447	
		Client Sample No.:	SS-F	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	458	µg/kg	1	8/16/2012 9:19:00 PM	APS
Aroclor - 1221	BQL	458	µg/kg	1	8/16/2012 9:19:00 PM	APS
Aroclor - 1232	BQL	458	µg/kg	1	8/16/2012 9:19:00 PM	APS
Aroclor - 1242	BQL	458	µg/kg	1	8/16/2012 9:19:00 PM	APS
Aroclor - 1248	BQL	458	µg/kg	1	8/16/2012 9:19:00 PM	APS
Aroclor - 1254	1278	458	µg/kg	1	8/16/2012 9:19:00 PM	APS
Aroclor - 1260	BQL	458	µg/kg	1	8/16/2012 9:19:00 PM	APS
Aroclor - 1268	BQL	458	µg/kg	1	8/16/2012 9:19:00 PM	APS
Aroclor - 1262	BQL	458	µg/kg	1	8/16/2012 9:19:00 PM	APS

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	MI
TCMX	MI

Reviewed By: Mandapi Mishra, Organics QC Rep.

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AIHA/ELLAP 100527, ISO/IEC 17025, NVLAP 101150-0, NYELAP/NELAC 11413

LABORATORY ANALYSIS REPORT

Account:	1491-12-3137	**Date/Time Collected:**	Not available	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/14/2012	9:50 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	8/20/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	Rev MV Elec Dist	**Sample Matrix:**	OIL	
Project No.:				
Job Location:	NASA KSC			
P.O.#:	PCN 98860			

Sample Description: E-BT0911-0101

SLI Sample No.: 31573448

Client Sample No.: SS-119A

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	496	µg/kg	1	8/16/2012 9:34:00 PM	APS
Aroclor - 1221	BQL	496	µg/kg	1	8/16/2012 9:34:00 PM	APS
Aroclor - 1232	BQL	496	µg/kg	1	8/16/2012 9:34:00 PM	APS
Aroclor - 1242	BQL	496	µg/kg	1	8/16/2012 9:34:00 PM	APS
Aroclor - 1248	BQL	496	µg/kg	1	8/16/2012 9:34:00 PM	APS
Aroclor - 1254	BQL	496	µg/kg	1	8/16/2012 9:34:00 PM	APS
Aroclor - 1260	BQL	496	µg/kg	1	8/16/2012 9:34:00 PM	APS
Aroclor - 1268	BQL	496	µg/kg	1	8/16/2012 9:34:00 PM	APS
Aroclor - 1262	BQL	496	µg/kg	1	8/16/2012 9:34:00 PM	APS

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	MI
TCMX	MI

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3137	**Date/Time Collected:**	Not available	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/14/2012	9:50 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	8/20/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	Rev MV Elec Dist	**Sample Matrix:**	OIL	
Project No.:				
Job Location:	NASA KSC			
P.O.#:	PCN 98860			
Sample Description:	E-689240B	**SLI Sample No.:**	31573449	
		Client Sample No.:	SS-D	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	394	µg/kg	1	8/16/2012 9:50:00 PM	APS
Aroclor - 1221	BQL	394	µg/kg	1	8/16/2012 9:50:00 PM	APS
Aroclor - 1232	BQL	394	µg/kg	1	8/16/2012 9:50:00 PM	APS
Aroclor - 1242	BQL	394	µg/kg	1	8/16/2012 9:50:00 PM	APS
Aroclor - 1248	BQL	394	µg/kg	1	8/16/2012 9:50:00 PM	APS
Aroclor - 1254	BQL	394	µg/kg	1	8/16/2012 9:50:00 PM	APS
Aroclor - 1260	BQL	394	µg/kg	1	8/16/2012 9:50:00 PM	APS
Aroclor - 1268	BQL	394	µg/kg	1	8/16/2012 9:50:00 PM	APS
Aroclor - 1262	BQL	394	µg/kg	1	8/16/2012 9:50:00 PM	APS

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	MI
TCMX	MI

m mishra

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3137	**Date/Time Collected:**	Not available	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/14/2012	9:50 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	8/20/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	Rev MV Elec Dist	**Sample Matrix:**	OIL	
Project No.:				
Job Location:	NASA KSC			
P.O.#:	PCN 98860			

Sample Description: E-694831

SLI Sample No.: 31573450

Client Sample No.: SS-E

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	464	µg/kg	1	8/16/2012 10:05:00 PM	APS
Aroclor - 1221	BQL	464	µg/kg	1	8/16/2012 10:05:00 PM	APS
Aroclor - 1232	BQL	464	µg/kg	1	8/16/2012 10:05:00 PM	APS
Aroclor - 1242	BQL	464	µg/kg	1	8/16/2012 10:05:00 PM	APS
Aroclor - 1248	BQL	464	µg/kg	1	8/16/2012 10:05:00 PM	APS
Aroclor - 1254	BQL	464	µg/kg	1	8/16/2012 10:05:00 PM	APS
Aroclor - 1260	7657	464	µg/kg	1	8/16/2012 10:05:00 PM	APS
Aroclor - 1268	BQL	464	µg/kg	1	8/16/2012 10:05:00 PM	APS
Aroclor - 1262	BQL	464	µg/kg	1	8/16/2012 10:05:00 PM	APS

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	MI
TCMX	MI

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

Account:	1491-12-3137	**Date/Time Collected:**	Not available	
Client:	PbO3 ENV TESTING & SERVICES INC	**Date/Time Received:**	8/14/2012	9:50 AM
Address:	473 N PINE MEADOW DR	**Date Reported:**	8/20/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	Rev MV Elec Dist	**Sample Matrix:**	OIL	
Project No.:				
Job Location:	NASA KSC			
P.O.#:	PCN 98860			
Sample Description:	HBB1199	**SLI Sample No.:**	31573451	
		Client Sample No.:	SS-119B	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI Q17						
Aroclor - 1016	BQL	436	µg/kg	1	8/16/2012 10:21:00 PM	APS
Aroclor - 1221	BQL	436	µg/kg	1	8/16/2012 10:21:00 PM	APS
Aroclor - 1232	BQL	436	µg/kg	1	8/16/2012 10:21:00 PM	APS
Aroclor - 1242	BQL	436	µg/kg	1	8/16/2012 10:21:00 PM	APS
Aroclor - 1248	BQL	436	µg/kg	1	8/16/2012 10:21:00 PM	APS
Aroclor - 1254	BQL	436	µg/kg	1	8/16/2012 10:21:00 PM	APS
Aroclor - 1260	BQL	436	µg/kg	1	8/16/2012 10:21:00 PM	APS
Aroclor - 1268	BQL	436	µg/kg	1	8/16/2012 10:21:00 PM	APS
Aroclor - 1262	BQL	436	µg/kg	1	8/16/2012 10:21:00 PM	APS

Polychlorinated Biphenyls based on SW846 8082 -- Surrogate Recoveries using SLI Q17

Surrogate	Recovery
DCB	MI
TCMX	MI

Reviewed By: Mandapi Mishra, Organics QC Rep.

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LABORATORY ANALYSIS REPORT

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Address:	473 N PINE MEADOW DR	**Date Reported:**	8/20/2012	
	DEBARY, FL 32713	**Receipt Temp., °C:**		
Project Name:	Rev MV Elec Dist	**Sample Matrix:**	OIL	
Project No.:				
Job Location:	NASA KSC			
P.O.#:	PCN 98860			
Sample Description:	EE-4GR-43901	**SLI Sample No.:**	31573452	
		Client Sample No.:	SS-EE	

Analyte	Analysis Result	Quantitation Limit	Units	Dilution Factor	Analysis Date/Time	Analyst
Polychlorinated Biphenyls based on SW846 8082 using SLI O17						
Aroclor - 1016	BQL	439	µg/kg	1	8/16/2012 10:36:00 PM	APS
Aroclor - 1221	BQL	439	µg/kg	1	8/16/2012 10:36:00 PM	APS
Aroclor - 1232	BQL	439	µg/kg	1	8/16/2012 10:36:00 PM	APS
Aroclor - 1242	BQL	439	µg/kg	1	8/16/2012 10:36:00 PM	APS
Aroclor - 1248	BQL	439	µg/kg	1	8/16/2012 10:36:00 PM	APS
Aroclor - 1254	1958	439	µg/kg	1	8/16/2012 10:36:00 PM	APS
Aroclor - 1260	BQL	439	µg/kg	1	8/16/2012 10:36:00 PM	APS
Aroclor - 1268	BQL	439	µg/kg	1	8/16/2012 10:36:00 PM	APS
Aroclor - 1262	BQL	439	µg/kg	1	8/16/2012 10:36:00 PM	APS

Polychlorinated Biphenyls based on SW846 8082 – Surrogate Recoveries using SLI O17

Surrogate	Recovery
DCB	MI
TCMX	MI

m mishra

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SAMPLE LOG 1491-12-3137

PbO3 ENVIRONMENTAL, INC.
473 N. PINE MEADOW DR.
DEBARY, FL. 32713
Phone 386-668-4545
Fax 386-668-4566
Pbo3@comcast.net

5day TAT

PROJECT NAME: Rev. MV. Elec. Dist. Sys. IPPA
JOB LOCATION: NASA KSC
PROJECT #:
PO NO.: PCN 98860
DATE: 7/30/12 - 8/11/12

1 OF ___

SAMPLE LOG

ASBESTOS _____ LEAD _____ PCB's OTHER X

SAMPLE NUMBER	DESCRIPTION	LOCATION
SS-C	Transformer Oil	E-688749
SS-B		E-689245A
SS-F		E-689242
SS-119A		H-BT0911-0101
SS-D		E689240B
SS-E		E694831
SS-119B		HBB1199
SS-EE		EE-4GR-43901
	Kam 8/13/12	
	Tina Flaugbaugh 5888 vps (R)	
	8-14-12	

WorkOrderKey
V: \903\903485