Preparing Activity: NAVFAC

Superseding
UFGS-26 41 00 (November 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 26 41 00

LIGHTNING PROTECTION SYSTEM

08/23

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USACE / NAVFAC / AFCEC / NASA **UFGS-26 41 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 41 00 (November 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
****

SECTION 26 41 00

LIGHTNING PROTECTION SYSTEM
08/23

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NOTE: This guide specification covers the requirements for lightning protection systems for non-ordnance facilities. Modify this guide specification as needed to address unique requirements for ordnance-related facilities. Follow requirements in UFC 3-575-01, "Lightning and Static Electricity Protection Systems" and contact the service-specific ordnance organization for guidance.

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

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

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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****
NOTE: Show the following information on the project drawings:

1. Location and height of air terminals.
2. Location of down conductors, including locations where down conductors are subject to physical damage and require additional protection.
3. Location of ground rods.

4. Location of ground ring electrodes or alternate methods for grounding electrodes (if any).
5. Location of test wells.
6. Fence and gate bonding details.
7. For additions to lightning protection systems on existing facilities, show locations of tie-in points.
****

PART 1 GENERAL

1.1 REFERENCES

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

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

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

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 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

U.S. AIR FORCE (USAF)

DAFMAN 32-1065	(2020) Grounding and Electrical Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-575-01	(2012; with Change 1, 2021) Lightning and Static Electricity Protection Systems

UNDERWRITERS LABORATORIES (UL)

UL 96	(2016; May 2023) UL Standard for Safety Lightning Protection Components
UL 96A	(2016; Reprint Oct 2022) UL Standard for Safety Installation Requirements for Lightning Protection Systems
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL Electrical Construction	(2012) Electrical Construction Equipment Directory

1.2 RELATED REQUIREMENTS

1.2.1 Verification of Dimensions

Confirm all details of work, verify all dimensions in field, and advise Contracting Officer of any discrepancy before performing work. Obtain prior approval of Contracting Officer after engineering approval and before making any departures from the design.

1.2.2 System Requirements

****

NOTE: This specification is based on compliance with NFPA 780 as specified in UFC 3-575-01, "Lightning and Static Electricity Protection Systems."

NFPA 780 requires surge protective devices (SPDs) at all service entrances as part of a lightning protection system. Include Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM to specify SPD requirements.

****

Provide a system furnished under this specification consisting of the latest products of a manufacturer regularly engaged in production of lightning protection system components. Products must be UL listed for use on lightning protection systems unless this rating does not exist for items in question.

Comply with NFPA 70, NFPA 780, UL 96, and UFC 3-575-01.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****
NOTE: Modify submittals paragraphs to ensure that an appropriate submittal is required for each item in the project.
****

****
NOTE: For the Air Force, modify Division 1 paragraphs to require submission of lightning protection shop drawings, test reports and certificates to the Base Civil Engineer and to the Designer of Record via the Contracting Officer for approval. The Base Civil Engineer retains final site approval authority.
****

SD-06 Test Reports

Lightning Protection and Grounding System Test Plan; G[, [_____]]

Grounding Systems Testing; G[, [_____]]

SD-07 Certificates

Component UL Listed and Labeled; G[, [_____]]

Lightning Protection System Inspection Certificate; G[, [_____]]

Roof Manufacturer's Warranty; G[, [_____]]

1.4 QUALITY ASSURANCE

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" or "must" has been substituted for "should," wherever it appears. Interpret references that require LPS expertise in these standards to mean Base Civil Engineer (BCE) or BCE-designated representative with LPS training certification.

1.4.1 Component UL Listed and Labeled

Submit proof of compliance that components are UL Listed and Labeled for use on lightning protection systems. Listing alone in UL Electrical Construction, which is the UL Electrical Construction Directory, is not acceptable evidence. In lieu of Listed and Labeled, submit written certificate from an approved, nationally-recognized testing organization equipped to perform such services, stating that items have been tested and conform to requirements and testing methods of Underwriters Laboratories (UL).

1.4.2 Lightning Protection and Grounding System Test Plan

Provide lightning protection system and grounding system test plans in compliance with NFPA 780[and DAFMAN 32-1065 chapters 8 and 10, and Attachment 7].[Identify (by number or letter, at the preference of the base - 1.2.3. or a.b.c.) the system test points/locations along with a listing or description of the item to be tested and the type of test to be conducted.][DAFMAN 32-1065, Attachment 7, contains a Sample Visual Inspection Form (Figure A7.6) and a Sample 24-month Resistance/Continuity Test/Visual Inspection of LPS and Grounding System (Figure A7.7). Substitute-Forms may be used, but those forms created or substituted by the base must include the same contents and information as the samples provided in Attachment 7, Figures A7.6 and A7.7.] As a minimum, include a sketch of the facility and surrounding lightning protection system as part of the specific test plan for each structure. Include the requirements as "Testing of [Integral][Catenary][Mast] Lightning Protection System" in the test plan. For explosives facilities, the rolling sphere must be superimposed in elevation drawings, on all three of these types of lightning protection systems for installations with a high strike density as indicated in the NOAA Strike Density Maps. This may be accomplished by Computer Aided Design (CAD). Integral systems are discouraged on explosives and communications facilities because it has the potential to bring lightning closer to what is being protected. For explosives facilities, record drawings with materials description (wire size, air terminal material, etc.) is required by the base Weapons Safety Office. Testing of Surge Protective Devices must comply with UL 1449 and annual inspection of Surge Protective Devices should be included on Figures A7.6 and A7.7.

1.4.3 Lightning Protection System Inspection Certificate of Qualifications

Provide an approved third-party inspector who meets training certification requirements for final acceptance of the LPS. Inspection and certification of the LPS must be completed and certified in writing, before occupancy of the building. Compliance requirements are in

UFC 3-575-01[and DAFMAN 32-1065, paragraphs 4.2 and 4.3]. Signed Certificate of Qualifications must be placed in the LPS records.

[Optional certification (also described in UFC 3-575-01 and DAFMAN 32-1065): If available, base may provide LPS third-party qualified personnel via BCE-designated base individual who 1) routinely maintains and tests the lightning protection system and 2) has had advanced training, with a Certificate or Qualification signed and provided by the trainer, for LPS records. This option removes the requirement for a project-included third-party inspector to certify the LPS prior to LPS system acceptance.

] Note that the Contracting Officer may not accept the LPS system without a recommendation from a qualified person identified in the project documents.

1.5 SITE CONDITIONS

Confirm all details of work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before starting any work, if known at that time, or when it becomes known while performing work. Obtain prior approval of the BCE or BCE-designated representative with LPS training certification before design changes are made.

PART 2 PRODUCTS

2.1 MATERIALS

See NFPA 70, NFPA 780, UFC 3-575-01[, DAFMAN 32-1065]. Do not use a combination of materials that forms an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, provide conductors with protective coatings, such as tin or lead, or oversize conductors. Where a mechanical hazard is involved, increase conductor size to compensate for the hazard or protect conductors. When metallic conduit or tubing is provided, electrically bond conductor to conduit or tubing at the upper and lower ends by clamp type connectors or welds (including exothermic). All lightning protection components, such as bonding plates, air terminals, air terminal supports and braces, chimney bands, clips, connector fittings, and fasteners are to comply with the requirements of UL 96 classes, as applicable.

2.1.1 Main and Bonding Conductors

****

NOTE: NFPA 780 - Class I are ordinary building 23 m 75 ft or less in height and Class II are ordinary buildings over 23 m 75 ft in height.

****

Main and Bonding Conductors should be NFPA 780 and UL 96 Class I or Class II materials, as applicable. For explosives, Class II materials are in accordance with NFPA 780, Chapter 8.

2.1.2 Conductors

Provide copper or aluminum conductors, as applicable. See NFPA 780, UFC 3-575-01[, DAFMAN 32-1065].

2.2 COMPONENTS

2.2.1 Air Terminals on Integral Systems

Provide solid air terminals. Tubular air terminals are not permitted. Support air terminals more than 600 mm 24 inches in length by suitable brace, supported at not less than one-half the height of the terminal.

2.2.2 Ground Rods

****

NOTE: The designer will determine the type and number of ground rods to be used based on local conditions and earth resistivity data. NFPA 780 allows copper-clad steel, solid copper, or stainless steel ground rods for multiple ground rod applications.

Specify copper clad steel rods for normal conditions. The use of other materials such as galvanized coated steel will require written authorization in accordance with the MIL-STD-3007F, Paragraph 5.1.7, "Waivers and Exemptions."

In high resistivity soils, 3000 mm 10 foot sectional rods may be used to obtain the required resistance to ground; however, where rock is encountered, additional rods, a ground ring electrode, or ground grid may be necessary. Coordinate and standardize rod selection for individual facilities with other specification sections.

****

Provide ground rods conforming to NFPA 780. Provide ground rods that are not less than 16 mm 5/8 inch in diameter and 2440 mm 8 feet in length. Do not mix ground rods of copper-clad steel and solid copper on the job.

2.2.3 Connections and Terminations

Provide connectors for splicing conductors that conform to UL 96, class as applicable. Conductor connections can be made by compression clamps or welds (including exothermic). Provide style and size connectors required for the installation.

2.2.4 Connector Fittings

Provide connector fittings for "end-to-end", "Tee", or "Y" splices that conform to NFPA 780 and UL 96.

PART 3 EXECUTION

3.1 LIGHTNING PROTECTION SYSTEMS

****

NOTE: This specification is based on compliance with NFPA 780 as specified in UFC 3-575-01, "Lightning and Static Electricity Protection Systems."

****

Provide a lightning protection system that meets the requirements of NFPA 780 and UFC 3-575-01.

3.1.1 Integral Lightning Protection System

The integral type lightning protection system consists of air terminals, roof conductors, down conductors, ground connections, grounding electrodes and ground ring electrode conductor for the purpose of carrying lightning current from a direct strike to ground in a manner that will protect assets and personnel. Expose all conductors on the structures except where exterior down conductors are required to be in protective sleeves for prevention of mechanical damage (1830 mm 6 feet above grade level). Integral systems are the least preferred, especially for explosives and communications facilities. When use of integral systems is determined by the designer or site conditions to be necessary, do not run down conductors inside columns or other methods which will prevent visual access for required inspections. Visual access is required by NFPA 780[and DAFMAN 32-1065] so that the annual visual inspection may be performed on all LPS components.

Make interconnections within side-flash distances between down conductors and metallic equipment mounted on the exterior or interior of a facility, at or below the level of the grounded metallic parts. Calculate side-flash distances in accordance with NFPA 780. Be aware of side flashes that may occur through exterior walls.

Note that integral systems should be avoided as LPS for Explosives and Communications facilities and is discouraged for general facilities. Installation and maintenance costs of an integral system are excessive and this method is maintenance intensive. The complexity and number of test points dictates frequent interruption to missions and daily operations for required annual inspections and testing. Integral systems require fall protection and maintenance of that fall protection system. For fall protection, maintain NFPA 780-compliant separation distance between the integral system and metallic fall protection.

3.1.1.1 Roof-Mounted Components

Coordinate with the roofing manufacturer and provide certification that the roof manufacturer's warranty is not violated by the installation methods for air terminals and roof conductors. Adhesive fasteners may be used on the roof if the installation is observed by base-qualified personnel to be compliant with manufacturer's instructions. Installation must be observed until the observer is satisfied that the proper methods for preparing the surface are being performed. These fasteners will be added and considered a test point in Base records and must be part of the annual inspection. Observer must date and sign the test record.

No connection or physical attachment is allowed to any coping system on the roof as this violates the integrity and warranty of the coping system.

3.1.1.2 Air Terminals

Use of adhesive fasteners, when installing air terminals on "rubber" (EPDM) type roofs, should be in accordance with adhesive and roof manufactures’ recommendations. See paragraph ROOF-MOUNTED COMPONENTS.

3.1.1.3 Roof Conductors

Roof conductors should comply with NFPA 780[and DAFMAN 32-1065].

3.1.2 Catenary Lightning Protection System

A catenary lightning protection system consists of at least two wooden poles or metallic masts with overhead wires (cross conductors). Install air terminals on wooden masts at least 254 mm 10 inches higher than the top of the wooden pole, or use steel saddles on top of the wooden pole for conductor placement if saddle is at least 152 mm 6 inches above the wooden pole. Provide at two paths to ground for an overhead ground wire (cross conductor) and down conductors, to transport the current from a direct strike to grounding electrodes that are 16 mm by 2440 mm 5/8 in. by 8 ft. The class (diameter at the top of the pole and the pole height) of wooden pole must be designed to withstand the horizontal force of the cross conductor and any ice loading it could be subject to. Metallic masts used in a catenary lighting protection system do not require air terminals, but must be rated for use on electrical distribution or transmission lines because of horizontal forces that must be considered when sizing and selecting the metallic mast manufacturer. Consider resonant frequency in the design, if applicable, and use appropriate damping designed by the mast manufacturer. A rolling sphere proof of protection is a required submittal that must be approved prior to sizing or ordering the masts. This system shall comply with NFPA 780. Note that for randomly-shaped facilities (non-rectangular facilities), a catenary system is not required to be symmetrical. To maintain symmetry on the widest part of the building, the overhead ground wire (cross conductor) length sometimes drives the height of the masts by several sizes to compensate for added weight of the cross conductor and the fact that it could be laden with ice during winter, in some areas of a country. This system shall comply with NFPA 780 and UFC 3-575-01[, and DAFMAN 32-1065].

3.1.3 Mast Lightning Protection System

A mast lightning protection system consists of one or more individual masts not interconnected to each other, and isolated from the building, that provide sufficient protection for the structure contents. These masts may be wooden or metallic. Wood poles (masts) require air terminals on top that are at least 254 mm 10 inches higher than the top of the mast, down conductors that provide at least two paths to ground (as close to 180 degrees apart on the pole perimeter as possible), to transport the current from a direct strike directly to grounding electrodes (ground) that are 16 mm by 2440 mm 5/8 inches by 8 feet. Metallic masts do not require air terminals and are not required be rated for use on electrical distribution or transmission lines because only vertical forces are experienced by the mast. If lights or other items are mounted on the top of the masts, guy wires and proper bonding of the guy wires are required. The base of a metallic mast should have connections to two separate ground rods, 16 mm by 2440 mm 5/8 inches by 8 feet, unless equivalent protection is provided (designed within) in the footer or some other documented manner. Paths to ground must possess a visible test point. A rolling sphere diagram showing proof of protection is a required submittal that must be approved prior to sizing or ordering the masts. This system shall comply with NFPA 780 and UFC 3-575-01[, and DAFMAN 32-1065].

A lightning protection system may consist of a mixture of these three systems, in order to limit cost of the system while still providing protection. For instance, an irregularly shaped building that uses a

catenary system may use a single mast to cover an area that is just outside the zone of protection created by the catenary, as indicated by a rolling sphere diagram.

3.1.4 Down Conductors

A minimum of two paths to ground shall be provided on any system. This may be by two down conductors or with a down conductor in combination with other metallic connections to ground. Protect exposed down conductors from physical damage from ground level up to 1830 mm 6 feet. If this protection is a metal conduit, both ends must be bonded to the down conductor passing through it. For Schedule 80 conduit providing this protection, no bonding at both ends is necessary. Schedule 80 conduit or metallic conduit may be painted to match the surrounding surface. NO CONNECTIONS OR FASTENERS OF ANY LIGHTNING PROTECTION SYSTEM MAY BE PAINTED because this affects the ease with which lightning current can pass to ground.

3.1.5 Ground Connections

Attach each down conductor and ground ring electrode to a ground rod below grade by exothermic weld for all buried connections and exothermic weld or compression connectors for connections inside test wells. Terminate all down conductors to a grounding electrode inside a test well. Test connections and record resistances and continuity readings prior to covering.

Accessible connections above ground level and in test wells can be grounded with mechanical clamping, meeting installation requirements in NFPA 780.

3.1.6 Installation of Grounding Electrodes (Ground Rods)

****

NOTE: Where soil conditions indicate definitely that a ground ring electrode will not be required, all references to a ground ring electrode should be deleted from the specifications.

If required by soil conditions, select an alternate method for grounding electrodes in shallow soil. Utilize NFPA 780 or an alternate method meeting the intent of NFPA 780. Validate by calculations or historical data for site conditions. Modify the wording below as necessary to specify the system design.

****

Extend driven ground rods vertically into the existing undisturbed earth for a distance of not-less-than 2400 mm 8 feet if exothermic welds are used for bonds. Inside test wells, the 16 mm by 2400 mm 5/8 in. by 8 ft rod may be driven to a point above the base of the test well, that will provide working/testing access to the mechanically-fastened bond. Set ground rods not less than 915 mm 3 feet nor more than 1830 mm 6 feet (see NFPA 780) from the structural foundation, and at least 915 mm 3 feet beyond the drip line for the facility. After the completed installation, measure the total resistance to ground using the fall-of-potential method described in IEEE 81. Maximum allowed resistance of a single driven ground rod is 25 ohms (NFPA 70). If resistance-to-ground of a single

ground rod for the lightning protection system exceeds 25 ohms and another ground rod is driven in accordance with NFPA 780, 25 ohms does not apply to this test point. See NFPA 70 exception to Article 250.53.

[For explosives facilities: For a ground ring electrode, provide continuous No. 1/0 (minimum) bare stranded copper cable (NFPA 780-2023, Chapter 8, *Explosives Facilities*).

]3.2 APPLICATIONS

3.2.1 Personnel Ramps and Covered Passageways

****
NOTE: Personnel ramps and covered passageways that are in the zone of protection of a lightning protection system, as defined by NFPA 780, do not need additional lightning protection. Protect personnel ramps and covered passageways that are outside the zone of protection with lightning protection conforming to the requirements for buildings of similar construction.
****

Lightning Protection is required in accordance with NFPA 780 and UFC 3-575-01.

3.3 INTERFACE WITH OTHER STRUCTURES

3.3.1 Fences

****
NOTE: Coordinate with Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION for additional electrical distribution system requirements. Coordinate with Section 32 31 13 CHAIN LINK FENCES AND GATES for fence grounding requirements.
****

Bond metal fence and gate systems to the lightning protection system at the point where the fence, any fence post, or gate is within 1830 mm 6 feet of any part of the lightning protection system (usually a down conductor) in accordance with ANSI C2 and NFPA 780 and UFC 3-575-01.

3.4 RESTORATION

Where sod has been removed, replace sod as soon as possible after completing the backfilling. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work, to original condition. Overfill the trench to accommodate for settling. Include necessary topsoil, fertilizing, liming, seeding, sodding, sprigging or mulching in any restoration, to match existing. Maintain disturbed surfaces and replacements until final acceptance. Return to site after six months to fill in compacted surface.

3.5 FIELD QUALITY CONTROL

3.5.1 Lightning Protection Systems Testing

A 100 percent test point test and inspection is required by all services.

Identify test points for lightning protection system connections and bonds. Provide a sketch (NTS) with identified test points as part of the contract acceptance. Number points in a manner consistent with the installation (Base or Post) nomenclature for existing lightning protection systems; for example, use letters or numbers to track the test results. Test each lightning protection system connection to ensure continuity across each connection or bond is 1 ohm or less, and record the value indicated on a copy of the test form located at the back of DAFMAN 32-1065, Attachment 7.

a. LPS testing must also be accomplished on smaller projects, such as roofing and HVAC projects, where lightning protection systems are installed on any facility with existing LPS, to ensure the LPS is not damaged or reconfigured during construction.

b. Comply with UL 96A. A third-party inspector (not the designer and not the installer) must be present for the 100 percent inspection and data documentation by the contractor. This is to take place prior to project acceptance. Note that in many cases Air Force personnel have been trained to inspect and accept projects as the third-party inspector. Verify this before contract award.

3.5.2 Grounding Systems Testing

****

NOTE: Use 25 ohms unless the specific facility, such as a telecommunications facility, requires a lower value.

****

A 100 percent test point resistance test and inspection is required. Identify all test points for grounding system connections and bonds. Provide a sketch (NTS) with identified test points as part of the contract acceptance. Number points in a manner consistent with the installation (Base or Post) nomenclature for existing grounding systems; for example, use letters or numbers to track the test results. Test each grounding system connection or bond to ensure resistance-to-ground is 25 ohms or less or as excepted by NFPA 70 or NFPA 780. Record the resistance measurement on a copy of the test form located at the back of DAFMAN 32-1065 for Air Force or a similar form provided by the Army or Navy. Test the ground rod for resistance to ground before making connections to the rod. Tie the grounding system together and test for resistance to ground. Make resistance measurements in dry weather, and not earlier than 48 hours after rainfall. Include in the written report: locations of test points, measured values for continuity and ground resistances, and soil conditions at the time that measurements were made. Submit results of each test to the Contracting Officer.

-- End of Section --