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USACE / NAVFAC / AFCEC / NASA **UFGS-26 35 44 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 35 44.00 20 (February 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2022
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DIVISION 26 - ELECTRICAL

SECTION 26 35 44

270 VDC SOLID STATE CONVERTER

08/21

ATTACHMENTS:

Figure 263544-1: Transient Voltage Recovery Limits for 270 VDC

Figure 263544-2: Transient Voltage Recovery Limits for 28 VDC

-- End of Section Table of Contents --

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SECTION 26 35 44

270 VDC SOLID STATE CONVERTER
08/21

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NOTE: This guide specification has been specifically limited to cover the requirements for the procurement, installation, and testing of 72 kW, 270 VDC solid state converters.

For Navy projects, the use of any other size converter is no longer authorized. If a different size unit is required for a specific project, contact NAVFAC Atlantic (LANT), Code DC 44 - Electrical Criteria Manager at (757) 322-4327 for authorization, and for the additional requirements necessary to appropriately modify this specification.

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

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

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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NOTE: These converters are used to supply 270 VDC and limited amounts of 28 VDC electrical power to aircraft in shore facility environments. Typical applications include aircraft operating in flight line conditions or in hangars, avionics shops, laboratories, training buildings, flight simulators, and computer rooms.

This specification is not to be used for procurement of power converters installed on board aircraft or ships without specific authorization from Naval Air Warfare Center Aircraft Division (NAWCAD Power and Energy Division (AB43) at (301) 342-4161), and from the Naval Sea Warfare Command (contact the Technical Warrant Officer for the appropriate ship classification).

This specification is not intended for medium-voltage applications.

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NOTE: For Navy projects, incorporate the special SUBMITTAL REVIEW PROCESS paragraph in the SUBMITTALS section. Coordinate with NAVAIR, NAVFAC, and the Activity to see whether the "review and approval", or the "surveillance only" options are required.

1) If "review and approval" (reach-back support) is desired, for a specific NAVFAC project, the technical representative (electrical engineer) editing this document for that project must contact NAVFAC LANT for consultation during the design stage of the project, prior to including the requirement in the specification. Point of Contact (POC) information is included in the first introductory technical note.

2) If "surveillance only" is agreed to, it requires the submittal information to be sent to NAVAIR and NAVFAC LANT for review and comment at the same time as the information is being sent to the Designer of Record for Review and Approval. The surveillance mode would give NAVAIR or NAVFAC LANT the opportunity to confirm compliance, without inadvertently holding up the project if the appropriate personnel are not available to do the review in a timely manner.

The Electrical Designer of Record must also insure that the Division 1, Section 01 33 00 SUBMITTAL PROCEDURES, paragraphs FORWARDING SUBMITTALS REQUIRING GOVERNMENT APPROVAL and SUBMITTALS RESERVED FOR NAVFAC [_____] APPROVAL of the project document are edited to identify the agreed upon special process.

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NOTE: Coordination is required between this section and the project power systems study to determine which of the standardized Arc Flash Warning labels are required on the equipment. These labels (Graphics) are available in metric (SI) and U.S. Customary (IP) system dimensions. Use these files to develop project specific drawings.

File Name	Description
ARCFLASH	Arc Flash Warning Label

NOTE: To download UFGS Forms, Graphics, and Tables, go to: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Go to the specification section number, select the appropriate Electrical.ZIP file(s) and extract the desired details.

Do not include the Arc Flash Warning Labels in the project specifications. Insert the appropriate details on drawings and modify optional and blank items.

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NOTE: To the Project Specification Editors: The following two Attachments are included with the pdf version of this specification section and are referenced several times.

File Name	Description	
Figure 263544-1	Transient Voltage Recovery Limits for 270 VDC	Rev 07 26 21
Figure 263544-2	Transient Voltage Recovery Limits for 28 VDC	Rev 07 26 21

When developing your final project documents, you must download and attach the pdf versions of both figures to the end of this edited Section 26 35 44 270 VDC SOLID STATE CONVERTER.

NOTE: To download UFGS Forms, Graphics, and Tables, go to: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Go to the specification section number, select Figure 263544 -1 and Figure 263544-2 and download.

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NOTE: The following information must be shown on the project drawings:

1. Show location of all equipment including converter, paralleling controls when required, and remote monitoring and control panels.

2. Provide functional block diagram, single line diagrams, power, and control wiring interconnection diagrams, wiring diagrams, conduit entry diagrams, equipment elevations, maintenance envelope, limiting dimensions, and equipment ratings which are not covered in the specifications.

3. Design equipment rooms with working spaces as required by NFPA 70 and manufacturers extra limitations. Provide ventilation for equipment rooms based on converter components heat load generated when operating at 100 percent load. Provide 60 Hz convenience receptacles.

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NOTE: Ensure that the 270 VDC distribution systems are properly coordinated including the ratings of the power cables, ground cables, circuit breakers, transformers, filters, rectifiers, and control equipment. Provide calculations in Basis of Design per UFC 3-501-01, Electrical Engineering, including voltage drops, which can be critical in DC systems.

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PART 1 GENERAL

1.1 REFERENCES

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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.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 519	(2014) Recommended Practices and

	Requirements for Harmonic Control in Electrical Power Systems
IEEE 1159	(2019) Recommended Practice on Monitoring Electric Power Quality
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60947-4-1	(2018; INT 1 2020; Corr 2 2021) Low-voltage Switchgear and Controlgear, Part 4-1: Contactors and Motor Starters - Electromechanical Contactor and Motor Starters

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; ERTA 20-3 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4; TIA 20-5; TIA 20-6; TIA 20-7; TIA 20-8; TIA 20-9; TIA 20-10; TIA 20-11; TIA 20-12; TIA 20-13; TIA 20-14; TIA 20-15; TIA 20-16; ERTA 20-4 2022) National Electrical Code
NFPA 70E	(2021) Standard for Electrical Safety in the Workplace

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AS7974	(2010; Rev A) Cable Assemblies and Attachable Plugs, External Electrical

	Power, Aircraft
SAE AS7974/5	(2017; Rev A) Cable Assembly, External Electrical Power, Aircraft, Single-Jacketed 270 VDC, 90 KW

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-704	(2016; Rev F; Change 1; Notice 3 2021) Aircraft Electric Power Characteristics

UNDERWRITERS LABORATORIES (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers
UL 1012	(2010; Reprint Apr 2016; Rev Mar 2021) UL Standard for Safety Power Units Other than Class 2
UL 1449	(2021) UL Standard for Safety Surge Protective Devices

[1.2 RELATED REQUIREMENTS

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NOTE: Include this optional reference to Section 26 08 00 APPARATUS INSPECTION AND TESTING when it is already being used and referred to for other electrical equipment on the project. Coordinate with optional paragraph in PART 3.

Coordinate converter equipment with Government's cybersecurity requirements and interpretations. Include this optional reference to Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS if the 270 VDC system includes remote control or remote access capability.

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Section [26 08 00 APPARATUS INSPECTION AND TESTING] [and 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS] applies to this section, with the additions and modifications specified herein.

]1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, must be as defined in IEEE 100.

1.4 SUBMITTALS

****

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

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

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

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

****

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

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NOTE: Ensure the optional bracketed "Remote Monitoring and Control Panel" is not included when that equipment is not included in the body of the specification.

****

SD-02 Shop Drawings

Converter Drawings; G[, [_____]]

SD-03 Product Data

Converter; G[, [_____]]

270 VDC Aircraft Power Cable Assembly; G[, [_____]]

28 VDC Interlock; G[, [_____]]

[Remote Monitoring and Control Panel; G[, [_____]]

] SD-06 Test Reports

Work Plan; G[, [_____]]

Routine Factory Test Plan; G[, [_____]]

Special Factory Test Plan; G[, [_____]]

Factory Test Schedule; G[, [_____]]

Routine Factory Tests Certification; G[, [_____]]

Special Factory Tests Certification; G[, [_____]]

SD-07 Certificates

Qualifications of Manufacturer; G[, [_____]]

Nationally Recognized Testing Laboratory (NRTL) Listing; G[, [_____]]

SD-09 Manufacturer's Field Reports

Field Test Plan; G[, [_____]]

Field Test Schedule; G[, [_____]]

Field Test Certification; G[, [_____]]

Training Syllabus; G[, [_____]]

SD-10 Operation and Maintenance Data

****
NOTE: Coordinate with options under paragraph OPERATION AND MAINTENANCE MANUALS.
****

Converter O&MM, Data Package 5; G[, [_____]]

Preliminary Converter O&MM, Data Package 5; G[, [_____]]

[Remote Monitoring and Control Panel, Data Package 5; G[, [_____]]

] **********
NOTE: On Navy projects, include at least one of the bracketed options below. The first option is for surveillance only, and the second option is for complete approval where "reach-back support" has already been coordinated with either NAVAIR or NAVFAC LANT per the third introductory Technical

Note. Add the appropriate information in Section 01 33 00 SUBMITTAL PROCEDURES to coordinate with the special requirements.

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[1.4.1 Government Submittal Review

[NAWCAD Air Vehicle Electrical Power Systems Group (AB43), (301) 342-4161 [and Code DC 44, NAVFAC LANT, Naval Facilities Engineering Command] will provide surveillance. If they have comments or concerns, they will contact and coordinate resolution of their comments with the appropriate approving agent.

] [(NAWCAD Air Vehicle Electrical Power Systems Group (AB43), (301) 342-4161][Code DC 44, NAVFAC LANT, Naval Facilities Engineering Command][_____] will review and approve all submittals in this section requiring Government approval.

]1.5 QUALITY ASSURANCE

1.5.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 5 years prior to bid opening. The 5-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 5-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.2.1 Alternative Qualifications

Products having less than a 5-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site must not be used, unless specified otherwise.

1.5.3 Converter Drawings

****

NOTE: Provide a detail on the drawings that identifies the location, mounting and permitted maintenance access areas for each converter.

For Navy projects, include the bracketed options that require surface mounting against the wall, and prohibits rear access to converter.

****

Furnish scaled drawings of enclosure outline including front, top, side views, and overall dimensions. Include "maintenance envelope" dimensions confirming space limitations identified on the drawings[, and surface mounting flush against the wall.[Rear access for maintenance and repair purposes is prohibited]]. The "maintenance envelope" drawings must also indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Provide external power and control wiring, cabling, connector, and backplane interconnect drawings. Provide single line, schematic, and wiring diagrams. Drawings must include details of input and output circuit breakers, contactors, rectifiers, surge protectors, control devices and conduit entry and exit locations. If parallel operation is included, provide an interconnection diagram. Submittals must include the nameplate data, size, and capacity.

1.5.4 Qualifications of Manufacturer

****

NOTE: The experience clause in this section has been approved by a Level I Contracting Officer in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS). NFAS can be found at the following link:

https://www.navfac.navy.mil/products_and_services/sb/opportunities/guidelines/navfac.html

This clause may be used without further approval or request for waiver.

****

Submit a certification stating that the manufacturer has a minimum of five years' experience in the design, manufacturing, and testing of a 270 VDC solid state converter at the equivalent or greater kW and voltage ratings for direct connection to aircraft electrical loads. When specifications require multiple converters operating in parallel, the manufacturer must provide specific experience with equal or greater kW rated converters.

Experience in manufacturing motor generator sets does not qualify as equivalent. Experience in manufacturing portable engine-driven 28 VDC power units does not qualify as equivalent. The manufacturer must be experienced in producing units for installation in permanent buildings, in environmentally closed spaces, or in weatherproof enclosures as applicable. The manufacturer must furnish documented experience with converters in various environmental conditions including exterior flight line, hangar, and environmentally enclosed spaces within buildings.

1.5.5 Work Plan

Submit a written work plan with the initial shop drawing submittal, which consists of a schedule of dates of the routine and special factory tests, installation of equipment, field tests, and operator training for the system. Furnish a list of the test instrumentation equipment complete with the documented calibration program, for the factory and the field tests.

1.5.6 Routine Factory Test Plan

****

NOTE: Coordinate calendar day requirements with Activity and with special review requirements.

****

Submit test plan and procedures at least [21][_____] calendar days prior to the tests being conducted. Provide detailed description of test procedures, including test equipment and setups complete with their current calibration dates, to be used to ensure the converter meets this specification and explain the test methods used. As a minimum, include the tests required under the paragraph ROUTINE FACTORY TESTS.

1.5.7 Special Factory Test Plan

Submit the Special Factory Test Plan and procedures with the Routine Factory Test Plan. Provide detailed description of test procedures, including test equipment and setups complete with their calibration dates, used to ensure the converter meets this specification and explain the test methods used. As a minimum, include the tests required under the paragraph SPECIAL FACTORY TESTS.

1.5.8 Field Test Plan

****

NOTE: Coordinate calendar day requirements with Activity and with special review requirements. For Navy projects, use 30 days to coordinate with NAVAIR requirement to have time to arrange attendance.

****

Submit test plan and procedures at least [30][15][_____] calendar days prior to the start of field tests. Provide detailed description and dates and times scheduled for performance of tests, and detailed description of test procedures, including test equipment and setups of the tests to be conducted to ensure the system meets this specification. List make, model, and current calibration dates, and provide functional description of the test instruments and accessories. Explain the test methods to be used. As a minimum, include the tests required under the paragraph FIELD QUALITY CONTROL. Test reports must include power quality measurement data collected in accordance with IEEE 1159.

1.5.9 Nationally Recognized Testing Laboratory (NRTL) Listing

270 VDC converters must be identified with a nationally recognized testing laboratory (NRTL) label or UL label prior to shipping.

1.5.9.1 Currently Listed Products

Submit NRTL or UL certification or UL file number for the actual converter to be shipped with the initial submittal to verify compliance of equipment.

1.5.9.2 Proposed Listed Products

Submit NRTL or UL certification or UL file number for same or similar rating or product size range of like design unit with the initial submittal to verify compliance of equipment.

1.5.10 Routine Factory Tests Certification

****
NOTE: Coordinate calendar day requirements with Activity and with special review requirements.
****

Submit within [45][_____] calendar days after completion of tests. Receive approval of test prior to shipping unit. Certify tests were conducted on each converter in accordance with the requirements set forth in paragraph ROUTINE FACTORY TESTS and certify converter satisfactorily operated within specified limits. Include copies of the test procedures, test configuration diagrams and schematics, test data, and results.

1.5.11 Special Factory Tests Certification

Certify tests were conducted on a converter of the same design, construction, kW rating, and voltage rating to be provided. Tests must be in accordance with the requirements set forth in paragraph SPECIAL FACTORY TEST and certify converter operated without malfunctioning within specified limits. Include copies of the test procedures, test configuration diagrams and schematics, test data, and results.

1.5.12 Field Test Certification

****
NOTE: Coordinate calendar day requirements with Activity and with special review requirements.
****

Submit report of test results as specified by paragraph FIELD QUALITY CONTROL within [15][_____] calendar days after completion of tests. Certify tests were conducted on each converter in accordance with the paragraph FIELD QUALITY CONTROL and certify converter satisfactorily operated within specified limits. Include copies of the test procedures, test configuration diagrams and schematics, test data, and results.

1.6 OPERATION AND MAINTENANCE MANUALS

Submit converter Operation and Maintenance Manuals (O&MM) in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.1 Additions to Converter O&MM

****
NOTE: Include the paralleling bracketed option when paralleling has been included as a requirement of the equipment.

****

In addition to requirements of Data Package 5, include the following on the actual converter provided:

a. A "one-line diagram" from the building service entrance panel to the converter and out to the end utilization point(s).

b. A concise, duplicatable, single page data sheet with operating instructions for each unit including startup[, paralleling,] and shutdown procedures.

c. Routine and field test reports.

d. NRTL or UL certification or UL file number.

e. A list of all code required identification and warning signage and labels that have been provided on the converter.

1.6.2 Preliminary Converter O&MM

Prior to scheduling Field Tests, two bound copies of a Preliminary O&MM must be submitted to and approved by the Contracting Officer.

1.6.3 Spare Parts Information

Furnish recommended manufacturer's spare parts list, quantities, lead time to receive after ordering, and a schedule of prices,(guaranteed for one year after warranty expires), for each type of converter and other equipment specified in this section. Include the following:

a. Fuses

b. Human Machine Interface (HMI)

c. Indicator lamp/LED

d. Output switching modules

e. Plug-in logic cards

f. Power filter capacitors

g. Power semi-conductors

h. Ventilation system filters

i. 270 VDC Aircraft Power Cable Assembly

j. 28 VDC Aircraft Power Cable Assembly

1.7 WARRANTY

The equipment items must be supported by service organizations which are most convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 270 VDC CONVERTER

****

NOTE: Do NOT edit this paragraph to specify the internal architecture of the converter (e.g. type of power supply, rectifier type or switching technology to be utilized). Specifying this type of technology may make this a sole source specification which requires justification and approval per federal contract law.

For the options: Choose 50 or 60 Hz based on the exterior power distribution system at the project location. Choose 24,000 for the MTBF unless the project has documented, more stringent requirements.

****

Provide converter consisting of modular construction solid-state components for [50][60] Hz to 270 VDC conversion, input/output devices, and ancillary control devices. Converter must be a standard product of the manufacturer and the manufacturer's latest design that complies with the specification requirements. The converters provided under this contract must be products of the same manufacturer. Each unit must have a calculated Mean Time Between Failures (MTBF) exceeding [24,000][_____] hours as calculated when the converter is provided with yearly servicing and maintenance. Provide converter with NRTL or UL listing complying with UL 1012. The converter must have minimum 12 pulse, active input rectification circuit or a demonstrated design achieving equal or better performance characteristics. Circuit breakers operating at 270 VDC and 28 VDC must be designed and UL tested for [50][60] Hz operation [and derated] for the applicable VDC operation, as appropriate. Provide startup and shutdown instructions posted on the front of the unit using engraved plastic or aluminum plate. Provide a plastic encapsulated schematic diagram attached to the inside of the unit in clear view of maintenance personnel.

2.1.1 Electrical Characteristics

The 270 VDC output and the associated 28 VDC Interlock voltage, measured at the aircraft end of the servicing cable, must be in accordance with MIL-STD-704, must be controlled to the voltage regulation requirements within this document throughout all loadings defined, and must comply with the additional modifications identified herein.

2.1.1.1 Input Voltage

****

NOTE: Using input voltage other than 480 volts (US) or 380 volts (European) will increase the cost and weight and decrease the efficiency of the converter. Show input voltage on the construction drawings.

Choose 60 or 50 Hz based on the exterior power distribution system at the project location. Choose 10 percent voltage variation unless specific project documents require a higher percentage input

variation to be permitted.

A voltage changing transformer is not permitted at the input of the converter unit on any new facilities. Adding a voltage changing transformer at the input is only permitted in the rare case when retrofitting an existing facility and there is no other voltage available. In this exception, remove the last sentence in the section below.

****

[480][380][_____] V, three phase, three wire, grounded, [60][50] Hz. Converter must provide rated output voltage when input voltage is varied plus or minus [10][_____] percent. A voltage changing transformer is not permitted at the input of the converter unit.

2.1.1.2 Input Power Factor

Between 0.8 lagging and unity, under all conditions of steady state line and load variations specified herein.

2.1.1.3 Surge Protection

****

NOTE: Select Location Category C for outdoor locations only.

****

Provide converter capable of sustaining an input surge described in and tested in accordance with UL 1449, and IEEE C62.41.1 and IEEE C62.41.2, Location Category [B][C], and continue to operate with no alarms within the specified tolerance.

2.1.1.4 Inrush Current

The inrush current must not exceed 100 percent of the rated full load input current.

2.1.1.5 Input Current Distortion

****

NOTE: Where total connected converter load is a small percentage (less than 40 percent) of the total connected facility load, use 12 percent Total Harmonic Distortion (THD)and 8 percent individual. For large converters (e.g. 312 kW or larger) or where total connected converter load is a significant percentage of the total connected facility load, use 5 percent THD and 3 percent individual.

For installation in shipboard environments using Type 1 power (60 hertz per MIL-Std-1399-300, Part 1 (2018) Low Voltage Electric Power, Alternating Current), use 5 percent THD and 3 percent individual.

Note that per NAVAIR request, the converter Special Tests paragraph requires data to be provided at the 25, 50, 75 and 100 percent load points. This is

intentionally more stringent than the "full load" requirement below, and is intended for data acquisition only. It will be used to help develop a resolution to known field problems.

****

Input current Total Harmonic Distortion (THD) must not exceed [12][5] percent of the fundamental frequency with nominal input voltage at full load. Individual harmonic content must not exceed [8][3] percent of the fundamental frequency.

2.1.1.6 Output Voltage

As an exception to the requirements of MIL-STD-704, the 270 VDC converter must simultaneously provide and regulate (when measured at the cable head) to the following steady state voltage limits:

a. 270 VDC (plus or minus 3 VDC).

b. 28 VDC (plus 1 VDC or minus 2 VDC).

2.1.1.7 Power Output

The 270 VDC converter must have a power output rating of:

a. 270 VDC: 267 amperes (72 kW) with overload / transient capability as defined herein.

b. 28 VDC: 15 amperes (0.42 kW) with overload / transient capability as defined herein.

2.1.1.8 Load Range

The 270 VDC converter must be capable of meeting the following load ranges:

a. 270 VDC: 0 to 72 kW of any combination of resistive and constant power loads with overload / transient capability as defined herein, in parallel with up to 2,500 microfarads of capacitance, with a minimum current demand rate of 200 Amperes per millisecond.

b. 28 VDC: 0 to 0.42 kW of any combination of resistive and constant power loads with overload / transient capability as defined herein, in parallel with up to 100 microfarads of capacitance, with a minimum current demand rate of 60 Amperes per millisecond.

2.1.1.9 Efficiency

****

NOTE: For the Navy, the use of any size converter other than 72 kW is no longer authorized. If a different size is required for a specific project, contact NAVFAC LANT for approval and for the appropriate efficiency modifications. The POC information is located at the beginning of this specification.

****

Provide 72 kW units with a minimum efficiency of 89 percent at 50 percent load and 92 percent at 100 percent load.

2.1.1.10 No Load Input Losses

Provide converter with no-load input losses no greater than 7 percent of the output kW rating.

2.1.1.11 Overload

The converter outputs, both 270 VDC and 28 VDC, must have overload capabilities in accordance with the following table. The satisfactory overload operating time is based on no more than one overload of the same or longer conditions, within the following specified time between overloads.

Percent of Full Load (Rated Output)	Satisfactory Operating Time	Time Between Overloads
110 percent	30 minutes	2 hours Note: Unit must still be capable of withstanding any of the other conditions for their respective operating times. e.g. Unit can still do 150 percent for less than 10 seconds, before tripping, etc.
125 percent	5 minutes	10 minutes
150 percent	10 seconds	10 minutes
200 percent	2 seconds	5 minutes
250 percent	100 milliseconds	5 minutes

After minimum operating time is achieved, unit must interrupt output power. Unit must be capable of sustaining the overload without damage until the protective device interrupts the overload.

2.1.1.12 Short Circuit

When a bolted positive to negative fault is applied to the unit, unit must be capable of sustaining the short circuit current without damage until the protective device interrupts the fault. The output transient voltage recovery time and thresholds are more stringent than those required by MIL-STD-704, and must comply with the following:

a. During a bolted fault the current output must be regulated between 485 and 550 Amps for 5 seconds. If the fault condition clears in less than 5 seconds, the power source must recover to the voltage range of 250 to 280 volts within 40 milliseconds, and then settling out to the regulated voltage levels of 270 VDC (plus or minus 3 VDC) within 10 milliseconds, as shown in Figure 263544-1: Transient Voltage Recovery Limits for 270 VDC.

b. During this 270 VDC bolted fault condition, as well as for any high

di/dt load or overload condition (e.g. over voltage, over current, under voltage, ripple), the 28 VDC interlock power output must not be disrupted and power quality must remain as defined in Figure 263544-2: Transient Voltage Recovery Limits for 28 VDC, throughout the fault isolation event.

2.1.1.13 Ripple Amplitude

Ripple amplitude is the maximum absolute value of the difference between the steady state and the instantaneous DC voltage. The maximum allowable ripple amplitude for the 270 VDC output is more stringent than what is required by MIL-STD-704. The maximum allowable ripple amplitude for the 28 VDC output must be in accordance with MIL-STD-704 These must comply with the following:

a. 270 VDC output: 1.5V (peak to mean).

b. 28 VDC output: 1.5V (peak to mean).

2.1.1.14 Distortion Spectrum

The converter output distortion spectrum must meet the following requirements:

a. 270 VDC: MIL-STD-704 Figure 18, inclusive of the fundamental voltage ripple component.

b. 28 VDC: MIL-STD-704 Figure 15.

2.1.1.15 Distortion Factor

The DC distortion factor is the ratio of the DC distortion to the DC steady state voltage. The maximum allowable distortion factor for the 270 VDC converter must be as follows per Table IV of MIL-STD-704:

a. 270 VDC output: 0.015.

b. 28 VDC output: 0.035.

2.1.1.16 Transient Output Voltage Recovery

The transient output voltage recovery time and thresholds are more stringent than those required by MIL-STD-704. Monitor and record output voltage at the load end of the cable. Comply with the following:

a. The 270 VDC output must remain within the range of 220 to 330 VDC for any step load change as defined in paragraph LOAD RANGE herein.

b. The 270 VDC output must begin recovery from the worst case transient excursion within 10 milliseconds and must be recovered to within the steady-state operating range specified in paragraph OUTPUT VOLTAGE within 40 milliseconds per Figure 263544-1: Transient Voltage Recovery Limits for 270 VDC.

c. The 28 VDC output must remain within a range of 26 to 40 VDC for any step load change as defined in paragraph LOAD RANGE herein. The voltage must not drop below 26 VDC for more than 50 microseconds.

d. The 28 VDC output must begin recovery from the worst case transient

excursion within 15 milliseconds and must be recovered to within the steady-state operating range specified in paragraph OUTPUT VOLTAGE within 100 milliseconds per Figure 263544-2: Transient Voltage Recovery Limits for 28 VDC.

2.1.2 Environmental Rating

****

NOTE: Select 55 degrees C 130 degrees F for the ambient temperature rating unless in areas subject to extreme temperatures (e.g. Middle East and desert environments.). Use 0-95 percent relative humidity unless extreme condensation such as in a jungle climate.

Use 915 meters 3000 feet level unless location of installation will be at higher elevations.

****

The converter must be rated for continuous operation from no load to rated full load under the following conditions:

a. Ambient temperatures ranging from -20 to [55][60][65] degrees C. -4 to [130][140][150] degrees F.

b. Relative humidity from [0 to 95] [_____] percent noncondensing.

c. Ambient pressures from sea level to [915] [_____] meters [3,000] [_____] feet.

2.1.3 Monitoring and Control Panel

Provide converter with a control panel that is equipped with the following controls, indicators, instrumentation, data logging, diagnostics, and alarm functions.

2.1.3.1 Controls

Controls must be mounted on the front of the control panel, accessible without opening any doors or covers. Specific sequencing, or the requirement for simultaneous pushbutton operation, is not acceptable for any input or output control.

****

NOTE: Include the remote control panel option when unit is platform mounted or located out of sight of aircraft.

****

a. Start/stop pushbutton for input device control (circuit breaker or contactor).

b. Lamp/light emitting diode (LED) test - A push-to-test button or switch to test indicator lamps/LEDs. If panel lights all blink as part of the startup Built-in-Test (BIT) sequence, then a separate push to test button is not required.

c. Emergency power off - A separate pushbutton for emergency power off.

d. Output device ON/OFF.

e. Alarm silence and "silence" indicator - A switch that must disable the audible alarm without clearing the alarm codes.

f. Additional individual controls for the following functions (Note - these may be included as part of the Human-Machine Interface (HMI) as described in paragraph HUMAN MACHINE INTERFACE REQUIREMENTS):

- Output voltage adjust

- Alarm reset - resets and clears the silenced audible alarm.

2.1.3.2 Indicators

a. The following are mandatory indicators. They must be included on the control panel on the exterior of the unit[, and on the exterior of the remote control panel] in addition to any that are included in the HMI:

- Input power available - Lamp/LED to indicate that the supply voltage is available.

- Output power On/Off - Lamp/LED to indicate that the converter output voltage is available.

- Output device "ON".

- Audible alarm.

- Aircraft interlock bypass - Lamp/LED to indicate that the Aircraft Interlock has been bypassed.

b. In addition, include the following additional indicators, if they are not included in the HMI:

- System alarm - Lamp/LED to indicate that a fault has been detected. This indicator must be latched in the "ON" position whenever an alarm condition described in paragraph ALARM ANNUNCIATOR, is detected and must remain "ON" until the alarm reset pushbutton is pressed.

- Indicating lamp/LED to indicate that the alarm silence switch is in the disable position.

- Elapsed time meter in hours; (may be internal or visible externally).

2.1.3.3 Human Machine Interface (HMI) Requirements

Provide an HMI with a minimum of four by twenty (4 x 20) character backlit LED display for presenting the digital instrumentation, diagnostic system, and fault indicating system data. The HMI display must be viewable in direct sunlight and the HMI must be rated for harsh environments.

a. Digital Instrumentation. Provide true RMS, plus/minus one percent accuracy, microprocessor-based readings that include the following functions:

(1) Output voltage.

(2) Output current.

(3) Inverter temperature. This function is desired for field diagnostics, but is not mandatory.

b. Alarm Annunciator. The unit must be capable of detecting and displaying the following abnormal conditions:

(1) Input overvoltage.

(2) Input undervoltage.

(3) Output undervoltage.

(4) Output overvoltage.

(5) Output overload.

(6) System alarm.

(7) Control logic failure.

(8) Over-temperature.

(9) Logic power supply failure.

2.1.4 Input/Output Devices

****
NOTE: Coordinate 50 Hz vs 60 Hz requirement with Activity. Provide appropriate short circuit ratings in accordance with Basis of Design Calculations per UFC 3-501-01, Electrical Engineering.
****

Provide fully-rated, UL approved devices for control of [60][50] Hz input and for control of DC outputs from the converter. Derate devices and cables operating at 270 VDC in accordance with IEEE 519.

2.1.4.1 Input Device

Provide converter with a UL listed input device (circuit breaker conforming to requirements of UL 489 or contactor) as an integral part of the converter. Device must be operable from the front of the converter. Device must have a short-circuit current rating of [_____] amperes symmetrical minimum.

2.1.4.2 Output Contactor

****
NOTE: Include option for IEC on Oconus projects.
****

Provide converter output with an automatic magnetically-held contactor with interlock circuit. Output contactor must have sufficient capacity to handle rated load, overload, and available short circuit current. Contactor must additionally be rated for make / break operation into a 2,500 microfarads capacitance without damage to the converter.

Contactor must open when any circuit identified in the paragraph SAFETY

FUNCTIONS causes the system to shut down. Electrically interlock contactor with ON/OFF circuitry so that when the converter is shut down, the contactor opens immediately and remains open.[Conform to the requirements of IEC 60947-4-1.]

[2.1.4.3 Output Circuit Breaker

****

NOTE: Only add an output circuit breaker, (and delete the OUTPUT CONTACTOR paragraph above), if the converter is supplying a downstream distribution panelboard (such as in a shop or laboratory), or multiple outputs with distribution internal to the converter.

****

Provide converter output(s) with non-automatic manual circuit breaker(s), with appropriate frame size and a shunt trip coil rated for DC operation. Trip circuit breaker by the unit's OFF circuit [local or remotely activated] and when any circuit identified in the paragraph SAFETY FUNCTIONS causes the system to shut down. Output breaker(s) must be operable from the front of the unit.

]2.1.4.4 Aircraft Interlock Circuit

The 270 VDC output power contactors must be interlocked with the unit's fault indicators, alarms, and the 28 VDC interlock power circuit. When the 28 VDC interlock power source is "broken" (e.g. when the power cord is removed from the aircraft receptacle), the 270 VDC output power source must be disabled.

2.1.5 Safety Functions

2.1.5.1 270 VDC Power Source

The 270 VDC power source internal 270 VDC buss must automatically discharge to below 12 VDC within 2 seconds after the following:

a. 270 VDC power source has been turned off.

b. Whenever any access panel is opened on the equipment. Under this condition, the interlock circuitry must open the input device and the 270 VDC output device, and not allow the input or output device to close. For maintenance purposes, provide an internal bypass switch to defeat the interlock circuitry.

c. Detection of system fault that results in a converter shut down condition, including the following:

(1) Input undervoltage.

(2) Input overvoltage.

(3) Loss of input phase.

(4) Loss of input power.

2.1.5.2 270 VDC Output Cable

The 270 VDC power must be removed from the output cable within 100 milliseconds after one of the following occurs:

a. Receiving a stop command.

b. Loss of 28 VDC interlock power.

c. Detection of a fault that results in an output shut down, including the following:

(1) Output overvoltage - Protect by tripping output devices for instantaneous overvoltage of 30 percent or more and for 10 to 30 percent overvoltage lasting more than 0.25 seconds.

(2) Output undervoltage - Protect by preventing the closing of the output disconnect until the output voltage is 95 percent of the rated output. If, after closing, the voltage decreases to below 90 percent for longer than 5 seconds, provide relaying to trip output devices utilizing a field-adjustable time-delayed circuit with a range of 4 to 10 seconds.

(3) Output overload.

(4) Converter overtemperature protection.

2.1.6 Automatic Line Drop Compensation

Provide automatic line drop compensation (ALDC) from zero to ten percent adjustable internally. Separate ALDC functions are required for the 270 VDC power source and for the 28 VDC interlock power source.

[2.1.7 Auto Restart

****

NOTE: Auto restart should be considered when the converter is installed in a remote location that is not readily accessible to operating personnel and maintaining 270 VDC power is critical to operations. Use of auto restart should be studied carefully to ensure that it does not create a potential personnel safety hazard.

This is an additional cost item and should not be specified unless specifically requested by the user.

****

After a total input power outage the unit must be capable of automatically restarting and re-energizing loads upon restoration of normal power. Provide units with a manual/auto restart switch and with backup battery power supply if it is needed to meet the auto restart requirement. When interlock circuit has been interrupted or when interlock is in the maintenance position (manual restart), the system should not restart.

][2.1.8 Built-In Test Equipment

****

NOTE: Built-in test equipment (BIT) should be

considered when the converter is installed in a remote location that is not readily accessible to operating personnel and maintaining 270 VDC power is critical to operations. It may also be needed when high reliability is a defined concern.

This may be an additional cost item and although some manufacturers include it at no cost, it should not be required unless specifically requested by the user.

****

Converter must include Built-in test equipment(BIT), which monitors both primary circuits and protection circuits of the unit. Provide visual indication to assist diagnosis of unit failures to a modular level. Provide visual indication of converter status using cabinet mounted light emitting diodes and Human Machine Interface (HMI). As a minimum the indicator lights must include a "machine on" light, and an "output faulted" indicator light that comes on when the unit has shut down.

]2.1.9 Magnetic Components

****

NOTE: Magnetic components are used within the converter unit. Do not delete this information. It is not included to imply permission to utilize transformers for modifying the input voltages to the converter.

****

Provide Class 180 power magnetic transformer and inductors in accordance with NEMA ST 20 and UL 506. The limits of Class 180 must not be exceeded at the maximum specified ambient temperature and at 100 percent load.

2.1.10 Acoustical Noise

****

NOTE: Converters are inherently noisy. Manufacturers standard for a 72 kW converter is 72 dBa, and their lowest attainable value is 68 dBa. If 68 dBa is specifically required by the Activity because of the location of the converter, include the "optional Acoustical Noise Test" in paragraph SPECIAL FACTORY TESTS, to verify that the equipment furnished meets the more stringent requirement. The test parameters (height and range) are included in that paragraph.

If a different size converter is required for a specific project, contact NAVFAC LANT for approval and for the appropriate acoustical noise modifications. The POC information is located at the beginning of this specification.

****

Provide unit with a maximum continuous acoustical noise level less than [72][68] dBa (A weighted scale).

2.1.11 Assembly Construction

****

NOTE: Per manufacturers, all converter enclosures require ventilation. Per NEMA 250 Tables 1 and 2, only NEMA Types 1,2,3R and 3RX are permissible to be ventilated. Verify availability by multiple manufacturers before using other enclosure types.

When location is outdoors, include the appropriate outdoor location coating and painting options.

When location is indoors, in item a:
- For Navy and Air Force, choose first option requiring flush wall mounting.
- For Army, choose second option and identify if pedestal mounted in hangars or floor mounted in lab or other locations.

****

Provide enclosures suitable for [indoor][outdoor][corrosive][direct spray][_____] environments in accordance with NEMA 250, Type [l][2][3R][3RX]. Arrange to provide required louvers, cooling air, entry and exit provisions for equipment within enclosures.

a. [Units must be mounted flush against the wall, must not require back access for maintenance, and must comply with the "Maintenance Envelopes" identified on the drawings.][Units must be [pedestal][floor] mounted as indicated and comply with the "Maintenance Envelopes" identified on the drawings.]

b. Construct unit(s) so that components, with the exception of control and monitoring components, are totally enclosed within the enclosure. Electronic circuits including power circuits must be modular construction readily accessible for maintenance, repair and module replacement from the front of the enclosure.[For units installed outdoors or in corrosive environments, [provide a conformal (rust-inhibiting) coating for the printed circuit boards][enclose electronic circuits in a sealed electronics compartment that is not provided with direct cooling ventilation or forced air cooling].]

c. Provide permanent identification tags for wiring. Uniquely identify each wire. Use the same identification system in the wiring diagrams in the Operation and Maintenance Manual. Enclosures must be painted in accordance with paragraph FACTORY APPLIED FINISH and as specified herein. Provide each enclosure with a finish coat over a rust inhibiting substrate or a substrate that has been provided with a rust inhibiting treatment.[For outdoor enclosures, if the unit is not painted using the powder coating process, provide two finish coats on the unit.]

d. Provide units with a Mean Time To Repair (MTTR) of 30 minutes from the time of the diagnosed failure based on documented manufacturer's historical data for the average time of repair for their top ten faults. Provide the supporting data with the equipment submittal.

2.2 AIRCRAFT POWER CABLE ASSEMBLY

****

NOTE: Coordinate cable assembly requirements with unit voltage requirements, aircraft requirements, and with paragraph AIRCRAFT INTERLOCK CIRCUIT. Point of use systems are required. Distributing through pits is not permitted on new installations. Distributing through other areas that increase total length beyond 43 meters 140 feet is not permitted on new installations.

For the Navy:

1) Use the 333 Amperes option and the 25 meters 83 feet length for all cable assemblies.

2) If a different amperage is specifically identified in the project requirements, or a longer length is required due to a specific aircraft layout, approval must be obtained from NAVFAC LANT. The POC information is located at the beginning of this specification.

****

Provide a single-jacketed 270 VDC aircraft power cable assembly in compliance with SAE AS7974 and SAE AS7974/5. The 270 VDC output cable assembly must be constructed and tested to meet the power requirements of this specification, to minimize cross coupling, to meet current demand rates and to ensure power regulation, ripple, distortion, and transient voltage recovery, as defined herein, is not exceeded.

Rate cable for [333][_____] amperes. Cable length must be [43][_____]meters [83][_____]feet. Provide control cabling included within the jacket for interlock circuit. Terminate control wiring on accessible terminal blocks in unit. Provide cable assembly with integrally molded 270 VDC connector capable of connecting to the aircraft receptacle. Provide cable/connector assembly suitable for severe duty, with crimped contact terminations. Banded cables are not permitted. In addition, the assembly must comply with the following:

a. The 270 VDC and 28 VDC returns must be tied together only on the aircraft side of the on-aircraft external power receptacle.

b. The 28 VDC interlock output positive will be on pin "1" and output negative voltage will be on pin "2".

c. Pins "3" and "4" must be internally connected within the cable connector end to provide a "jumper" for interlock control (less than 0.1 ohms).

d. The contact section of the molded aircraft servicing connector must be capable of being repaired in the field. The contact section must be a one-piece, molded, replacement section or have individually replaceable pins and a molded one-piece cover. Installation of the replacement contact section must restore watertight integrity to the molded aircraft servicing connector. Repair must not include replacement of the entire aircraft servicing connector.

2.2.1 28 VDC Interlock

The 28 VDC interlock power must be within MIL-STD-704 "Normal Operating

Limits", be available on power initiation, and must remain present throughout the duration of connection of power to the aircraft.

a. The 28 VDC interlock power must provide at least 15 amps of power capacity for aircraft equipment use.

b. The 270 VDC output must only be enabled when the 28 VDC interlock is present.

c Power must only be available when the plug is fully seated in the aircraft receptacle.

d. The sensing back of the 28 VDC interlock from the aircraft must indicate a proper connection of the receptacle.

[2.3 REMOTE MONITORING AND CONTROL PANEL

****
NOTE: Delete this paragraph unless plans clearly indicate requirement for remote monitoring and control panel.
****

Provide remote monitoring and control panel and circuitry. Connect to clearly and permanently labeled terminal blocks located inside the converter's enclosure. Provide the circuitry such that indicator lamp/LED information and control function(s) can be extended from the terminals to a remote location in the future.

a. Pushbutton or switch for de-energizing the output terminals.

b. Indicator lamp/LED showing the unit status (energized or not energized).

c. Indicator lamp/LED showing the output control device position (open or closed).

d. System alarm.

]2.4 MANUFACTURER'S NAMEPLATE

Each frequency converter, each major component within the frequency converter, and each item of other equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.5 FACTORY APPLIED FINISH

****
NOTE: This paragraph covers only the basic painting requirements for most electrical equipment. Include any special finishes for high or low temperatures and extremely corrosive atmospheres. Use manufacturer's standard color unless the Activity requires a special color.
****

Electrical equipment must have factory-applied painting systems which

must, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements as specified herein. Interior and exterior steel surfaces of equipment enclosures must be thoroughly cleaned and then receive a rust-inhibitive phosphatizing treatment, a primer powder coat, or equivalent treatment prior to painting. Exterior surfaces must be free from holes, seams, dents, weld marks, loose scale or other imperfections. Interior surfaces must receive not less than one coat of corrosion-resisting paint or powder coating process in accordance with the manufacturer's standard practice. When enclosure is aluminum, interior may optionally be coated with rust inhibiting treated film. Exterior surfaces must be primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish, or finished with a powder coating process.[Color must be the manufacturer's standard color.][Equipment located indoors must be ANSI Light Gray,[and equipment located outdoors must be ANSI[Light Gray][Dark Gray]].] Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.6 SOURCE QUALITY CONTROL

2.6.1 Factory Test Schedule

The Government reserves the right to witness tests and reserves the right to request the raw data from the tests whether witnessed or not. Provide the converter test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

Test Instrument Calibration.

a. The manufacturer must have a documented calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b. The accuracy must be directly traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule must not exceed 12 months for both test floor instruments and leased specialty equipment.

d. Provide dated calibration labels, that are visible on all test equipment.

e. Calibrating standard must be of higher accuracy than that of the instrument tested.

f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

(1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.6.2 Routine Factory Tests

****

NOTE: Include the bracketed option, "As an exception..." when there are multiple, identically sized (in kW) converters on the same contract. Intent is to only do the "automatic line drop compensation test' on the first converter.

In item c, the aircraft power cable assembly is normally included in the project. If for some reason it is not part of the contract, modify the item and provide additional appropriate cable information (e.g. length and type) that the manufacturer should use for tests.

****

Perform routine tests by the manufacturer at the factory, on each of the actual converter(s) prepared for this project to ensure that the design performance is maintained in production.[As an exception, test automatic line drop compensation on only one unit on multiple unit orders of the same kW rating. If there are multiple units with different kW ratings, then testing one of each of the kW ratings is acceptable.] Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Include a list of the current test equipment calibration dates. Required tests, test conditions, and testing sequence is as follows:

a. For tests which require full load, use the nameplate full load kW of the unit being tested unless otherwise noted.

b. All measurements must be true RMS measurements. Obtain measurements in accordance with IEEE 1159. Monitor and record all data at the load end of the cable.

c. Connect loads to the converter with the specified aircraft power cable assembly.

d. No adjustments to the frequency converter are allowed between load tests.

2.6.2.1 Test Conditions

Tests must include the following conditions:

a. Initial Safety Verification: Perform tests and checks to validate the safe and timely shutdown for each condition (for the power source and the output cable) identified in paragraph SAFETY FUNCTIONS.

b. Input current and power factor: Operate converter at low, nominal and high input voltage at full load. Measure and record input voltage, input power factor and input current in each phase.

c. Output voltage, output current, and voltage regulation. Operate converter at nominal input voltage unless otherwise specified.

(1) 50 percent of rated capacity.

(2) 100 percent of rated capacity.

(3) 50 percent of rated capacity with the loads as specified in the paragraph LOAD RANGE.

(4) 100 percent of rated capacity at low and high input voltage.

(5) 100 percent of rated capacity with the loads as specified in the paragraph LOAD RANGE.

(6) Note - Operate for not less than 10 minutes at each test condition in (1), (2), (3) and (4) above, and for not less than 30 minutes at test condition in (5) above.

(7) Note - Monitor and record each of the following at the beginning and end of each test condition: output voltage, output voltage waveform, output voltage ripple (peak-to-peak, distortion factor and distortion spectrum), output current, output current waveform, output current ripple (peak-to-peak, distortion factor and distortion spectrum). Verify output remains within specified regulation limits at each load level by overlaying the graphs of Figure 263544 - 1 with the 270 VDC test data, and Figure 263544 - 2 with the 28 VDC test data.

d. Efficiency: Operate at nominal input voltage at half load and full load. Measure and record input voltage, input current, output voltage, and output current. Calculate the unit efficiency.

e. No load losses: Operate at no load and nominal input voltage. Measure and record input voltage, input current, input power, input power factor, and output voltage. Calculate the no load losses.

f. Overload: Operate at nominal input voltage and output voltage with loads and in sequence listed below:

****

NOTE: For the Navy: Coordinate with NAVAIR (POC information is at front of specification), to see if the NAVAIR Digital File Information has been completed before including the bracketed documentation option.

****

Percent of Full Load	Time	Time Between Overloads	Iterations
250 percent	50 milliseconds	5 minutes	3
200 percent	2 seconds	5 minutes	1
150 percent	10 seconds	10 minutes	1
125 percent	5 minutes	10 minutes	1
110 percent	30 minutes	2 hours	1

(1) Monitor output to confirm there is no 270 VDC power interruption.

(2) Provide graph showing current magnitude over time[in accordance with NAVAIR Digital File Information] for each condition above.

(3) Provide graph showing Output Voltage Response is in accordance

with paragraph TRANSIENT OUTPUT VOLTAGE RECOVERY time and thresholds.

(4) After minimum operating time is achieved, unit must interrupt output power.

****

NOTE: Utilize the identified burn-in hours, unless a validated reason has been identified by the Activity (such as a requirement for a higher uptime confidence limit) to either reduce or increase the number of hours.

The last sentence in the BURN-IN TEST paragraph permits not using the Aircraft power cable assembly that has been mandated for all the other tests. This exception has been added because the specified cable may not withstand the current draw for this length of time without overheating.

****

g. Burn-in Test: Before delivery, burn-in all units[under full load conditions for at least [24][_____] hours][by cycling units [6][_____] hours "ON" under full load conditions and [3][_____] hours "OFF" at no load conditions for at least [4][_____] complete "ON" cycles]. Perform burn-in test with the converter enclosure doors closed, load connected directly to the output terminals, and all ventilation in the final operating condition. The specified aircraft cable is not required to be used for this test.

h. Include harmonic frequency spectrum analysis depicting harmonic order across the range of individual harmonic occurrence, and harmonic magnitude for each load condition in the test reports. Conduct tests at the unit's input terminals (to the 37th harmonic) per IEEE standards. Output voltage distortion spectrum analysis must be measured out to 16,000 Hz.

i. Automatic line drop compensation: Operate converter at nominal voltage and verify specified performance of the line drop compensation at the following loads.

(1) No-load.

(2) 50 percent of rated capacity.

(3) 100 percent of rated capacity.

j. 28 VDC Interlock. Perform each of the above tests (a through h) at 50 percent and 100 percent of full 28 VDC load. Verify operation within specified limits. However, the burn-in test (item g) must be performed only at full load, and not at 50 percent load of 28 VDC.

k. Post Routine Test Safety Verification: Repeat tests conducted under item a. Initial Safety Validation to confirm safety features were not affected by previous tests.

2.6.3 Special Factory Tests (Design Tests)

****

NOTE: Include the bracketed option "each of" when there are multiple sizes of converters in the project.

****

Submit special factory test (design test) reports (complete with test data, explanations, formulas, results, setup and cable information, and the list of the calibration dates of the test equipment used), in the same submittal package as the catalog data and drawings for [each of] the specified converter(s). Tests must be certified and signed by a registered professional engineer or by a "company certified professional designee" within the manufacturers' organization. Submit designee's credentials with the initial design test report for approval. Tests must be on file based on a production model of converters of the same design, construction and kW rating provided.

****

NOTE: Include the first bracketed option below, "As an exception..." unless there are more than 5 units on the project, or the units are going to a severe or hard to reach environment / strategic location. When choosing the second option instead of the first, coordinate with the Activity to determine the number of "production units" that must be tested.

The "As an exception..." sentence has always permitted the Special Factory Tests to be done on one of the first units produced, at the same time scheduled for the Routine Tests. However it was rarely used, since it only applies when the manufacturer already meets the experience requirements in the QUALIFICATIONS OF MANUFACTURER paragraph in Part 1 of this specification, but was building a slightly different unit without the specific design tests already on file.

With the new requirements in this specification, this exception may become more frequently used since test data may not be on file. The manufacturer still has to meet the QUALIFICATIONS OF MANUFACTURER paragraph, and all of the Special Factory Tests will still be subject to being witnessed by the government with the Routine tests.

****

[As an exception, when the manufacturer does not have the special factory tests for the specific unit characteristics already on file, the manufacturer may conduct the special factory tests on the first "production unit" along with the routine tests.][The manufacturer must test [one][_____] unit[s] at the same time scheduled for routine tests, of each rating and size converter.] To assure compliance with the specification, these tests are also subject to government witnessing at the same time as the routine tests. For all tests which require full load, use the nameplate full load kW of the unit being tested, unless otherwise noted. For all tests that are "not already on file", connect loads to the converter with an aircraft power cable assembly, 43 meters 140 feet long, similar to the specified project aircraft power cable assembly. Monitor and record all data at the load end of the cable, unless otherwise noted. The tests conducted on the unit must include the

following:

****
NOTE: Select Location Category C for outdoor locations only.
****

a. Initial Safety Verification: Perform tests and checks to validate the safe and timely shutdown for each condition (for the power source and the output cable) identified in paragraph SAFETY FUNCTIONS.

b. Surge protection: Apply input surges in accordance with IEEE C62.41.1 and IEEE C62.41.2, Location Category [B][C] and monitor output. Conduct a minimum of three consecutive successful tests on each unit listed. Confirm there is no interruption to 270 VDC output power and voltage stays within specified regulation tolerances. Surge protection tests must be applicable on all converter units utilizing same surge protection device by manufacturer and part number regardless of converter kW size.

c. Input current: Perform the following tests at nominal input voltage. Conduct each test a minimum of three times. Monitor the input and output power to demonstrate the duration of the transients until the converter reaches steady state. Provide copies of waveforms and analysis in test report.

(1) Measure inrush current when initially turning on machine with no load.

(2) After applying power and unit is at steady state, conduct load application test, going from 0 to full load to measure affect on input.

d. Input current distortion: Operate at nominal input voltage at 0, 25, 50, 75, and 100 percent of rated full load. Measure and record the input current THD for the current in each phase.

e. Input current and power factor: Operate converter at low, nominal and high input voltage at full load. Measure and record input voltage, input power factor and input current in each phase and neutral if the neutral conductor is connected to the converter input.

f. Output voltage, output current, and voltage regulation. Operate converter at nominal input voltage unless otherwise specified.

(1) 50 percent of rated capacity.

(2) 100 percent of rated capacity.

(3) 50 percent of rated capacity with the loads as specified in the paragraph LOAD RANGE.

(4) 100 percent of rated capacity at low and high input voltage.

(5) 100 percent of rated capacity with the loads as specified in the paragraph LOAD RANGE.

(6) Note - Operate for not less than 10 minutes at each test condition in (1), (2), (3) and (4) above, and for not less than 30 minutes

at test condition in (5) above.

(7) Note - Monitor and record each of the following at the beginning and end of each test condition: output voltage, output voltage waveform, output voltage ripple (peak-to-peak, distortion factor and distortion spectrum), output current, output current waveform, output current ripple (peak-to-peak, distortion factor and distortion spectrum). Verify converter is operating within specified regulation limits at each load level by overlaying the graph of Figure 263544 - 1 with the 270 VDC test data, and Figure 263544 - 2 with the 28 VDC test data.

g. Include harmonic frequency spectrum analysis depicting harmonic order across the range of individual harmonic occurrence, and harmonic magnitude for each load condition in the test reports. Conduct tests at the unit's input terminals (to the 37th harmonic) per IEEE standards. Output voltage distortion spectrum analysis must be measured out to 500,000 Hz per MIL-STD-704.

****

NOTE: For the Navy: Coordinate with NAVAIR (POC information is at front of specification), to see if the NAVAIR Digital File Information has been completed before including the bracketed documentation option. Include bracketed option once NAVAIR has established a defined version of Digital File Requirements (still in progress).

****

h. Overload: Operate at nominal input voltage and output voltage with loads as listed below:

Percent of Full Load	Satisfactory Operating Time	Time Between Overloads	Iterations
110 percent	30 minutes	2 hours	3
125 percent	5 minutes	10 minutes	3
150 percent	10 seconds	10 minutes	3
200 percent	2 seconds	5 minutes	3
250 percent	50 milliseconds	5 minutes	3

Monitor output to confirm there is no 270 VDC power interruption. After minimum operating time is achieved, unit must interrupt output power. Provide voltage and current waveforms [in accordance with NAVAIR Digital File Information] documenting the unit's response for each test.

i. Short-circuit: Apply a bolted positive to negative fault directly to the output terminals of the unit. Conduct a minimum of three consecutive successful tests on each unit. Provide unit capable of carrying the fault current until the integral system protective devices interrupts the fault with no damage to the unit. Provide waveforms of short circuit current during short circuit tests.

j. Transient Output Voltage Recovery: Operate at the following load steps: 0 to 100 percent, 0 to 50 percent, 100 to 0 percent and 50 to 0 percent. Measure and record recovery time and output voltage

deviation limits. Provide recordings or display of output voltage during transient recovery test. Verify converter is operating within specified regulation limits at each load level by overlaying the graph of Figure 263544 - 1 with the 270 VDC test data, and Figure 263544 - 2 with the 28 VDC test data.

****

NOTE: Delete bracketed acoustical noise test unless converter is installed in special locations such as test laboratories or other confined spaces and a lower than 72 dBa value is specified.

The test parameters (Height and Range)identified below, meet the ANSI SI 4 requirements. However the standard is not referenced because it "allows units to be averaged over a certain production range /quantity", whereas we want each unit to be individually compliant.

The optional paralleling test has been removed from this version of the specification. If it is required because of a critical location, approval and specific verbiage must be obtained from NAVFAC LANT. The POC information is located at the beginning of this specification.

****

[k. Acoustical noise: Operate at no load, 50 percent and 100 percent of full load. Measure continuous steady sound pressure level 1525 mm 5 feet horizontally from the center of each side of the converter at a point 1525 mm 5 feet above the floor. Decibels (dB) are referenced to 20 micropascal.

] l. Post Special Test Safety Verification: Repeat tests conducted under item a. Initial Safety Verification, to confirm safety features were not affected by previous tests.

2.7 ARC FLASH WARNING LABEL

****

NOTE: Include the Arc Flash Warning Label detail on the drawings. See the technical notes at the beginning of this section to obtain the AutoCAD drawing file of the label.

****

Provide arc flash warning labels for arc flash protection in accordance with NFPA 70E and NEMA Z535.4 for the enclosures of electrical equipment that are likely to require examination, adjustment, servicing, or maintenance while energized. Locate this self-adhesive warning label on the outside of the equipment compartment doors warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated. The marking must be clearly visible to everyone, including qualified persons, before examination, adjustment, servicing, or maintenance of the equipment.

2.8 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the following paragraph where nameplates are fabricated to identify specific equipment designated on the drawings. Provide note on panelboard schedules to indicate where other than black center core labels are required

****

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 25 by 65 mm 1 by 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.9 GROUNDING AND BONDING

****

NOTE: Include the reference to Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION when equipment is also being provided outside.

****

UL 467. Provide grounding and bonding as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM[and for exterior work, in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].

[2.10 CAST-IN-PLACE CONCRETE

****

NOTE: Include concrete requirements when equipment is also being provided outside on concrete pads.

****

Provide concrete associated with electrical work for other than encasement of underground ducts rated for 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise. Conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

]PART 3 EXECUTION

3.1 INSTALLATION

Install products to operate at 270 VDC in the same manner as specified in other sections of this specification for products operating at [50] [60] Hz, unless indicated or specified otherwise. Conform to the requirements of NFPA 70 and IEEE C2 and to manufacturer's instructions and recommendations.

3.2 EQUIPMENT

3.2.1 Floor Mounted

Provide proper floor mounting channels and install in accordance with the manufacturer's drawings and instructions and as indicated. Align, level, and bolt units to channels to allow easy withdrawal or insertion of removable components and to permit proper operation and maintenance of

equipment. When in a Class 1, Division 2 area, mount units at least 18 inches above finished floor.

[3.2.2 Wall Mounted

****
NOTE: Wall mount units 5 kW or less. Floor mount all other units.
****

Bracket mount, but otherwise install as required for floor-mounted units.

][3.2.3 Maintenance Platform Mounted

****
NOTE: When used, verify drawings identify:
1) An appropriate maintenance platform with safety details including the maintenance envelope.
2) The location of the remote control panel and interconnecting conduit and wiring.
****

Install as required for floor-mounted units.

]3.2.4 Grounding and Bonding

In accordance with NFPA 70 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

[3.2.5 Grounding and Bonding - Exterior Equipment

****
NOTE: When equipment in the project is located outdoors, include the optional grounding and foundation (concrete pad) requirements. Use 25 ohms unless the project requires more stringent requirements.
****

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding [25][_____] ohms.

3.2.5.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.5.2 Pad-Mounted Equipment Grounding

****
NOTE: Ensure plans show the pad details and ground connections matching how this paragraph is edited. Converter is to have a ground ring and the normal number of ground rods is two. The one ground rod option should only be chosen if required by local installation requirements.
****

Provide a ground ring around the equipment pad with 4/0 AWG bare copper.[

Provide two ground rods in the ground ring at opposite corners.][Provide one ground rod in the ground ring with the ground rod located in the equipment cabinet.] Install the ground rods at least 3000 mm 10 feet apart from each other. Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.5.3 Connections

Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors. Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.6 Foundation for Equipment and Assemblies

****
NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the requirement is located. Include construction requirements for concrete slab only if slab is not detailed on drawings.
****

Mount equipment on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 200 mm 8 inches thick, reinforced with a 152 by 152 mm MW19 by MW19 6 by 6 inches - W2.9 by W2.9 mesh placed uniformly 100 mm 4 inches from the top of the slab.

b. Place slab on a 150 mm 6 inch thick, well-compacted gravel base.

c. Install slab such that top of concrete slab is approximately 100 mm 4 inches above the finished grade with gradual slope for drainage.

d. Provide edges above grade with 15 mm 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 200 mm 8 inches beyond the equipment.

Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with equipment cable training areas.

3.2.6.1 Cast-In-Place Concrete

Provide cast-in-place concrete work in accordance with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

[3.2.6.2 Sealing

****
NOTE: Require sealing of cable wells (windows) in the concrete pad if rodent intrusion is a problem.

****

When the installation is complete, seal all entries into the equipment enclosure with an approved sealing method. Provide seals of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

]]3.2.7 Wiring and Conduit

****

NOTE: Designers of Record must provide calculations and ratings for conductors, circuit breakers (50Hz / 60Hz), and devices operating at 270 VDC and at 28 VDC.

Use of a distributed 270 VDC power system (instead of a Point of Use system), is prohibited on new projects, and is limited to making modifications to existing systems. If used, a distributed system may require additional special calculations.

See UFC 3-555-01 (Draft in progress) for additional information.

****

Provide wiring and conduit as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Use copper conductors for DC systems.

3.2.8 Manufacturer's Representative

The manufacturer's representative must place the system in operation and make necessary adjustments to ensure optimum operation of the equipment. The manufacturer's representative must have at least 2 years of practical experience in the installation and testing of 270 VDC solid state converters.

3.3 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.5 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.6 FIELD QUALITY CONTROL

3.6.1 Field Test Schedule

****

NOTE: Include the bracketed options below on Navy projects where "reach-back support" has already been coordinated with NAVAIR / NAVFAC LANT per the third introductory Technical Note at the beginning of this specification section.

****

Give Contracting Officer[and (NAWCAD Air Vehicle Electrical Power Systems Group (AB43) (301) 342-4161] 30 days notice of dates, times and scheduled tests which require the presence of the Contracting Officer. The Contracting Officer will coordinate with the using activity[and NAVAIR / NAVFAC LANT,] and schedule a time that will eliminate or minimize interruptions and interference with the activity operations.

3.6.2 Instruments

Provide test instruments capable of measuring and recording or displaying test data at a higher resolution and greater accuracy than specified for the converter's performance. The test instruments used in the field tests must have current valid calibration stickers issued by an approved calibration laboratory. Verify calibration and adjustments of converter instruments provided prior to field tests. Calibrate instruments for 270 VDC operation when measuring 270 VDC signals.

3.6.3 Initial Inspection and Tests

****

NOTE: Include the bracketed option for the NETA ATS Representative when Section 26 08 00 APPARATUS INSPECTION AND TESTING is included in the project. Ensure that the list of identified specification sections that the NETA inspector is responsible for includes this section (see bracketed options in Section 26 08 00 APPARATUS INSPECTION AND TESTING.

****

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests.[In addition, coordinate with the NETA ATS representative to witness, document, and validate the converter Field Quality Control.]

a. Compare equipment nameplate information with specifications and approved shop drawings.

b. Inspect physical and mechanical condition. Inspect cables and wiring harnesses for damage and strain relief.

c. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey. Perform thermographic survey while the unit is at full load during the loadbank test.

d. Perform specific inspections and mechanical tests as recommended by manufacturer.

e. Verify correct equipment grounding.

3.6.4 Field Performance Checks and Tests

Conduct converter field checks and tests under the supervision of the manufacturer's representative. Provide labor, equipment, test instruments, and incidentals required for the tests including load banks, except the Government will furnish the electricity.

All tests must be performed with the load connected to the load end of the specified aircraft cable assembly. The cable must be laid out / uncoiled to provide heat dissipation. No adjustment to the converter is allowed between tests. Successfully complete the safety verification, preliminary operation, and the control and protective devices check prior to performing load and transient tests. Load tests must be performed with the converter doors closed and the 28 VDC at full load. If the converter fails to operate within the specified limits during any of the tests, discontinue the test, make necessary repairs to correct the failure, and restart testing of the converter. Repeat all previously completed tests and document the respective failed test data and new data.

3.6.4.1 Initial Safety Verification

Perform tests and checks to validate the safe and timely shutdown for each condition (for the power source and the output cable) identified in paragraph SAFETY FUNCTIONS. As an exception, a representative fault test will be sufficient at this time.

3.6.4.2 Preliminary Operation

****

For the Navy: NAVAIR is working on and will provide the requirements for a "digital manual" / type of "Data Acquisition system." All Manufacturers should also already have one of their own. The future goal is to include the standardized requirement as part of the specification so that NAVAIR will have the various manufacturer's equipment information, in a consistent format, submitted and then on file in the NAVAIR Database system for maintenance and problem solving. At that time, we will determine whether it will be possible to include as an attachment / sample in the specification or possibly as a reference to a UFC Appendix.

****

Inspect the converter and make adjustments necessary to assure proper operation in accordance with the manufacturer's instructions. Operate converter at 0, 25, 50, 75, and 100 percent of rated full load. On the input measure and record the voltage, current, frequency, and THDs (voltage and current) at each load. On both the 270 VDC and the 28 VDC outputs, measure and record the voltage, current, DC ripple, distortion spectrum, and distortion factor at each load. Verify converter is operating within specified regulation limits at each load level by overlaying the graph of Figure 263544 - 1 with the 270 VDC test data, and Figure 263544 - 2 with the 28 VDC test data. Verify the operation of the 28 VDC Interlock Power.

Test data must include input voltage and current harmonic distortion amplitudes of all individual harmonics presented in a spectrum analysis format up to the 15th order at the 50 percent and 100 percent load

points. Output voltage distortion spectrum analysis must be measured out to 6,000 Hz.

3.6.4.3 Control and Protective Device Checks

Operate each control, switch, input/output device that is capable of being operated manually a minimum of three times, demonstrating satisfactory operation each time. Perform operation test on each protective device to ensure that devices function properly. After each operation measure and record the converter output voltage and current. Verify converter is operating within specified limits.

3.6.4.4 Load (Burn-in) Test

****

NOTE: Include the bracketed option "For converters used ..." only when one of the converters, on a multi converter project, will not be connected to the aircraft cable assembly when in service; e.g. used in a lab setting instead.

In the rare condition, where there is only the one converter in a lab setting, then delete the entire sentence before the bracketed option as well.

****

Operate each unit continuously a minimum of 1 hour at 100 percent rated full load. Perform a concurrent load (burn in) test for the 270 VDC and the 28 VDC loads. Measure and record the converter output voltage and current (both 270 VDC and the 28 VDC Interlock Power), at beginning, 30 minutes, and 1 hour. Verify converter is operating within specified limits. Load test must be performed with the converter doors closed and the test load connected to the converter at the cable head with specified aircraft cable assembly.[For converters used to supply test bench loads, perform load tests with the converter doors closed at the output of the converter.]

3.6.4.5 Post Load Test Verification

Repeat tests identified in paragraph PRELIMINARY OPERATION, to validate converter was not affected by the Load test. However apply loads in the reverse order (e.g. 100, 75, 50, 25, and 0 percent of the rated full load).

Conduct tests on each converter with the load connected to the load end of the specified aircraft power cable assembly. No adjustment to the converter is allowed between load tests. Monitor and record output voltage at the load end of the cable. Verify converter is operating within specified regulation limits at each load level by overlaying the graph of Figure 263544 - 1 with the 270 VDC test data, and Figure 263544 - 2 with the 28 VDC test data. In addition, verify specified performance of the line drop compensation.

3.6.4.6 Final Safety Verification

Repeat tests conducted under paragraph INITIAL SAFETY VERIFICATION to confirm safety features were not affected by previous tests.

3.6.5 Grounding System

Inspect grounding system for compliance with contract plans and specifications.

3.7 DEMONSTRATION

3.7.1 Instructing Government Personnel

****

NOTE: For Navy: Include bracketed option requiring coordination with NAVAIR and coordination with Activity on availability of aircraft for conducting training.

****

Provide field training to Government personnel on the operation and maintenance of the converter provided at the same time as the Field Acceptance Testing.[For Navy projects contact NAWCAD Air Vehicle Electrical Power Systems Group (AB43) at (301) 342-4161 to obtain the name and e-mail of the NAVAIR point-of-contact so they can attend the training. Coordinate with the Activity to establish availability and non-availability to train on actual aircraft.] Include up to a maximum of 2 hours of instruction on operation and up to a maximum of 4 hours of repair and maintenance of the converters. The instructor must be approved by the manufacturer of the unit provided. Submit training syllabus including each topic of training and a brief outline of each topic to the Contracting Officer at least 4 weeks prior to training for approval.

Training must be approved by the Contracting Officer at least 2 weeks in advance. The Government may record, video and audio, the training sessions and use these recordings to train personnel on the operation and maintenance of the converter system. Provide two copies of video or audio DVDs, and of any supplemental information and examples covered in the training sessions, to the Contracting Officer.

-- End of Section --