
USACE / NAVFAC / AFCEA / NASA UFGS-01 86 26.07 40 (February 2010)

Preparing Activity: NASA New

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2010

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SECTION 01 86 26.07 40

RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS 02/10

NOTE: This specification covers the **AIR FORCE ARMY
NASA NAVY** requirements for Reliability Centered
Building and Equipment Acceptance for Electrical
Systems. The contents universally apply to
electrical systems and may be utilized 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.

Edit this guide specification for project specific
requirements by adding, deleting, or revising text.
For bracketed items, choose applicable items(s) or
insert appropriate information.

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

Comments and suggestions on this guide specification
are welcome and should be directed to the technical
proponent of the specification. A listing of
technical proponents, including their organization
designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as
a Criteria Change Request (CCR).

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

This specification establishes acceptance requirements to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that will shorten the design life of the equipment. These requirements utilize Predictive Testing & Inspection (PT&I) technologies and are essential elements in the Government's Reliability Centered Building and Equipment Acceptance Program.

This 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.

1.2 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 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.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE

(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the

submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

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

SD-01 Preconstruction Submittals

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

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

SD-02 Shop Drawings

Connection Diagrams[; G][; G, [_____]]

Fabrication Drawings[; G][; G, [_____]]

Installation Drawings[; G][; G, [_____]]

SD-03 Product Data

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

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

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

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

Warranty[; G][; G, [_____]]

SD-05 Design Data

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

SD-06 Test Reports

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

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

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

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

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

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

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

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

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

[Continuity Test[; G][; G, [_____]]

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

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

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

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

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

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

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

[Overpotential Test[; G][; G, [_____]]

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

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

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

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

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

[Visual Inspection[; G][; G, [_____]]

SD-07 Certificates

Certificates[; G][; G, [_____]]

SD-08 Manufacturer's Instructions

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

SD-10 Operation and Maintenance Data

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

SD-11 Closeout Submittals

Acceptance Documentation[; G][; G, [_____]]

Record Drawings[; G][; G, [_____]]

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

1.4 DESIGN DATA

Submit applicable **design analysis and calculations** for the equipment listed below as instructed to by the project specification.

- [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]

1.5 QUALITY ASSURANCE

Submit a Quality Control plan outlining the intended methods of receiving, testing, and installing equipment. The [RCBEA GUIDE](#) specifies minimum test equipment requirements. Use trained and adequately certified personnel in the appropriate acceptance testing PT&I technologies to ensure that the results are accurate and consistent. Submit the following as part of the [quality control plan](#) for all required acceptance testing:

- a. List of all test equipment used, including its manufacturer, model number, calibration date, certificate of calibration, and serial number.
- b. Certificates of test personnel qualifications and certifications.

1.6 WARRANTY

Furnish workmanship and performance **warranty** for the work performed for a period not less than [1][_____] years from the date of Government acceptance of the work; issued directly to the Government. Perform corrective action that becomes necessary because of defective materials and workmanship while system is under warranty [7][_____] days after 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 the cost billed to the Contractor. Provide a [1][_____] year minimum contractor installation warranty.

PART 2 PRODUCTS

2.1 PRODUCT DATA

Submit **material, equipment, and fixture lists** for all equipment, materials, and fixtures planned for use to complete the job before commencing work. Include at a minimum, the item's description, quantity, manufacturer's style or catalog numbers, and specification and drawing reference numbers. Provide a complete list of construction equipment to be used.

2.1.1 Manufacturer Product Data

Submit **fabrication drawings** for equipment and specialties consisting of fabrication and assembly details to be performed in the factory. Show connection diagrams and assemblies in switchgear fabrication drawings

Submit for all equipment listed. Include manufacturer's standard catalog data, at least [5 weeks][_____] prior to the purchase or installation of a particular component, highlighted to show material, size, options, equipment performance data charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Include manufacturer's recommended installation instructions and procedures. 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 for each specified component.

Submit **manufacturer's catalog data** and **equipment foundation data** (as applicable) for the following equipment:

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.

- [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]

2.1.2 Certification Data

Submit applicable [certificates](#) for the equipment listed below showing conformance with test requirements, laboratory certifications, etc. as instructed by the project specification.

- [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]

2.1.3 Specific Equipment Data

Submit the following information for all equipment listed below: location of installation, [AIR FORCE ARMY NASA NAVY](#) Identification number, date of installation (required or actual acceptance date), and applicable [AIR FORCE ARMY NASA NAVY](#) reference drawing number. Unless explicitly stated in submitted manufacturer's literature, provide and 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 Buss]
- [(1) Buss Type]
- [(2) Buss 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) EMI levels (if applicable)]
- [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 (if applicable)]
- [(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 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 (if applicable)]
- [(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 (if applicable)]
- [(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 (if applicable)]
 - [(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, <600V and ¼-50HP, etc.)]
 - [(3) Overload settings]
 - [(4) Dimensions, Weight]
 - [(5) UL certification, EMI levels (if applicable)]
- [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]

2.1.4 Extra Materials

Submit [spare parts list](#) data for each different item of material and equipment specified, after approval of detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 12 months operation, and a list of the parts recommended by the manufacturer to be replaced after [1] [and] [_____] year(s) of service.

PART 3 EXECUTION

3.1 INSTALLATION

Submit [installation drawings](#) for all installed equipment consisting of equipment layouts including assembly, applicable [manufacturer's instructions](#), installation details and electrical connection diagrams; layout and installation details including support structures, conduit and related system components. Include on the drawings any information required to

demonstrate that the system has been coordinated and will properly function within the electrical system, and show equipment relationship 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 all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Submit [record drawings](#), at least [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.

3.2 EXAMINATION

Perform [visual inspection](#) on the equipment listed below. Correct all abnormalities or defects as directed by the Contracting Officer.

- [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]

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 all equipment is free of latent manufacturing and installation defects, and acceptance criteria are met. Perform acceptance testing as defined in this specification and 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 non-intrusive and non-destructive 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 **AIR FORCE ARMY NASA NAVY** 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 non-critical, non-configured, 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 **AIR FORCE ARMY NASA NAVY** 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 all 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 Buss]
- [(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 & 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 (600V Maximum) [optional]]
 - [(9) Cables- Medium Voltage (600V-33,000V) [optional]]
 - [(10) Cables- High Voltage (33,000V 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 & 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 Buss [optional]]
- [(20) Electrical Rectifiers [optional]]
- [(21) Electric Switch, Cutouts [optional]]
- [(22) Electric Switch, Low Voltage Air [optional]]
- [(23) Electric Switch, Medium & 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 (600V Maximum)]
 - [(9) Cables- Medium Voltage (600V-33,000V)]
 - [(10) Cables- High Voltage (33,000V Minimum)]
 - [(11) Capacitor, Dry-Type]
 - [(12) Capacitor, Liquid Filled]
 - [(13) Electrical Automatic Transfer Switch]
 - [(14) Electric Buss]
 - [(15) Electrical Rectifiers]
 - [(16) Electrical Relays]
 - [(17) Electric Switch, Cutouts]
 - [(18) Electric Switch, Low Voltage Air]
 - [(19) Electric Switch, Medium & 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 Buss]
- [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 (600V-33,000V) [optional]]
 - [(12) Cables- High Voltage (33,000V 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 & 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 (600V Maximum) [optional]]
- [(18) Cables- Medium Voltage (600V-33,000V) [optional]]
- [(19) Cables- High Voltage (33,000V Minimum) [optional]]
- [(20) Capacitor Banks [optional]]
- [(21) Capacitor, Dry-Type [optional]]
- [(22) Capacitor, Liquid Filled [optional]]
- [(23) Electrical Automatic Transfer Switch [optional]]
- [(24) Electric Buss [optional]]
- [(25) Electrical Rectifiers [optional]]
- [(26) Electric Switch, Cutouts [optional]]
- [(27) Electric Switch, Low Voltage Air [optional]]
- [(28) Electric Switch, Medium & 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

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.

Upon completion of all PT&I tests submit [baseline data report](#) to the Contracting Officer. Include a summary of all 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 (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]

Submit [Six][_____] complete copies of operations and maintenance manuals in bound 216 by 279 8-1/2 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 brief description of all equipment and their 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 electronic format publications are provided, only two copies of the document are required. Submit operations and maintenance manuals 30 calendar days prior to testing any equipment.

3.5 ACCEPTANCE DOCUMENTATION

Upon completion of the project and acceptance testing the Contracting

Officer will provide [acceptance documentation](#) to the Contractor. Complete, sign and date this documentation and submit back to the Contracting Officer for processing and approval.

-- End of Section --