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USACE / NAVFAC / AFCEC / NASA **UFGS-01 86 26.07 40 (February 2018)**
Change 1 - 02/15

Preparing Activity: NASA **Superseding**
UFGS-01 86 26.07 40 (February 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION 01 86 26.07 40

RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS
02/18, CHG 1: 02/15

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NOTE: This guide specification covers the requirements for Reliability Centered Building and Equipment Acceptance for Electrical Systems. The contents universally apply to electrical systems and may be used by other organizations, if deemed beneficial.

Refer to Section 01 83 00.07 40 RELIABILITY CENTERED ACCEPTANCE FOR FACILITY SHELLS (foundations, structure, walls, openings, roofs, insulation and vapor barrier systems, etc.).

Refer to Section 01 83 13.07 40 RELIABILITY CENTERED ACCEPTANCE FOR SUPERSTRUCTURE PERFORMANCE REQUIREMENTS for externally exposed structures such as communication towers, launch facilities; and partially open shelters such as those for fueling chemical storage, as well as underground special structures for explosives and ordinance.

Refer to Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.

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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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.
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE (2004) NASA Reliability Centered Building and Equipment Acceptance Guide

1.2 SUBMITTALS

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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.

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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:

SD-01 Preconstruction Submittals

Quality Control Plan[; G[, [____]]]

Material, Equipment, and Fixture Lists[; G[, [____]]]

SD-02 Shop Drawings

Connection Diagrams[; G[, [____]]]

Fabrication Drawings[; G[, [____]]]

Installation Drawings[; G[, [____]]]

SD-03 Product Data

Manufacturer's Catalog Data[; G[, [____]]]

Equipment Foundation Data[; G[, [____]]]

Specific Equipment Data[; G[, [____]]]

Spare Parts List[; G[, [____]]]

Warranty[; G[, [____]]]

SD-05 Design Data

Design Analysis and Calculations[; G[, [____]]]

SD-06 Test Reports

SF6 Gas Test[; G[, [____]]]

SF6 Gas Leakage Test[; G[, [____]]]

Air Compressor Performance Test[; G[, [____]]]

Automatic Transfer Test[; G[, [____]]]

Battery Impedance Test[; G[, [____]]]

Breaker Timing Test[; G[, [____]]]

Capacitor Bank Acceptance Test[; G[, [____]]]

Capacitor Discharge Test[; G[, [____]]]

Contact Resistance Test[; G[, [____]]]

Continuity Test[; G[, [____]]]

Fall of Potential Test[; G[, [____]]]

General Battery Test[; G[, [____]]]

General Charger Test[; G[, [____]]]

High Voltage Test[; G[, [____]]]

Infrared Thermography Test[; G[, [____]]]

Insulation Oil Test[; G[, [____]]]

Insulation Resistance Test[; G[, [____]]]

Overpotential Test[; G[, [____]]]

Point to Point Test[; G[, [____]]]

Power Factor Test[; G[, [____]]]

Turns Ratio Test[; G[, [____]]]

Ultrasonic (Airborne)Test[; G[, [____]]]

Vacuum Bottle Integrity Test[; G[, [____]]]

Visual Inspection[; G[, [____]]]

SD-07 Certificates

Certificates[; G[, [____]]]

SD-08 Manufacturer's Instructions

Manufacturer's Instructions[; G[, [____]]]

SD-10 Operation and Maintenance Data

Operations and Maintenance Manuals[; G[, [____]]]

SD-11 Closeout Submittals

Acceptance Documentation[; G[, [____]]]

Record Drawings[; G[, [____]]]

Baseline Data Report[; G[, [____]]]

1.3 QUALITY CONTROL

Submit a quality control plan outlining the intended methods of receiving, testing, and installing equipment. Ensure that the plan meets the minimum requirements for test equipment specified in the RCBEA GUIDE. To ensure that the results are accurate and consistent, use personnel who have been trained and certified in the appropriate predictive testing and inspection (PT&I) technologies. Submit the following as part of the quality control plan for required acceptance testing:

a. List of test equipment used, including the manufacturer, model number, calibration date, certificate of calibration, and serial number.

b. Certificates showing test personnel qualifications and certifications.

1.4 WARRANTY

Submit a workmanship and performance warranty directly to the Government for the work performed for a period at least [1][_____] years from the date of Government acceptance of the work. Perform corrective action that becomes necessary because of defective materials and workmanship while system is under warranty within [7][_____] days of notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time constitutes grounds for having the corrective action and repairs performed by others and billing the cost to the Contractor. Provide a contractor installation warranty that covers a period of at least [1][_____] year.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

This guide specification establishes acceptance requirements to ensure that building equipment and systems meet installation requirements and contain no identifiable defects that will shorten the design life of the equipment. These requirements use PT&I technologies and are essential elements in the Government's Reliability Centered Building and Equipment Acceptance (RCBEA) Program.

This guide specification is not intended to limit the inspection and acceptance process to the use of PT&I techniques. This guide is intended to supplement comprehensive and detailed commissioning and quality control specifications.

2.1.1 Design Requirements

Submit design analysis and calculations for the equipment listed below.

[a. Batteries (general)

][b. Batteries (lead-acid)

][c. Battery chargers

][d. Breakers:

][(1) General

][(2) Air blast

][(3) Air magnetic

][(4) Oil

][(5) SF6 Gas

][(6) Vacuum

][e. Cables:

][(1) General

][(2) Low Voltage (600V maximum)

][(3) Medium Voltage (600V-33,000V)

][(4) High Voltage (33,000V minimum)

][f. Electrical, capacitor banks

][g. Capacitors, dry-type

][h. Capacitors, liquid filled

][i. Electrical automatic transfer switches

][j. Electric buss

][k. Electrical control panels

][l. Electrical distribution panels

][m. Electrical grounding grid

][n. Electrical lightning protection

][o. Electrical power centers

][p. Electrical power supplies

][q. Electrical rectifiers

][r. Electrical relays

][s. Electrical starters

][t. Electric switches:

][(1) Cutouts

][(2) Low voltage air

][(3) Medium & High Voltage Air, Open

][(4) Medium voltage air, metal enclosed

][(5) Medium voltage, oil

][(6) Medium voltage, SF6

][(7) Medium voltage, vacuum

][u. Electrical transformer load tap changer

][v. Motor control centers

][w. Switchgear

][x. Transformers

]2.2 PRODUCT DATA

Before starting work, submit material, equipment, and fixture lists for equipment, materials, and fixtures planned for use to complete the job. Include the item's description, quantity, manufacturer's style or catalog numbers, and specification and drawing reference numbers. List of construction equipment to be used.

2.2.1 Manufacturer Product Data

Submit fabrication drawings for equipment and specialties. Ensure that drawings contain details on fabrication and assembly details to be performed in the factory. Show connection diagrams and assemblies in switchgear fabrication drawings.

Submit manufacturer's catalog data for the equipment listed. Include manufacturer's standard catalog data at least [5 weeks][_____] before the purchase or installation of a particular component, highlighted to show material, size, options, and equipment performance data charts and curves and in adequate detail to demonstrate compliance with contract requirements. Include the manufacturer's instructions and procedures for installation. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

Submit equipment foundation data for the following equipment, including 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.

[a. Batteries (general)

][b. Batteries (lead-acid)

][c. Battery chargers

][d. Breakers:

][(1) General

][(2) Air blast

][(3) Air magnetic

][(4) Oil

][(5) SF6 gas

][(6) Vacuum

][e. Cables:

][(1) General

][(2) Low Voltage (600V Maximum)

][(3) Medium Voltage (600V-33,000V)

][(4) High Voltage (33,000V Minimum)

][f. Electrical, capacitor banks

][g. Capacitors, dry-type

][h. Capacitors, liquid filled

][i. Electrical automatic transfer switches

][j. Electric bus

][k. Electrical control panels

][l. Electrical distribution panels

][m. Electrical grounding grid

][n. Electrical lightning protection

][o. Electrical power centers

][p. Electrical power supplies

][q. Electrical rectifiers

][r. Electrical relays

][s. Electrical starters

][t. Electric switches:

][(1) Cutouts

][(2) Low voltage air

][(3) Medium and high voltage air, open

][(4) Medium voltage air, metal enclosed

][(5) Medium voltage, oil

][(6) Medium voltage, SF6

][(7) Medium voltage, vacuum

][u. Electrical transformer load tap change

][v. Motor control centers

][w. Switchgear

][x. Transformers

]2.2.2 Certification Data

Submit certificates for the equipment listed below, showing conformance with test requirements and laboratory certifications.

[a. Batteries (general)

][b. Batteries (lead-acid)

][c. Battery chargers

][d. Breakers:

][(1) General

][(2) Air blast

][(3) Air magnetic

][(4) Oil

][(5) SF6 Gas

][(6) Vacuum

][e. Cables:

][(1) General

][(2) Low voltage (600V maximum)

][(3) Medium voltage (600V-33,000V)

][(4) High voltage (33,000V minimum)

][f. Electrical, capacitor banks

][g. Capacitors, dry-type

][h. Capacitors, liquid filled

][i. Electrical automatic transfer switches

][j. Electric bus

][k. Electrical control panels

][l. Electrical distribution panels

][m. Electrical grounding grid

][n. Electrical lightning protection

][o. Electrical power centers

][p. Electrical power supplies

][q. Electrical rectifiers

][r. Electrical relays

][s. Electrical starters

][t. Electric switches:

][(1) Cutouts

][(2) Low voltage air

][(3) Medium and high voltage air, open

][(4) Medium voltage air, metal enclosed

][(5) Medium voltage, oil

][(6) Medium voltage, SF6

][(7) Medium voltage, vacuum

][u. Electrical transformer load tap changer

][v. Motor control centers

][w. Switchgear

][x. Transformers

]2.2.3 Specific Equipment Data

Submit the following information for equipment listed below: location of installation, Identification number, date of installation (required or actual acceptance date), and reference drawing number. Unless explicitly stated in submitted manufacturer's literature, submit the following specific equipment data:

[a. Batteries (general)

][(1) Battery identification (Type)

][b. Battery (lead-acid)

][(1) Battery identification (Type)

][(2) Battery specifications

][c. Battery chargers

][(1) Battery charger type

][(2) Battery charger specifications

][d. Breakers- general, air blast, air magnetic, oil, SF6 gas, and vacuum types

][(1) Breaker type

][(2) Breaker specifications (including current transformer ratios)

][e. Cables- low-, medium-, and high-voltage

][(1) Power cable type

][f. Electrical capacitors- banks, dry-type, liquid filled

][(1) Capacitor type

][g. Electrical automatic transfer switch (ATS)

][(1) ATS Identification (Type)

][h. Electric bus

][(1) Bus type

][(2) Bus specifications (including current and load capacity)

][i. Electrical Control Panel

][(1) Electrical control panel type (NEMA enclosure type)

][(2) Voltage configuration (120/240 VAC, 12/24 VDC, etc.)

][(3) Amperage

][(4) Dimensions

][(5) Weight

][(6) UL certification

][(7) Electromagnetic interference (EMI) levels

][j. Electrical distribution panel

][(1) Electrical control panel type (NEMA enclosure type)

][(2) Voltage configuration (120/240 VAC, 12/24 VDC, etc.)

][(3) Amperage (panel main bus maximum)

][(4) Dimensions

][(5) Weight

][(6) UL certification

][(7) EMI levels

][(8) Number of circuit breaker positions (outputs)

][(9) Electrical distribution panel impedance

][k. Electrical grounding grid

][(1) Grid Identification (Type)

][l. Electrical lightning protection

][(1) Electrical lightning protection for Type I or II building structures

][(2) Class I Type structures (buildings below 75 feet in height)

][(3) Class II Type structures (buildings at or above 75 feet in height)

][(4) Class I & Class II Type structures where the structural steel will be used in lieu of downlead or vertical cables

][(5) Electrical lightning protection specifications: UL certification – “Master Label” rating by a UL inspector

][(6) Installation configuration

][m. Electrical power centers

][(1) Electrical power center type (NEMA enclosure)

][(2) Voltage configuration (120/240 VAC, 12/24 VDC)

][(3) Amperage (panel main bus maximum)

][(4) Dimensions

][(5) Weight

][(6) UL certification

][(7) EMI levels

][(8) Number of circuit breaker positions (outputs)

][(9) Electrical power center impedance

][n. Electrical power supplies

][(1) Electrical power supply type

][(2) DC output ratings

][(3) Dimensions, weight

][(4) UL certification, EMI levels

][(5) Electrical power supply impedance

][o. Electrical rectifiers

][(1) Electrical rectifier type (enclosure type)

][(2) DC voltage range (and DC current supply, kA)

][(3) Thyristor configurations (bridge, double-star, parallel)

][(4) Pulse number per unit

][(5) Dimensions, weight

][(6) UL certification

][p. Electrical relays

][(1) Electrical relay type (NEMA enclosure type)

][(2) Voltage configuration

][(3) Time over current curves (time delay curves)

][(4) Phase and ground operating curves (shapes)

][(5) Dimensions, weight

][(6) UL certification, EMI levels

][(7) Number and types of output relays

][(8) Current loading

][q. Electrical starters

][(1) Electrical starter type (NEMA enclosure type)

][(2) Amperage and voltage configuration (25A - 60A, <600 V and ¼ - 50HP)

][(3) Overload settings

][(4) Dimensions, weight

][(5) UL certification, EMI levels

][r. Electric switch, all types

][(1) Switch type

][(2) Switch specifications

][s. Electrical transformer load tap changer

][(1) Electrical transformer load tap changer type (NEMA enclosure type)

][(2) Step-down voltage configuration (number of positions)

][(3) Maximum current loading

][(4) Maximum tapping range (kV)

][(5) Insulation level (to ground and phase-to-phase)

][(6) Arcing time

][(7) Dimensions, weight

][(8) Oil capacity

][(9) UL certification, EMI levels (if applicable)

][t. Motor control center

][(1) Motor control center type

][(2) Motor control center specifications

][u. Switchgear

][(1) Switchgear type

][(2) Switchgear specification data (voltage rating)

][v. Transformers

][(1) Transformer type

][(2) Winding resistance

][(3) Current transformer ratios

][(4) Transformer impedance

][(5) Load loss at rated voltage and current

][(6) Current loading

]2.2.4 Extra Materials

Submit spare parts list data for each different item of material and equipment specified, after approval of detail drawings and at least [_____] months before the date of beneficial occupancy. List of parts and supplies, providing current unit prices and source of supply, and list spare parts recommended for 12 months of operation. List parts that the manufacturer recommends replacing after [1] [and] [_____] years of service.

PART 3 EXECUTION

3.1 EXAMINATION

Perform visual inspection on the equipment listed below. Correct abnormalities or defects.

[a. Batteries (general)

][b. Batteries (lead-acid)

][c. Battery chargers

][d. Breakers:

][(1) General

][(2) Air blast

][(3) Air magnetic

][(4) Oil

][(5) SF6 gas

][(6) Vacuum

][e. Cables:

][(1) General

][(2) Low voltage (600V maximum)

][(3) Medium voltage (600V-33,000V)

][(4) High voltage (33,000V minimum)

][f. Electrical, capacitor banks

][g. Capacitors, dry-type

][h. Capacitors, liquid filled

][i. Electrical automatic transfer switches

][j. Electric bus

][k. Electrical control panels

][l. Electrical distribution panels

][m. Electrical grounding grid

][n. Electrical lightning protection

][o. Electrical power centers

][p. Electrical power supplies

][q. Electrical rectifiers

][r. Electrical relays

][s. Electrical starters

][t. Electric switches:

][(1) Cutouts

][(2) Low-voltage air

][(3) Medium and high voltage air, open

][(4) Medium voltage air, metal enclosed

][(5) Medium voltage, oil

][(6) Medium voltage, SF6

][(7) Medium voltage, vacuum

][u. Electrical transformer load tap changer

][v. Motor control centers

][w. Switchgear

][x. Transformers

]3.2 INSTALLATION

Submit installation drawings for installed equipment including equipment layouts with assembly instructions, manufacturer's instructions, installation details, and electrical connection diagrams. Ensure that layout and installation details include support structures, conduit, and related system components. Include on the drawings information required to demonstrate that the system has been coordinated and will function within the electrical system, and show the relationship of the equipment to other parts of the work, including clearances required for operation and maintenance.

Submit connection diagrams for electrical equipment, panels, conduit, and specialties, indicating the relations and connections of devices and apparatus by showing the general physical layout of controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

3.3 FIELD QUALITY CONTROL AND ACCEPTANCE TESTING

****

NOTE: The acceptance criteria, as defined in this specification, may also be used to establish the required baselines for future maintenance.

At the Government's option, Government may elect not to have the Contractor perform acceptance testing, but instead the acceptance testing may be performed either by Government personnel or other designated third party personnel. This option can be exercised on a case-by-case basis. Regardless of who performs the acceptance testing, Contractor compliance with the requirements of acceptance is still mandatory.

****

Deliver equipment and services that meet the contract requirements and specifications. Ensure that equipment is free of latent manufacturing and installation defects, and that acceptance criteria are met. Perform acceptance testing as defined in the RCBEA GUIDE, using both traditional

and PT&I technologies. The Government will observe and monitor the acceptance testing, analysis, and documentation as part of the Government's Quality Assurance Program. Not until the requirements of acceptance are met will the equipment or facility be accepted by the Government.

3.3.1 Predictive Testing and Inspection Tests

****

NOTE: Predictive Testing and Inspection (PT&I) involves the use of acceptance and inspection techniques that are nonintrusive and nondestructive in order to avoid introducing problems. It also involves the use of data collection devices, data analysis and computer databases to store and trend information. Typical PT&I technologies used during electrical equipment acceptance include, but are not limited to: infrared thermography, contact resistance tests, high-voltage and power factor tests, airborne ultrasonics, electrical system testing, and insulation resistance tests.

The PT&I tests prescribed in this section are MANDATORY for all assets and systems identified as Critical, Configured, or Mission Essential. Unless the PT&I test is designated as "optional", do not remove the requirement from this specification. If the system is noncritical, nonconfigured, and not mission-essential, use sound engineering discretion to assess the value of adding these additional test and acceptance requirements.

Enhanced acceptance criteria may have an impact on contractor cost, and therefore cost. It is not the intent of these acceptance criteria to unnecessarily drive up the cost of equipment installations and contractor work. If the cost of the added inspections and the cost of enhanced equipment designs outweigh their performance and life-cycle value, then obviously requiring overly restrictive acceptance criteria should not be used. The acceptance criteria should define the “minimum” limits essential for a good, quality installation. See the RCBEA Guide for additional information regarding cost feasibility of PT&I.

****

Perform the following PT&I tests in accordance with the requirements and criteria established in the RCBEA GUIDE. Include test point locations in submitted reports.

Provide final test reports to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the System name, Date, and the words "[Preliminary] [Final] Test Report Data - Forward to the [Systems Engineer] [Condition Monitoring Office] [Predictive Testing Group] for inclusion in the Maintenance Information Database."

[a. Perform SF6 Gas Test for:

][(1) Breakers, SF6 gas

][(2) Electric switch, medium-voltage, SF6

][b. Perform SF6 Gas Leakage Test for:

][(1) Breakers, SF6 gas

][c. Perform Air Compressor Performance Test for:

][(1) Breakers, SF6 gas

][d. Perform Automatic Transfer Test for:

][(1) Electrical automatic transfer switch

][e. Perform Battery Impedance Test for:

][(1) Batteries (general)

][(2) Batteries (lead-acid)

][f. Perform Breaker Timing Test for:

][(1) Breakers, general [optional]

][(2) Breakers, air blast [optional]

][(3) Breakers, air magnetic [optional]

][(4) Breakers, oil [optional]

][(5) Breakers, SF6 Gas [optional]

][(6) Breakers, vacuum [optional]

][g. Perform Capacitor Bank Acceptance Test for:

][(1) Electrical, capacitor bank

][h. Perform Capacitor Discharge Test for:

][(1) Electrical, capacitor bank

][(2) Capacitor, dry-type

][i. Perform Contact Resistance Test for:

][(1) Battery (lead-acid)

][(2) Battery chargers

][(3) Breakers, general

][(4) Breakers, air blast

][(5) Breakers, air magnetic

][(6) Breakers, oil

][(7) Breakers, SF6 gas

][(8) Breakers, vacuum

][(9) Electrical automatic transfer switch

][(10) Electric bus

][(11) Electrical control panel

][(12) Electrical distribution panel

][(13) Electrical power centers

][(14) Electrical power supplies

][(15) Electrical rectifiers

][(16) Electric switch, cutouts

][(17) Electric switch, low-voltage air

][(18) Electric Switch, medium and high-voltage air, open

][(19) Electric switch, medium-voltage air, metal enclosed

][(20) Electric switch, medium-voltage, oil

][(21) Electric switch, medium-voltage, SF6

][(22) Electric switch, medium-voltage, vacuum

][(23) Electrical transformer load tap changer

][(24) Electrical relays [optional]

][(25) Electrical starters [optional]

][(26) Switchgear [optional]

][(27) Transformers [optional]

][j. Perform Continuity Test for:

][(1) Electrical lightning protection

][k. Perform Fall of Potential Test for:

][(1) Electrical grounding grid

][l. Perform General Battery Test for:

][(1) Battery (lead-acid)

][m. Perform General Charger Test for:

][(1) Battery chargers

][n. Perform High Voltage Test for:

][(1) Breakers, general [optional]

][(2) Breakers, air blast [optional]

][(3) Breakers, air magnetic [optional]

][(4) Breakers, oil [optional]

][(5) Breakers, SF6 gas [optional]

][(6) Breakers, vacuum [optional]

][(7) Cables (general) [optional]

][(8) Cables, low-voltage (600 V maximum) [optional]

][(9) Cables, medium-voltage (600 V-33,000 V) [optional]

][(10) Cables, high-voltage (33,000 V minimum) [optional]

][(11) Electrical distribution panel [optional]

][(12) Electrical power centers [optional]

][(13) Electrical Rectifiers [optional]

][(14) Electric switch, cutouts [optional]

][(15) Electric switch, medium and high-voltage air, open [optional]

][(16) Electric switch, medium-voltage air, metal enclosed [optional]

][(17) Electric switch, medium-voltage, oil [optional]

][(18) Electric switch, medium-voltage, SF6 [optional]

][(19) Electric switch, medium-voltage, Vacuum [optional]

][(20) Electrical transformer load tap changer [optional]

][(21) Switchgear [optional]

][(22) Transformers [optional]

][o. Perform Infrared Thermography Test for:

][(1) Electrical control panels

][(2) Electrical distribution panel

][(3) Electrical power centers

][(4) Electrical power supplies

][(5) Electrical starters

][(6) Motor control center

][(7) Switchgear

][(8) Transformers

][(9) Batteries (general) [optional]

][(10) Batteries (lead-acid) [optional]

][(11) Battery chargers [optional]

][(12) Breakers, general [optional]

][(13) Breakers, air blast [optional]

][(14) Breakers, air magnetic [optional]

][(15) Breakers, oil [optional]

][(16) Breakers, SF6 gas [optional]

][(17) Breakers, vacuum [optional]

][(18) Electrical automatic transfer switch [optional]

][(19) Electric bus [optional]

][(20) Electrical rectifiers [optional]

][(21) Electric switch, cutouts [optional]

][(22) Electric switch, low-voltage air [optional]

][(23) Electric switch, medium and high-voltage air, open [optional]

][(24) Electric switch, medium-voltage air, metal enclosed [optional]

][(25) Electric switch, medium-voltage, oil [optional]

][(26) Electric switch, medium-voltage, SF6 [optional]

][(27) Electric switch, medium-voltage, vacuum [optional]

][(28) Electrical transformer load tap changer [optional]

][p. Perform Insulation Oil Test for:

][(1) Breakers, oil

][(2) Capacitor, liquid filled

][(3) Electric switch, medium-voltage, oil

][(4) Electric switch, medium-voltage, vacuum

][(5) Transformers

][(6) Breakers, general [optional]

][q. Perform Insulation Resistance Test for:

][(1) Breakers, general

][(2) Breakers, air blast

][(3) Breakers, air magnetic

][(4) Breakers, oil

][(5) Breakers, SF6 gas

][(6) Breakers, vacuum

][(7) Cables (general)

][(8) Cables, low-voltage (600 V maximum)

][(9) Cables, medium-voltage (600 V - 33,000 V)

][(10) Cables, high-voltage (33,000 V minimum)

][(11) Capacitor, dry-type

][(12) Capacitor, liquid filled

][(13) Electrical automatic transfer switch

][(14) Electric bus

][(15) Electrical rectifiers

][(16) Electrical relays

][(17) Electric switch, cutouts

][(18) Electric switch, low-voltage air

][(19) Electric switch, medium and high-voltage air, open

][(20) Electric Switch, medium-voltage air, metal enclosed

][(21) Electric switch, medium-voltage, oil

][(22) Electric switch, medium-voltage, SF6

][(23) Electric switch, medium-voltage, vacuum

][(24) Electrical transformer load tap changer

][(25) Switchgear

][(26) Electrical control panel [optional]

][(27) Electrical distribution panel [optional]

][(28) Electrical lightning protection [optional]

][(29) Electrical power centers [optional]

][(30) Electrical power supplies [optional]

][(31) Electrical starters [optional]

][(32) Motor control centers [optional]

][(33) Transformers [optional]

][r. Perform Overpotential Test for:

][(1) Capacitor, dry-type

][(2) Electric bus

][s. Perform Point to Point Test for:

][(1) Electrical Grounding grid

][t. Perform Power Factor Test for:

][(1) Electrical rectifiers

][(2) Electrical transformer load tap changer

][(3) Transformers

][(4) Breakers, general [optional]

][(5) Breakers, air blast [optional]

][(6) Breakers, air magnetic [optional]

][(7) Breakers, oil [optional]

][(8) Breakers, SF6 gas [optional]

][(9) Breakers, vacuum [optional]

][(10) Cables (general) [optional]

][(11) Cables, medium-voltage (600 V - 33,000 V) [optional]

][(12) Cables, high-voltage (33,000 V minimum) [optional]

][(13) Electrical automatic transfer switch [optional]

][(14) Electrical control panel [optional]

][(15) Electrical distribution panel [optional]

][(16) Electrical power centers [optional]

][(17) Electrical power supplies [optional]

][(18) Electric switch, cutouts [optional]

][(19) Electric switch, medium and high-voltage air, open [optional]

][(20) Electric switch, medium-voltage air, metal enclosed [optional]

][(21) Electric switch, medium-voltage, oil [optional]

][(22) Electric switch, medium-voltage, SF6 [optional]

][(23) Electric switch, medium-voltage, vacuum [optional]

][(24) Switchgear [optional]

][u. Perform Turns Ratio Test for:

][(1) Electrical transformer load tap changer

][(2) Electrical rectifiers

][(3) Electric switch, medium-voltage, SF6

][(4) Transformers

][v. Perform Ultrasonic (Airborne) Test for:

][(1) Electrical control panel

][(2) Electrical distribution panel

][(3) Electrical power centers

][(4) Electrical starters

][(5) Motor control centers

][(6) Switchgear

][(7) Transformers

][(8) Batteries (lead-acid) [optional]

][(9) Battery chargers [optional]

][(10) Breakers, general [optional]

][(11) Breakers, air blast [optional]

][(12) Breakers, air magnetic [optional]

][(13) Breakers, oil [optional]

][(14) Breakers, SF6 gas [optional]

][(15) Breakers, vacuum [optional]

][(16) Cables (general) [optional]

][(17) Cables, low-voltage (600 V maximum) [optional]

][(18) Cables, medium-voltage (600v-33,000 V) [optional]

][(19) Cables, high-voltage (33,000 V minimum) [optional]

][(20) Capacitor banks [optional]

][(21) Capacitor, dry-type [optional]

][(22) Capacitor, liquid filled [optional]

][(23) Electrical automatic transfer switch [optional]

][(24) Electric bus [optional]

][(25) Electrical rectifiers [optional]

][(26) Electric switch, cutouts [optional]

][(27) Electric switch, low-voltage air [optional]

][(28) Electric switch, medium and high-voltage air, open [optional]

][(29) Electric switch, medium-voltage air, metal enclosed [optional]

][(30) Electric switch, medium-voltage, oil [optional]

][(31) Electric switch, medium-voltage, SF6 [optional]

][(32) Electric switch, medium-voltage, vacuum [optional]

][(33) Electrical transformer load tap changer [optional]

][w. Perform Vacuum Bottle Integrity Test for:

][(1) Breakers, SF6 gas

][(2) Electric switch, medium-voltage, vacuum

]3.3.2 Baseline Data from Verification Testing

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NOTE: PT&I data allows for effective planning and scheduling of maintenance or repairs so that consequences from failure can be minimized or eliminated. For PT&I data to be effective, initial baseline data, normally taken at inception, is needed for comparisons and trending. From an equipment acceptance perspective, PT&I tests have become one of the most effective methods for testing new and in–service equipment for hidden defects.

Ensuring that facilities and equipment meet acceptance criteria and obtaining and documenting critical baseline data is extremely important during the construction phase. As RCM decisions are made later in the life cycle, it becomes more difficult to achieve the maximum possible benefit from Reliability Centered Maintenance programs.

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After PT&I tests have been completed, submit baseline data report to the Contracting Officer. Summarize performance data, set points, operating

parameters and PT&I test results obtained for equipment and building systems.

3.4 OPERATIONS AND MAINTENANCE

Submit manufacturer's operations and maintenance manuals for the following equipment:

[a. Batteries (general)

][b. Batteries (lead-acid)

][c. Battery chargers

][d. Breakers:

][(1) General

][(2) Air blast

][(3) Air magnetic

][(4) Oil

][(5) SF6 gas

][(6) Vacuum

][e. Cables:

][(1)General

][(2) Low-voltage (600 V maximum)

][(3) Medium-voltage (600 V - 33,000 V)

][(4) High-voltage (33,000 V minimum)

][f. Electrical, capacitor banks

][g. Capacitors, dry-type

][h. Capacitors, liquid filled

][i. Electrical automatic transfer switches

][j. Electric bus

][k. Electrical control panels

][l. Electrical distribution panels

][m. Electrical grounding grid

][n. Electrical lightning protection

][o. Electrical power centers

][p. Electrical power supplies

][q. Electrical rectifiers

][r. Electrical relays

][s. Electrical starters

][t. Electric switches:

][(1) Cutouts

][(2) Low-voltage air

][(3) Medium and high-voltage air, open

][(4) Medium-voltage air, metal enclosed

][(5) Medium-voltage, oil

][(6) Medium-voltage, SF6

][(7) Medium-voltage, vacuum

][u. Electrical transformer load tap changer

][v. Motor control centers

][w. Switchgear

][x. Transformers

] Submit [six][_____] complete copies of operations and maintenance manuals in bound 216 by 279 8 1/2 inch by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown. Include the manufacturer's name, model number, parts list, routine maintenance procedures, possible breakdowns and repairs, trouble shooting guide, and a briefly describe the equipment and the basic operating features. Include piping and equipment layouts and simplified wiring and control diagrams of the system as installed. Where available, provide technical manuals in electronic format with Standard Graphics Markup Language. When publications are provided in electronic format, only two copies of the document are required. Submit operations and maintenance manuals 30 calendar days before testing equipment.

3.5 CLOSEOUT ACTIVITIES

Submit record drawings, within [14][_____] days after completion of equipment installation and acceptance testing. Update electrical system drawings to reflect final record as-built conditions after all related work is completed.

After the project and acceptance testing have been completed, the Contracting Officer will provide acceptance documentation to the Contractor. Complete, sign and date this documentation and submit the documentation to the Contracting Officer for processing and approval.

-- End of Section --