
USACE / NAVFAC / AFCEA / NASA UFGS-01 86 12.07 40 (February 2010)

Preparing Activity: NASA New

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2010

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SECTION 01 86 12.07 40

RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS 02/10

NOTE: This specification covers the **AIR FORCE ARMY
NASA NAVY** requirements for Reliability Centered
Building and Equipment Acceptance for Mechanical
systems. The contents universally apply to
mechanical 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 26.07 40** RELIABILITY CENTERED
ACCEPTANCE FOR ELECTRICAL SYSTEMS for facility
electrical power and distribution 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, [_____]]

Bearing Layout[; 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

[Alignment Test[; G][; G, [_____]]

[Balancing Test[; G][; G, [_____]]

[Borescope Inspection Test[; G][; G, [_____]]

[Code and Requirements Verification Test[; G][; G, [_____]]

[Cold Starting Test[; G][; G, [_____]]

[Cooling System Evaluation Test[; G][; G, [_____]]

[Ductwork Leakage Test[; G][; G, [_____]]

[Exhaust Emissions Test[; G][; G, [_____]]

[Flux Analysis Test[; G][; G, [_____]]

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

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

[Hydrostatic Test[; G][; G, [_____]]

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

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

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

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

[Mechanical Performance Test[; G][; G, [_____]]

[Motor Circuit Evaluation Test[; G][; G, [_____]]

[Noise Level Acceptance Test[; G][; G, [_____]]

[Operational Fire Damper Test[; G][; G, [_____]]

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

[Power/Output Test[; G][; G, [_____]]

[Thermodynamic Performance Test[; G][; G, [_____]]

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

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

[Vibration Analysis Test[; G][; G, [____]]]

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

[Warranty Test[; 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

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

Acceptance Documentation[; 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. Blowers]

[b. Boilers]

[c. Compressors]

[d. Condensers]

[e. Cranes]

[f. Diesel Engine]

[g. Diesel Generator]

[h. Gearboxes]

[i. Fans]

[j. Fluid Piping]

[k. Heat Exchangers]

[l. Heat Exchange Cooling Tower]

[m. HVAC Ducts]

[n. Material Handling Conveyor]

[o. Miscellaneous Safety Wash]

- [p. Motors]
- [q. Pumps]
- [r. Valves]
- [s. Steam Traps]
- [t. Turbine Expander]
- [u. Turbines- Gas]
- [v. Turbines- Steam]

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 cutaway and sectional views in gearbox fabrication drawings.]

Submit data for all equipment listed in the paragraph entitled, "Product Data," of this section. 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 [bearing layout](#) drawings detailing the type, size, and orientation of bearings for equipment containing bearings, such as motors, pumps, fans, cranes, gearboxes, etc.

Submit for all equipment listed in the paragraph entitled, "Product Data," of this section. 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.

Submit [manufacturer's catalog data](#) and [equipment foundation data](#) for the following equipment:

- [a. Blowers]
- [b. Boilers]
- [c. Compressors]
- [d. Condensers]
- [e. Cranes]
- [f. Diesel Engine]
- [g. Diesel Generator]
- [h. Gearboxes]
- [i. Fans]
- [j. Fluid Piping]
- [k. Heat Exchangers]
- [l. Heat Exchange Cooling Tower]
- [m. HVAC Ducts]
- [n. Material Handling Conveyor]
- [o. Miscellaneous Safety Wash]
- [p. Motors]
- [q. Pumps]
- [r. Valves]

- [s. Steam Traps]
- [t. Turbine Expander]
- [u. Turbines- Gas]
- [v. Turbines- Steam]

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. Blowers]
- [b. Boilers]
- [c. Compressors]
- [d. Condensers]
- [e. Cranes]
- [f. Diesel Engine]
- [g. Diesel Generator]
- [h. Gearboxes]
- [i. Fans]
- [j. Fluid Piping]
- [k. Heat Exchangers]
- [l. Heat Exchange Cooling Tower]
- [m. HVAC Ducts]
- [n. Material Handling Conveyor]
- [o. Miscellaneous Safety Wash]
- [p. Motors]
- [q. Pumps]
- [r. Valves]
- [s. Steam Traps]
- [t. Turbine Expander]
- [u. Turbines- Gas]
- [v. Turbines- Steam]

2.1.1.3 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. Blowers]

- [(1) Blower type]
- [(2) Number of rotating vanes]
- [(3) Number of stationary vanes]
- [(4) Rotating Speed(s)]
- [(5) Number of belts (if belt driven)]
- [(6) Belt lengths - measured at the pitch line (if belt driven)]
- [(7) Diameter of the drive sheave at the drive pitch line (if belt driven)]
- [(8) Diameter of the driven sheave at the drive pitch line (if belt driven)]

[b. Boilers]

- [(1) Boiler type]

[c. Compressors]

- [(1) Compressor type]
- [(2) Number of compressor sections]
- [(3) Number of blades per section]
- [(4) Number of diffusers]
- [(5) Number of gear teeth on drive gear]
- [(6) Number of driven shafts]
- [(7) Number of gear teeth per driven shaft]
- [(8) Rotating speed of each rotor]
- [(9) Lubricating Oil information, viscosity grade in ISO units, AGMA or SAE classification and identification of all additives]
- [(10) Grease lubricant information, type of base stock, NLGI number, type and percent of thickener, dropping point, and base oil viscosity range in SUS]

[d. Condensers]

- [(1) Condenser type]
- [e. Cranes]
- [(1) Crane type, duty class and capacity]
- [(2) Operating speeds]
- [(3) Hoist lift]
- [(4) Number of hoists per crane]
- [f. Diesel Engines]
- [(1) Engine type]
- [(2) Engine specifications]
- [g. Diesel Generator]
- [(1) Engine type]
- [(2) Generator type]
- [(3) Engine specifications]
- [h. Fans]
- [(1) Fan type]
- [(2) Number of rotating fan blades/vanes]
- [(3) Number of stationary fan blades/vanes]
- [(4) Rotating Speed(s)]
- [(5) Number of belts (if belt driven)]
- [(6) Belt lengths - measured at the pitch line (if belt driven)]
- [(7) Diameter of the drive sheave at the drive pitch line (if belt driven)]
- [(8) Diameter of the driven sheave at the drive pitch line (if belt driven)]
- [i. Fluid Piping]
- [(1) Pipe material]
- [(2) Pipe size and schedule]
- [j. Gearboxes]
- [(1) Gearbox type]
- [(2) Type of gear tooth]

- [(3) Gear material]
- [(4) Number of teeth on each gear]
- [(5) Gear ratio]
- [(6) Input and output speeds]
- [k. Heat Exchangers]
 - [(1) Heat Exchanger type]
- [l. Heat Exchange Cooling Tower]
 - [(1) Cooling Tower Identification (Type)]
- [m. HVAC Ducts]
 - [(1) Type of duct installed]
- [n. Material Handling Conveyor]
 - [(1) Conveyor type]
- [o. Miscellaneous Safety Wash]
 - [(1) Type]
- [p. Motors]
 - [(1) Motor type]
 - [(2) Bearing information]
 - [(3) Frame size]
 - [(4) Motor class]
 - [(5) Full load and locked rotor current]
 - [(6) Winding resistance]
 - [(7) Winding inductance]
 - [(8) Cooling fan blades]
 - [(9) Number of rotor bars]
 - [(10) Number of stator slots]
 - [(11) SCR firing sequence]
- [q. Pumps]
 - [(1) Pump type]
 - [(2) Number of stages]
 - [(3) Number of vanes per stage]

- [(4) Number of gear teeth on each pump gear]
- [(5) Type of impeller or gear]
- [(6) Rotating speed]
- [(7) Number of volutes]
- [(8) Number of diffuser vanes]
- [r. Steam Traps]
- [(1) Steam trap type]
- [s. Turbine Expanders]
- [(1) Power Turbine Type]
- [(2) Manufacturer / PT Model Number]
- [(3) Major component list]
- [(4) Number of turbine stages with speed, blades per each row]
- [(5) Coupling type and information]
- [(6) Baseplate supports]
- [(7) Lube Oil System]
- [(8) Exhaust System]
- [(9) Control and Data Output Systems]
- [(10) Vibration System]
- [(11) Fire/Gas/Extinguishing System]
- [(12) Water Wash System]
- [(13) Performance Test by OEM with customer verification/1-yr HR-Output
]
- [t. Turbine- Gas]
- [(1) Gas Turbine Type]
- [(2) Site Design Conditions]
- [(3) Manufacturer/ GT Model Number]
- [(4) Major Component List]
- [(5) Number of compressor/turbines with speeds, blades per each row]
- [(6) Number of combustors and number of fuel nozzles per each combustor
]

- [(7) Gear box, drive, turbine cycle descriptions]
- [(8) Fuel type(s) along with combustion system info to control emissions]
- [(9) Baseplate supports]
- [(10) Acoustic enclosure - noise control]
- [(11) Air inlet information - with filtration details]
- [(12) Starting system]
- [(13) Lube oil system]
- [(14) Exhaust system]
- [(15) Control and data output systems]
- [(16) Vibration system]
- [(17) Emergency power system along with DC battery and controls info]
- [(18) Fire/gas/extinguishing system]
- [(19) Water wash system]
- [(20) Performance Test Criteria by OEM with Customer Verification/1-yr. HR/Output Warranty]
- [u. Turbine- Steam]
- [(1) Steam Turbine Type]
- [(2) Design Conditions]
- [(3) Manufacturer/ ST Model Number]
- [(4) Major Component List]
- [(5) Pressure sections, turbines with speed, blades per each row]
- [(6) Bearings/gear box, drive, turbine cycle descriptions]
- [(7) Baseplate supports]
- [(8) Steam conditions at various locations - flow/pressure/temperature - heat balance diagram]
- [(9) Lube oil system]
- [(10) Starting system/emergency power system]
- [(11) Control and data output systems]
- [(12) Vibration system]
- [(13) Fire/gas/extinguishing system]

[(14) Water wash system]

[v. Valves]

[(1) Valve type]

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, piping 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 [HVAC] [_____] system, and show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

Submit [connection diagrams](#) for equipment, pipes, valves 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 mechanical 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. Blowers]

[b. Boilers]

[c. Compressors]

[d. Condensers]

[e. Cranes]

[f. Diesel Engine]

[g. Diesel Generator]

- [h. Gearboxes]
- [i. Fans]
- [j. Fluid Piping]
- [k. Heat Exchangers]
- [l. Heat Exchange Cooling Tower]
- [m. HVAC Ducts]
- [n. Material Handling Conveyor]
- [o. Miscellaneous Safety Wash]
- [p. Motors]
- [q. Pumps]
- [r. Valves]
- [s. Steam Traps]
- [t. Turbine Expander]
- [u. Turbines- Gas]
- [v. Turbines- Steam]

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. The Government desires that all such equipment be free of latent manufacturing and installation defects, and acceptance criteria is defined to ensure, to the maximum extent possible within economic reason, that these 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

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 equipment acceptance include, but are not limited to, vibration analysis, oil and hydraulic fluid analysis, temperature monitoring, airborne ultrasonics, electrical system testing, and fluid flow and process analysis.

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 alignment test for:]
 - [(1) Blowers (laser preferred)]
 - [(2) Compressors (laser preferred)]

- [(3) Cranes (laser preferred)]
- [(4) Fans (laser preferred)]
- [(5) Heat Exchange Cooling Tower (laser preferred)]
- [(6) Material Handling Conveyor (laser preferred)]
- [(7) Motors (laser preferred)]
- [(8) Pumps (laser preferred)]
- [(9) Turbine Expander (laser preferred)]
- [(10) Turbines- Gas (laser preferred)]
- [(11) Turbines- Steam (laser preferred)]
- [b. Perform [balancing test](#) for:]
 - [(1) Blowers]
 - [(2) Compressors]
 - [(3) Cranes]
 - [(4) Fans]
 - [(5) Heat Exchange Cooling Tower]
 - [(6) Material Handling Conveyor]
 - [(7) Motors]
 - [(8) Pumps]
 - [(9) Turbine Expander]
 - [(10) Turbines- Gas]
 - [(11) Turbines- Steam]
- [c. Perform [borescope inspection test](#) for:]
 - [(1) Turbine Expander]
 - [(2) Turbines- Gas]
 - [(3) Turbines- Steam]
- [d. Perform [code and requirements verification test](#) for:]
 - [(1) Miscellaneous Safety Wash]
- [e. Perform [cold starting test](#) for:]
 - [(1) Diesel Engine]
 - [(2) Diesel Generator]

- [(3) Motors]
- [f. Perform [cooling system evaluation test](#) for:]
 - [(1) Diesel Engine]
 - [(2) Diesel Generator]
- [g. Perform [ductwork leakage test](#) for:]
 - [(1) HVAC Ducts]
- [h. Perform [exhaust emissions test](#) for:]
 - [(1) Diesel Engine]
 - [(2) Diesel Generator]
 - [(3) Turbines- Gas]
- [i. Perform [flux analysis test](#) for:]
 - [(1) Motors]
- [j. Perform [high voltage test](#) for:]
 - [(1) Motors [optional]]
- [k. Perform [hydraulic oil test](#) for:]
 - [(1) Gearboxes]
 - [(2) Compressors [optional]]
 - [(3) Cranes [optional]]
 - [(4) Pumps [optional]]
 - [(5) Turbine Expander [optional]]
 - [(6) Turbines- Gas [optional]]
 - [(7) Turbines- Steam [optional]]
- [l. Perform [hydrostatic test](#) for:]
 - [(1) Boilers]
 - [(2) Fluid Piping]
 - [(3) Heat Exchangers]
 - [(4) A Valves]
- [m. Perform [infrared thermography test](#) for:]
 - [(1) Compressors]

- [(2) Condensers]
- [(3) Fans]
- [(4) HVAC Ducts]
- [(5) Pumps]
- [(6) Turbine Expander]
- [(7) Turbines- Gas]
- [(8) Turbines- Steam]
- [(9) Boilers [optional]]
- [(10) Fluid Piping [optional]]
- [(11) Heat Exchangers [optional]]
- [(12) Motors [optional]]
- [(13) Valves [optional]]
- [n. Perform [insulation power factor test](#) for:]
 - [(1) Motors]
- [o. Perform [insulation resistance test](#) for:]
 - [(1) Cranes [optional]]
 - [(2) Motors [optional]]
- [p. Perform [lubricating oil test](#) for:]
 - [(1) Blowers]
 - [(2) Compressors]
 - [(3) Cranes]
 - [(4) Diesel Engine]
 - [(5) Diesel Generator]
 - [(6) Fans]
 - [(7) Gearboxes]
 - [(8) Heat Exchange Cooling Tower]
 - [(9) Material Handling Conveyor]
 - [(10) Motors]
 - [(11) Pumps]
 - [(12) Turbine Expander]

- [(13) Turbines- Gas]
- [(14) Turbines- Steam]
- [q. Perform [mechanical performance test](#) for:]
 - [(1) Cranes]
 - [(2) Diesel Engine]
 - [(3) Diesel Generator]
- [r. Perform [motor circuit evaluation test](#) for:]
 - [(1) Motors]
- [s. Perform [noise level acceptance test](#) for:]
 - [(1) Cranes]
 - [(2) Diesel Engine]
 - [(3) Diesel Generator]
 - [(4) Turbines- Gas]
- [t. Perform [operational fire damper test](#) for:]
 - [(1) HVAC Ducts]
- [u. Perform [performance test](#) for:]
 - [(1) Material Handling Conveyor]
- [v. Perform [power/output test](#) for:]
 - [(1) Turbines- Gas]
 - [(2) Turbines- Steam]
- [w. Perform [thermodynamic performance test](#) for:]
 - [(1) Blowers]
 - [(2) Boilers]
 - [(3) Compressors]
 - [(4) Condensers]
 - [(5) Fans]
 - [(6) Fluid Piping]
 - [(7) Heat Exchangers]
 - [(8) Heat Exchange Cooling Tower]

- [(9) HVAC Ducts]
- [(10) Pumps]
- [(11) Turbine Expander]
- [(12) Turbine- Gas]
- [(13) Turbine- Steam]
- [(14) Valves [optional]]
- [x. Perform **ultrasonic (airborne) test** for:]
 - [(1) Boilers]
 - [(2) Compressors]
 - [(3) Condensers]
 - [(4) Fans]
 - [(5) HVAC Ducts]
 - [(6) Motors]
 - [(7) Pumps]
 - [(8) Steam Traps]
 - [(9) Turbines- Gas]
 - [(10) Turbines- Steam]
 - [(11) Fluid Piping [optional]]
 - [(12) Heat Exchangers [optional]]
 - [(13) Valves [optional]]
- [y. Perform **ultrasonic (pulse) test** for:]
 - [(1) Fluid Piping [optional]]
 - [(2) Heat Exchangers [optional]]
- [z. Perform **vibration analysis test** for:]
 - [(1) Blowers]
 - [(2) Cranes]
 - [(3) Compressors]
 - [(4) Diesel Engine]
 - [(5) Diesel Generator]
 - [(6) Fans]

- [(7) Gearboxes]
- [(8) Heat Exchange Cooling Tower]
- [(9) Material Handling Conveyor]
- [(10) Motors]
- [(11) Pumps]
- [(12) Turbine Expander]
- [(13) Turbines- Gas]
- [(14) Turbines- Steam]
- [aa. Perform [warranty test](#) for:]
- [(1) Turbines- Gas]
- [(2) Turbines- Steam]

3.4 OPERATIONS AND MAINTENANCE

Submit manufacturer's [operations and maintenance manuals](#) for the following equipment:

- [a. Blowers]
- [b. Boilers]
- [c. Compressors]
- [d. Condensers]
- [e. Cranes]
- [f. Diesel Engine]
- [g. Diesel Generator]
- [h. Gearboxes]
- [i. Fans]
- [j. Fluid Piping]
- [k. Heat Exchangers]
- [l. Heat Exchange Cooling Tower]
- [m. HVAC Ducts]
- [n. Material Handling Conveyor]
- [o. Miscellaneous Safety Wash]
- [p. Motors]

- [q. Pumps]
- [r. Valves]
- [s. Steam Traps]
- [t. Turbine Expander]
- [u. Turbines- Gas]
- [v. Turbines- Steam]

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 --