UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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DIVISION 26 - ELECTRICAL

SECTION 26 35 44.00 20

270 VDC SOLID STATE GROUND POWER UNIT

02/18

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270 VDC SOLID STATE GROUND POWER UNIT
02/18

NOTE: This guide specification covers the requirements for the procurement, installation, and testing of 270 VDC converters.

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).

NOTE: These converters are used to supply 270 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. This specification is not intended for medium-voltage applications.

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

1. Show location of all equipment.

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

3. Design equipment rooms with working spaces as required by NFPA 70. 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 system is properly coordinated including the ratings of the power cables, ground cables, circuit breakers, filters, rectifiers, and control equipment.

****

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.

****

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 1159	(2009) 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

LOCKHEED MARTIN CORPORATION (LM)

2ZEU0004-0007	F-35 Ground Electrical Power Interface
5PTV6002-101	270 VDC 70 KW External Power Plug/Cable
JSFC1 2	External Power Receptacle Specification

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)
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; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 70E	(2021) Standard for Electrical Safety in the Workplace

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-704	(2004; Rev F; Notice 1 2008; Notice 2 2013) Aircraft Electric Power Characteristics

UNDERWRITERS LABORATORIES (UL)

UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 1012	(2010; Reprint Apr 2016) UL Standard for Safety Power Units Other than Class 2
UL 1449	(2014; Reprint Jul 2017) UL Standard for Safety Surge Protective Devices

1.2 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.

1.3 SUBMITTALS

****

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

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

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

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

****

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

SD-02 Shop Drawings

270 VDC Converter Drawings; G[, [_____]]

SD-03 Product Data

270 VDC Converter; G[, [_____]]

Cable and Plug Assembly; G[, [_____]]

SD-06 Test Reports

Work Plan; G[, [_____]]

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

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

Performance Test Plan; G[, [_____]]

Test Schedule; G[, [_____]]

Routine Factory Tests; G[, [_____]]

Special Factory Tests; G[, [_____]]

SD-07 Certificates

Qualifications of Manufacturer; G[, [_____]]

UL Listing; G[, [_____]]

SD-09 Manufacturer's Field Reports

Initial Inspection and Tests; G[, [_____]]

Performance Tests; G[, [_____]]

Training Syllabus; G[, [_____]]

SD-10 Operation and Maintenance Data

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

Data Package 5; G[, [_____]]

1.4 QUALITY ASSURANCE

1.4.1 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.

1.4.2 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 2 years prior to bid opening. The 2-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 2-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.

1.4.2.1 Alternative Qualifications

Products having less than a 2-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.

1.4.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site must not be used, unless specified otherwise.

1.4.3 270 VDC Converter Drawings

Furnish scaled drawings of enclosure outline including front, top, side views, and overall dimensions. Provide external power and control wiring and cable connections. Provide single line, schematic, and wiring diagrams. Drawings must include details of input and output circuit breakers, contactors, rectifiers, surge protectors, and control devices. Drawings must include conduit entry and exit locations. Drawings must indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals must include the nameplate data, size, and capacity.

1.4.4 Qualifications Of Manufacturer

Submit a certification that the manufacturer has a minimum of two (2) years' experience in the design, manufacturing, and testing of a 270 VDC Converter at the same or equivalent KW and voltage ratings for direct connection to aircraft electrical loads.

The certification must state that the manufacturer is experienced in manufacturing and testing solid state 270 VDC Converters of an equivalent or greater KW rating. Experience in manufacturing motor generator sets does not qualify as equivalent. Experience in manufacturing portable engine-driven 28VDC 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.

1.4.5 Work Plan

Submit a written schedule of dates of routine and special factory tests, installation, field tests, and operator training for the converter system. Furnish a list of instrumentation equipment for factory and field test reports.

1.4.6 Routine Factory Test Plan

Submit 7 copies of test plans and procedures at least 21 calendar days prior to the tests being conducted. Provide detailed description of test procedures, including test equipment and setups, to be used to ensure the GPU meets the performance specification and explain the test methods to be used. As a minimum, the test procedures must include the tests required under the paragraph ROUTINE FACTORY TESTS.

1.4.7 Special Factory Test Plan

Submit 7 copies of test plans and procedures with the Routine Factory Test Plan. Provide detailed description of test procedures, including test equipment and setups, used to ensure the converter meets the performance specification and explain the test methods used. As a minimum, the test procedures must include the tests required under the paragraph SPECIAL FACTORY TESTS.

1.4.8 Performance Test Plan

Submit 7 copies of test plans and procedures at least 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 (list make and model and provide functional description of the test instruments and accessories) and setups of the tests to be conducted to ensure the 270 VDC Converter meets the performance specification. Explain the test methods to be used. As a minimum, the test procedures must include the tests required under the paragraph FIELD QUALITY CONTROL. Test reports must include power quality measurement data collected in accordance with IEEE 1159.

1.4.9 UL Listing

Submit with the initial submittal to verify qualification of manufacturer. 270 VDC Converter must be identified with a UL or nationally recognized testing laboratory (NRTL) label prior to shipping.

1.4.9.1 Currently Listed Products

Submit UL or NRTL certification or UL file number for the actual 270 VDC Converter to be shipped.

1.4.9.2 Proposed Listed Products

Submit UL or NRTL certification or UL file number for same or similar rating or product size range of like design unit.

1.4.10 Routine Factory Tests Report

Submit within 45 calendar days after completion of tests. Receive approval of test prior to shipping unit. Certify tests were conducted on each 270 VDC Converter in accordance with the requirements set forth in paragraph ROUTINE FACTORY TESTS and certify converter satisfactorily operated within specified limits. Report must include copies of the test procedures, test data, and results.

1.4.11 Special Factory Tests Report

Certify tests were conducted on a 270 VDC Converter of the same design,

construction and KW and voltage rating to be provided and in accordance with the requirements set forth in paragraph SPECIAL FACTORY TEST and certify 270 VDC Converter operated without malfunctioning within specified limits. Report must include copies of the test procedures, test data, and results.

1.4.12 PERFORMANCE TESTS REPORT

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 270 VDC Converter in accordance with the paragraph FIELD QUALITY CONTROL and certify converter satisfactorily operated within specified limits. Report must include copies of the test procedures, test data, and results.

1.5 OPERATION AND MAINTENANCE MANUALS

Submit 270 VDC Converter operation and maintenance manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5.1 Additions to Operation and Maintenance Manuals

In addition to requirements of Data Package 5, include the following on the actual 270 VDC Converter provided:

a. A "one-line diagram" from service entrance to 270 VDC utilization panel or point.

b. A weatherproof, tear-resistant plastic data sheet with operating instructions for each unit including startup and shutdown procedures.

c. Routine and field acceptance test reports.

d. UL or NRTL certification or UL file number.

1.5.2 Preliminary Operation and Maintenance Manuals

Prior to scheduling Field Performance Tests, 2 copies of a Preliminary Operation and Maintenance Manual must be submitted to and approved by the Contracting Officer.

1.6 EXTRA MATERIAL

Furnish recommended manufacturer's spare parts list and schedule of prices for each type of 270 VDC Converter and other equipment specified in this section. This list must include the following:

a. Power semi-conductors.

b. Power filter capacitors.

c. Plug-in logic cards.

d. Output rectification modules.

e. Fuses.

f. Indicator lamp/LED.

1.7 WARRANTY

The equipment items must be supported by service organizations which are reasonably 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.

PART 2 PRODUCTS

2.1 270 VDC CONVERTER

Provide a 270 VDC Converter consisting of modular construction solid-state components for [60][50] hertz (Hz) to 270 VDC conversion, input/output devices, and ancillary control devices. The 270 VDC Converter must be a standard product of the manufacturer and must be the manufacturer's latest design that complies with the specification requirements. The 270 VDC Converters provided under this contract must be products of the same manufacturer. The unit must have a calculated MTBF exceeding 24,000 hours as calculated when the 270 VDC Converter is provided with yearly servicing and maintenance. The 270 VDC Converter must be UL or third party listed to comply with UL 1012. The 270 VDC Converter must have minimum 12 pulse or active input rectification circuit. Provide startup and shutdown instructions posted on the front of the unit using engraved plastic plate. Provide a plastic encapsulated schematic diagram attached to the inside of the unit in clear view of maintenance personnel.

2.2 ELECTRICAL CHARACTERISTICS

2.2.1 Input Voltage

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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. The input voltage must be shown on the construction drawings.

****

[480Y/277][380Y/220][_____] V, three phase, four wire, grounded, [60][50] Hz. Converter shall provide rated output voltage when input voltage is varied plus or minus [10][_____] percent. Input neutral currents shall not exceed [21][_____] percent of any individual phase current at no load and at full load.

2.2.2 Input Power Factor

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

2.2.3 Surge Protection

****

NOTE: Select Location Category C for outdoor locations only.

****

The 270 VDC Converter must be capable of sustaining an input surge described in and tested in accordance with UL 1449, IEEE C62.41.1 and IEEE C62.41.2, Location Category [B][C], and continue to operate with no

alarms within the specified tolerance.

2.2.4 Inrush Current

The inrush current must not exceed 100 percent of the rated full load input current. Inrush current limitation is based on a 270 VDC Converter that does not require a transformer at the input to the unit. Should the contractor choose to provide a 270 VDC Converter with a transformer at the input to the unit, the contractor is responsible for increasing the size of the upstream feeder breaker(s) and increasing the size of conductors and raceways in accordance with NFPA 70.

2.2.5 Input Current Distortion

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NOTE: Where total connected converter load is a small percentage (less than 40 percent) of the total connected facility load, use 12 percent THD and 8 percent individual. For large converters, 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, use 5 percent THD and 3 percent individual.

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

2.2.6 Efficiency

The 270 VDC Converter unit(s) must have a minimum efficiency of 89 percent at 50 percent load and 92 percent at 100 percent load.

2.2.7 Acoustical Noise

Maximum continuous acoustical noise level must be 72 dBa (A weighted scale).

2.3 CABLE AND PLUG ASSEMBLY

The 270 VDC performance requirements specified herein must be met when operating with the worst load conditions specified and inclusive of any 270 VDC output cables over any defined length and characteristics.

The 270 VDC output power built cables must be constructed to meet the power requirements of this specification and to minimize cross coupling, especially to meet current demand rates as well as to ensure power regulation, ripple, distortion, and transient voltage recovery, as defined herein, is not exceeded.

2.3.1 Aircraft Servicing Connector

The aircraft servicing connector must be integrally molded on one end of the cable and must be watertight. The connector must engage with the receptacle conforming to JSFC1 2.

2.3.2 28 VDC Interlock

The 28 VDC interlock power will be enabled when the 270 VDC power is verified ok and safe to use. The sensing back of the 28 VDC interlock from the aircraft indicates a proper connection of the receptacle. The 270 VDC output must only be enabled when the 28 VDC interlock is present.

2.3.3 Power Cable

The power cable interface and build must be per 5PTV6002-101 with the following highlighted design criteria:

a. The 270 VDC/28 VDC return must be a twisted pair or similar definition to meet the performance needs.

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

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

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

e. 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 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.

The interface between the F-35 External Power receptacle must be per 2ZEU0004-0007.

2.4 ELECTRICAL PERFORMANCE

The 270 VDC output must be controlled to the voltage regulation requirements within this document throughout all loadings defined.

2.5 OUTPUT STEADY-STATE CURRENT RATING

The power source must be equipped with outputs as follows:

a. 270 VDC Output (main power): 267 amperes (72 kW) steady-state at 270 VDC with overload/transient/profile load capability as specified herein.

b. 28 VDC Output (interlock power): 15 amperes (0.42 kW) at 28 VDC with transient capability as specified herein.

2.6 OUTPUT TRANSIENT VOLTAGE RECOVERY TIME AND THRESHOLDS

a. The 270 VDC output must remain within the range of 220 to 330 VDC for any step load change from 0 to 54 kW load and from 3 kW to the 150 percent overload capability as well as what is defined in the definitions for the Start-up, Baseline and Profile loading for either a positive or negative 200 amperes/millisecond current rate of change.

b. The 270 VDC output must begin recovery from their worst case transient excursion within 10 milliseconds and must be recovered to within the steady-state operating range specified in paragraph LOAD AND LINE REGULATION within 40 milliseconds per MIL-STD-704 for time durations.

c. The 28 VDC interlock output must remain within a range of 26 to 40 VDC under the worst case step change, under any load step change from 15 to 0 to 15 amperes, and during any defined 270 VDC loading conditions and under any fault current condition that occurs. The voltage must not drop below 26 VDC for more than 50 microseconds.

d. The 28 VDC interlock output must begin recovery from their worst case transient excursion within 15 milliseconds and must be recovered to within the steady-state operating range specified in paragraph LOAD AND LINE REGULATION within 100 milliseconds per MIL-STD-704 for time durations.

2.7 LOAD AND LINE REGULATION

The 270 VDC output must provide 270 VDC +/- 3 VDC under the worst case load variations defined for the Start-up, Baseline and Profile Loadings specified herein.

The 28 VDC interlock output must provide 28 VDC +1/-2 VDC under the worst case combination resistive or constant power load variations from no-load to full-load.

2.8 RIPPLE AMPLITUDE

The 270 VDC output voltage ripple amplitude and distortion factor for the Start-up, Baseline, and Profile Loading must be as defined in Table 1.

Table 1: Normal Operating Characteristics

Characteristic	Start-up and Baseline Loading	Typical Profile Loading
Ripple Amplitude	3.0Vpk-pk	12Vpk-pk
Distortion Factor	0.005 max	0.015 max

The 28 VDC interlock output ripple amplitude must be as defined in MIL-STD-704, Table IV.

2.9 OUTPUT CURRENT DEMAND RATES

The 270 VDC output must remain within the output transient voltage recovery time in paragraph OUTPUT TRANSIENT VOLTAGE RECOVERY TIME AND THRESHOLDS while providing a minimum current demand (at the on-aircraft external power receptacle) rate of 200 amperes/millisecond.

The 28 VDC interlock output must remain within the output transient voltage recovery time in paragraph OUTPUT TRANSIENT VOLTAGE RECOVERY TIME AND THRESHOLDS while providing a minimum current demand (at the on-aircraft external power receptacle) rate of 60 amperes/millisecond.

Both of these current demand rates will be met over any step load (from no-load to full-load) and transient load in the loading profiles.

2.10 DISTORTION SPECTRUM

The 270 VDC output distortion spectrum must meet the requirements of MIL-STD-704 Figure 18, inclusive of the fundamental voltage ripple component. The 270 VDC distortion factor must be as defined in Table 1 above. The 28 VDC interlock output distortion spectrum must meet the requirements of MIL-STD-704 Figure 15. The 28 VDC distortion factor must meet the requirements of MIL-STD-704 Table IV of 0.035 maximum.

2.11 OUTPUT TRANSIENT RATING

All power source outputs, 270 VDC and 28 VDC, must have transient capability as follows:

a. 150 percent of rated output for 5 seconds.

b. 200 percent of rated output for 1 second.

c. 250 percent of rated output for 50 milliseconds.

2.12 OUTPUT LOAD FAULT

2.12.1 270 VDC Output

The 270 VDC output must coordinate with the trip curve for a 120A contactor per 2ZEU0004-0007 Figure 5. This is to ensure that the 120A contactor will trip prior to the external power source output going off-line due to overcurrent or undervoltage.

2.12.2 Power Source

Upon a short between the aircraft receptacle and aircraft structure the power source must limit the current source on the 270 VDC supply. The power source must limit average current to 480 amperes by detecting the short circuit and maintaining a current threshold regardless of the resistance in the current path for a minimum of time duration so that the worst case fault duration is cleared by the aircraft 120 amperes overcurrent device. If the fault condition clears in less than the time allowed per 2ZEU0004-0007 Figure 5, the power source must recover to within the steady-state operating range defined between 250-280 volts within 40 milliseconds in accordance with time durations of MIL-STD-704 Figure 16 and then settling out to the regulated voltage levels defined in paragraph LOAD AND LINE REGULATION within 10 milliseconds.

2.12.3 Overcurrent

During this 270 VDC overcurrent condition, as well as for any high di/dt load or overload condition (e.g. overvoltage, overcurrent, undervoltage, ripple), the 28 VDC interlock power output must not be disrupted and power quality must remain as defined in paragraph LOAD AND LINE REGULATION throughout the fault isolation event.

2.12.4 28 VDC Interlock Output

The 28 VDC interlock output must provide an I^2t protective function to protect a 16 gauge wire during an overcurrent condition.

2.13 LINE DROP COMPENSATION

2.13.1 270 VDC Power Source

The 270 VDC power source must have an automatic compensation function on the main 270 VDC output in order to maintain the minimum voltage input thresholds at the aircraft external power receptacle, effectively canceling out the voltage drop in the 270 VDC output cable.

2.13.2 Testing

The manufacturer must test the unit with different length cables with 25.5 meters 83.5 feet being the longest. If the aircraft minimum voltage thresholds are met then the LDC boost circuit can be a manual setting.

2.13.3 28 VDC Interlock Power Source

The 28 VDC interlock power source must have an automatic line drop compensation function.

2.13.4 Compensation Levels

During this type of compensation control, the level of current loading will be changing and may range from the minimum to maximum transient type of loading, but the maximum voltage allowed must be per paragraph OUTPUT TRANSIENT VOLTAGE RECOVERY TIME AND THRESHOLDS.

2.14 SAFETY FUNCTIONS

2.14.1 270 VDC Power Source

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

a. 270 VDC power source has been turned off.

b. Detection of system fault.

2.14.2 270 VDC Output Connector

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

a. Receiving a stop command.

b. Detection of a fault that results in a shut down condition.

c. Loss of 28 VDC interlock power.

2.15 INPUT/OUTPUT DEVICES

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 power line is "broken" (e.g. when the power cord is removed from the aircraft receptacle), the 270 VDC output power source must be disabled.

The 270 VDC output contactors must be rated to handle the power requirements within this specification and for make/break operation into a

2,500 microfarads capacitance without damage to 270 VDC Converter.

2.16 PROTECTIVE FUNCTION COORDINATION

2.16.1 On-Aircraft Power

Coordination with on-aircraft power quality unit protective functions must be met to ensure that the power source protective functions defined below are enabled prior to the on-aircraft protection.

2.16.2 On-Aircraft Protective Function

On the aircraft, the unit which controls the external power provides power quality monitoring protective functions for overvoltage, undervoltage, voltage ripple and voltage reverse polarity. These protective functions, if met, result in the unit not allowing the external power source to be connected to the aircraft. Or if these conditions are met after application, the on-aircraft contactor (which distributes the external power to the aircraft loads) will open in a timely manner. The following is the definition of each on-aircraft protective function with time delays defined:

Table 2: Protective Function Devices

Protective Function	Voltage	Time Duration
Overvoltage	286 +/- 5 VDC with inverse delay with voltage per 2ZEU0004-0007 Figure 6	N/A
Undervoltage	246 +/- 6 VDC	for >0.500 second +/- 0.015 second
DC Ripple	>16.0 +2/- 0Vp-p	for >3.985 seconds +/- 0.015 second
Reverse Polarity	-12.0 +1/-0 VDC	for >0.250 second +/- 0.015 second

2.16.3 On-Aircraft External Power Source (EPS) Unit

The external power source performance must be met to not cause any of the protective functions defined above to be "activated" with reference to the on-aircraft external power source receptacle over all of the defined loading requirements defined within this specification.

2.17 START-UP LOADING

The 270 VDC power source must operate within the limits specified herein per paragraph OUTPUT TRANSIENT VOLTAGE RECOVERY TIME AND THRESHOLDS when the following loads are applied a) 0 to 1,500 microfarads of capacitance in parallel with 0 to 54 kW constant power load or b) 0 to 54 kW resistive load.

The 270 VDC power source must be designed to preclude inadvertent trips for inrush currents caused by output load transients. Prevention of over sensitivity to high di/dt or dv/dt loads will be taken into consideration to prevent nuisance trips on start-up and during voltage transient

conditions.

The 28 VDC interlock output must be able to source power to a minimum of 100 microfarads equivalent input capacitive load without tripping.

2.18 BASELINE LOADING

For all baseline loading conditions specified in this paragraph and outlined in Table 3, the source must meet the power quality in accordance with paragraph ELECTRICAL CHARACTERISTICS. The load type can be 100 percent resistive or 100 percent constant power or any combination in between.

The 270 VDC output must be designed to operate with a baseline load of 0 to 2,500 microfarads of capacitance in parallel with either of the following conditions listed in Table 3:

Table 3: Baseline Load Conditions

	Condition #1 (0 to 100 percent CONSTANT POWER Loads)	Condition #2 (0 to 100 percent RESISTIVE POWER Loads)
a	0 to 72 kW*	0 to 72 kW*
b	3 to 28 kW and an IPP start load of 12 kW for 30 seconds. Followed by 250 milliseconds of parallel operation with the IPP source. (See 2ZEU0004-0007 Figures 12 and 13.)	3 to 28 kW and an IPP start load of 12 kW for 30 seconds. Followed by 250 milliseconds of parallel operation with the IPP source. (See 2ZEU0004-0007 Figures 12 and 13.)

* Baseline Load: 0 to 2,500 microfarads of capacitance in parallel with (a) 0 to 72 kW of constant power +150 percent overload for 5 seconds, +200 percent overload for 1 second and +250 percent overload for 50 milliseconds while meeting the minimum current demand rate of 200 amperes/millisecond; or (b) 0 to 72 kW of resistive load +150 percent overload for 5 seconds, +200 percent overload for 1 second and +250 percent overload for 50 milliseconds while meeting the minimum current demand rate of 200 amperes/millisecond.

The IPP power source is a bi-directional PWM power converter, which can operate as an active load or as a power source. As an active load, the power bridge is a standard configuration 3 phase full wave bridge inverter topology at a switching frequency of 20 KHz. As a power source, the power bridge functions as an active rectifier to condition the power output and its fundamental frequency is 1KHz.

The time duration from when the IPP transitions from an active load to a power source per 2ZEU0004-0007 Figures 12 and 13 can range as short as 1 second to as long as 15 seconds.

The 28 VDC interlock output must operate within the limits specified herein when the following loads are applied: 0 to 100 microfarads of capacitance in parallel with either a resistive or constant power load from 0 to 15 amperes and with a 20 amperes total load level duration of up to 250 milliseconds while meeting the minimum current demand rate of 60

amperes/millisecond.

2.19 TYPICAL PROFILE LOADING

For all profile and transient loading conditions in this section, the power quality will be met in accordance with this specification and per 2ZEU0004-0007. The load type can be 100 percent resistive or 100 percent constant power or any combination in between. (See 2ZEU0004-0007 Figures 8, 9, 10 and 11.)

2.20 ENVIRONMENTAL RATING

The 270 VDC Converter must operate satisfactorily from no load to rated full load under the following conditions:

a. Ambient temperatures ranging from -20 degrees C to 55 degrees C -4 degrees F to 131 degrees F.

b. Relative humidity 0 to 95 percent non-condensing.

c. Ambient pressures from sea level to 915 meters 3000 feet.

2.21 MONITORING AND CONTROL PANEL

Provide 270 VDC Converter with a control panel that is equipped with the following controls, indicators, instrumentation, data logging, diagnostics, and alarm functions.

2.21.1 Controls

a. Start/stop pushbutton.

b. Lamp/light emitting diode (LED) test - A push-to-test button or switch to test indicator lamps/LEDs.

c. Alarm silence - A switch that must disable the audible alarm.

d. Alarm reset - A pushbutton to silence audible alarms.

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

f. Circuit breaker.

g. Output contactor ON/OFF.

h. Output voltage adjust.

2.21.2 Indicators

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

b. Output power On/Off - Lamp/LED to indicate that the 270 VDC Converter output voltage is available.

c. 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.

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

e. Audible alarm.

f. Output contactor "ON".

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

2.21.3 Digital Instrumentation

Provide one percent accuracy, microprocessor-based meter with a simultaneous three-line LCD display. Meter must display elapsed time (in hours). Meter must display output voltage and output current for 270 VDC.

2.21.4 Alarm Annunciator

The unit must be capable of detecting and displaying the following abnormal conditions:

a. Input overvoltage.

b. Input undervoltage.

c. Output undervoltage.

d. Output overvoltage.

e. Output overload.

f. System alarm.

g. Control logic failure.

h. Over-temperature.

i. Logic power supply failure.

2.21.5 Input/Output Devices

Provide fully-rated, UL approved devices for control of [60][50] Hz input and DC output from the 270 VDC Converter.

2.21.6 Circuit Breaker

Conform to requirements of UL 489.

2.21.6.1 Input Circuit Breaker

Provide 270 VDC Converter with a UL listed, three-pole input circuit breaker as an integral part of the 270 VDC Converter. Breaker must be operable from the front of the 270 VDC Converter. Breaker must have a short-circuit current rating of [25,000][_____] amperes symmetrical minimum.

2.21.6.2 Output Contactor

Provide 270 VDC Converter output with an automatic magnetically-held contactor with interlock circuit. Output contactor must be of sufficient capacity to handle rated load, overload, and available short circuit current. Contactor must open when any circuit identified in paragraph PROTECTIVE FUNCTION REQUIREMENTS causes the system to shut down. Output contactor must be electrically interlocked with ON/OFF circuitry, so when the 270 VDC Converter is shutdown, the contactor must open immediately and remain open.

2.21.6.3 Protective Function Requirements

Provide circuitry for the following protective controls.

a. Input undervoltage.

b. Input overvoltage.

c. Loss of phase.

d. Loss of input power.

e. Door interlock - When any access door is opened, the interlock circuitry must open the [60][50] Hz input device and DC output device and not allow the input or output device to close. For maintenance purposes, provide a bypass switch to defeat the interlock circuitry.

f. Output overvoltage - must be in accordance with Table 2.

g. Output undervoltage - must be in accordance with Table 2.

h. Output overload - must be in accordance with Table 2.

i. 270 VDC Converter over temperature protection.

2.21.7 Built-in Test Equipment

270 VDC Converter must include built-in test equipment 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 270 VDC Converter status using cabinet mounted light emitting diodes.

2.21.8 Assembly Construction

****
NOTE: Delete "louvers" when specifying NEMA Type 4X and 12K enclosures.
****

Provide enclosures suitable for [indoor][outdoor][corrosive][direct spray][_____] environments in accordance with NEMA 250, Type [l][3][3R][4X][12K]. Arrange to provide required[louvers,] cooling air, entry and exit provisions for equipment within enclosures. 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

exterior of the enclosure.[For units installed outdoors or in corrosive environments, electronic circuits must be enclosed in a sealed electronics compartment that is not provided with direct cooling ventilation or forced air cooling.] 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 substrate which has been provided with a rust inhibiting treatment.[Provide two finish coats for outdoor enclosures.]

2.22 SOURCE QUALITY CONTROL

2.22.1 270 VDC Converter Test Schedule

The Government reserves the right to witness tests. Provide 270 VDC 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.

a. Test Instrument Calibration.

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

(2) The accuracy must be directly traceable to the National Institute of Standards and Technology.

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

(4) Dated calibration labels must be visible on all test equipment.

(5) Calibrating standard must be of higher accuracy than that of the instrument tested.

(6) 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:

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

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

2.22.2 Routine Factory Tests

Routine tests must be performed by the manufacturer on each of the actual 270 VDC Converter(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site.

For tests which require full load, use the nameplate full load KW of the unit being tested unless otherwise noted. Tests must include the following:

a. Input current and power factor: Operate 270 VDC 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.

b. Output voltage, output current and voltage regulation: Operate converter at nominal input voltage for:

   (1) 50 percent of rated capacity.

   (2) 100 percent of rated capacity.

   (3) 100 percent of rated capacity at low and high input voltage.

   (4) Operate for not less than 15 minutes at each test condition above. Monitor and record output voltage, output current, output voltage ripple (peak-to-peak and distortion factor), at the beginning and end of each test condition. Monitor and record output.

c. Burn-in Test: Before delivery, burn-in all units under full load conditions for at least 24 hours. Burn-in test must be performed with the 270 VDC Converter enclosure doors closed and all ventilation in the final operating condition.

d. Automatic line drop compensation: Operate converter at nominal voltage at:

   (1) No-load.

   (2) 50 percent of rated capacity.

   (3) 100 percent of rated capacity.

   Loads shall be connected to the converter with the specified aircraft power cable assembly. No adjustments to the converter are allowed between load tests. Monitor and record output voltage at the load end of the cable. Verify specified performance of the line drop compensation.

2.22.2.1 Load Test

Loads must be connected to the 270 VDC Converter with the specified aircraft power cable assembly. Adjustments to the 270 VDC Converter must be allowed between load tests. Monitor and record output voltage at the load end of the cable. Verify specified performance of the line drop compensation as specified herein.

Provide the testing method, required instrumentation and test fixtures to provide compliance data for the following parameters:

a. Load and Line regulation at 270 VDC.

b. Ripple amplitude.

c. Output current demands rates. - this is more of a special test, and

more of a test of the load bank than the 270VCDC unit

d. Distortion spectrum. - this is more of a special test

e. Output Transient Voltage Recovery Time and Thresholds.

f. Output Load Fault.

g. Safety functions.

h. Protective Function Requirements and Protective controls.

i. Controls, Test to ensure proper function of each control.

j. Indicators. Test to ensure proper function of each indicator.

k. Digital Instrumentation and Alarm annunciator. Test to ensure proper function of each instrument and annunciator.

l. Built-in Test Equipment. Verify that design codes or test indicate the correct function for a defective or non-operating device.

2.22.3 SPECIAL FACTORY TESTS (DESIGN TESTS)

Submit special factory test (design test) reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for each of the specified 270 VDC Converter(s). Tests must be certified and signed by a registered professional engineer. Tests must be on file based on a production model of 270 VDC Converter of the same design, construction and KW rating provided.

2.22.3.1 Power Quality Tests

As an option, the manufacturer must test one unit at the time scheduled for routine tests, of each rating and size 270 VDC Converters to assure compliance with the specification. The tests must include the following:

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NOTE: Select Location Category C for outdoor locations only.

****

a. 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 the 270 VDC Converter output power and voltage stays within specified regulation tolerances. Surge protection tests must be applicable on all 270 VDC Converter units utilizing same surge protection device by manufacturer and part number regardless of 270 VDC Converter KW size.

b. Inrush current: After applying power to the 270 VDC Converter, conduct a minimum of three inrush current tests at full load. Provide copies of waveform and THD analysis in test report.

c. Input current distortion: Operate at nominal input voltage at full load. Measure and record the input current THD for the current in each phase.

2.22.3.2 Full Load Tests

For tests which require full load, use the nameplate full load KW of the unit being tested unless otherwise noted. Tests must include the following:

a. Input current and power factor: Operate 270 VDC 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.

b. Output voltage and voltage regulation: Operate converter at nominal input voltage for:

   (1) 50 percent of rated capacity.

   (2) 100 percent of rated capacity.

   (3) 100 percent of rated capacity at low and high input voltage.

   (4) Operate for not less than 15 minutes at each test condition above. Monitor and record output voltage, output current, output voltage ripple, at the beginning and end of each test condition. Monitor and record output

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

d. 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.

e. 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 four 270 VDC Converter "ON" cycles. Burn-in test must be performed with the 270 VDC Converter enclosure doors closed and all ventilation in the final operating condition.

f. Include harmonic frequency spectrum analysis depicting Harmonic Order and Harmonic Magnitude at the unit's input terminals during full load THD test in test reports.

g. Automatic line drop compensation: Operate converter at nominal voltage at:

   (1) No-load.

   (2) 50 percent of rated capacity.

   (3) 100 percent of rated capacity.

   (4) Loads must be connected to the 270 VDC Converter with the specified aircraft power cable assembly. No adjustments to the 270 VDC Converter must be allowed between load tests. Monitor and record output voltage at the load end of the cable. Verify specified performance of the line drop compensation as described

in paragraph OUTPUT CURRENT DEMAND RATES.

2.22.3.3 Compliance Data

Provide the testing method, required instrumentation and test fixtures to provide compliance data for the following parameters:

a. Load and Line regulation at 270 VDC.

b. Output transient rating.

c. Ripple amplitude.

d. Output current demands rates.

e. Distortion spectrum.

f. Output Transient Voltage Recovery Time and Thresholds.

g. Output Load Fault.

h. Safety functions.

i. Input/Output devices.

j. Protective Function Requirements and Protective controls.

k. Start-up Loading.

l. Baseline Loading.

m. Typical Profile Loading.

n. Controls, Test to ensure proper function of each control.

o. Indicators. Test to ensure proper function of each indicator.

p. Digital Instrumentation and Alarm annunciators. Test to ensure proper function of each instrument and annunciator.

q. Built-in Test Equipment. Verify that design codes or test indicate the correct function for a defective or non-operating device.

2.23 MANUFACTURER'S NAMEPLATE

Each item of 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.

2.24 FIELD FABRICATED NAMEPLATES

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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 red labels are required.

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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.[Provide red laminated plastic label with white center core where indicated.] 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 one by 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.25 WARNING SIGNS

Provide warning signs for 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. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. The marking must be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.26 FACTORY APPLIED FINISH

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NOTE: This paragraph covers only the basic painting requirements for most electrical equipment. Include any special finishes for high or low temperatures and corrosive atmospheres.

****

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 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 in accordance with the manufacturer's standard practice. Exterior surfaces must be primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.[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.

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 [60][50] Hz, unless indicated or specified otherwise. Electrical installations must 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 or weld units to channels to allow easy withdrawal or insertion of removable components and to permit proper operation and maintenance of equipment.

3.2.2 Grounding

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

3.2.3 Wiring and Conduit

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

3.2.4 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 Converter.

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

****

NOTE: Use and coordinate paint and coating requirements with Section 09 90 00 PAINTS AND COATINGS when provided in the job. Use the second bracketed option when Section 09 90 00 PAINTS AND COATINGS is not provided or when requirements are beyond what is specified in Section 09 90 00 PAINTS AND COATINGS.

****

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.[Painting must be as specified in Section 09 90 00 PAINTS AND COATINGS.][Where field painting of enclosures is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.]

3.6 FIELD QUALITY CONTROL

3.6.1 Instruments

Provide test instruments capable of measuring and recording or displaying test data at a higher resolution and greater accuracy than specified for the 270 VDC Converter 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.

3.6.2 Performance of Acceptance Checks and Tests

Perform field tests and conduct inspections. Provide labor, equipment tests instruments, and incidentals required for the tests including load banks, except the Government will furnish electricity.

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests.

3.6.3 Initial Inspection and Tests

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

b. Inspect physical and mechanical condition.

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.

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

e. Verify correct equipment grounding.

f. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

3.6.4 Performance Tests

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Since the units have been tested for specification compliance, and certification of that testing has been accepted by the contracting officer, and the unit (s) have been factory tested, and the factory test report has been accepted by the contracting officer, field testing will be limited as described in this section of the specification.

****

Conduct 270 VDC Converter performance tests under the supervision of the manufacturer's representative. Successfully complete the preliminary operation, control and protective devices check prior to performing load tests. If the 270 VDC Converter fails to operate within the specified limits during any of the performance tests the Contractor must discontinue the test and must make necessary repairs to correct the failure and restart testing of the 270 VDC Converter.

3.6.4.1 Preliminary Operation

Inspect the 270 VDC Converter and make adjustments necessary to assure proper operation in accordance with the manufacturer's instructions. Operate 270 VDC Converter at 0, 25, 50, 75, and 100 percent of rated full load. Measure and record the output voltage and current. Calculate output voltage regulation. Verify 270 VDC Converter is operating within specified limits at each load level.

3.6.4.2 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 functions properly. After each operation measure and record the 270 VDC Converter output voltage and current. Verify 270 VDC Converter is operating within specified limits as defined for controls and output devices.

3.6.4.3 Load Test

Operate each unit continuously a minimum of 2 hours at 100 percent rated load. Measure and record the 270 VDC Converter output voltage and current. Verify 270 VDC Converter is operating within specified limits. Load test must be performed with the 270 VDC Converter doors closed and the load connected to the 270 VDC Converter with specified aircraft cable assembly.

3.6.4.4 Automatic Line Drop Compensation

Conduct automatic line drop compensation tests on each 270 VDC Converter with the load connected to the 270 VDC Converter with the specified aircraft power cable assembly. Operate each 270 VDC Converter at no load, 50 percent and 100 percent of the rated capacity. No adjustments to the 270 VDC Converter must be allowed between load tests. Monitor and record output voltage at the load end of the cable. Verify specified performance of the line drop compensation.

3.6.5 Grounding System

Inspect ground system for compliance with contract plans and specifications.

3.6.6 Follow-up Verification

Upon completion of acceptance checks and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer must be given 5 working days advance notice of the dates and times of checking and testing.

3.7 DEMONSTRATION

3.7.1 Instructing Government Personnel

Provide field training to Government personnel on the operation and maintenance of the 270 VDC Converter provided. Provide field training 2

weeks prior to the scheduled date for field acceptance tests. As a minimum the training must include 2 hours of instruction on the theory of operation and 4 hours on the repair and maintenance of the 270 VDC Converter. 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 270 VDC Converter system. Provide two copies of video or audio tapes, if used in the training sessions, to the Contracting Officer.

-- End of Section --