SECTION 26 32 26 - FREQUENCY CONVERTER UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes freestanding, prepackaged frequency converter units for transforming and providing 400Hz electrical power to military aircraft during ground operations. The system shall be a solid-state, three phase, Frequency Converter designed to provide regulated and conditioned sinusoidal power to both linear and non-linear type loads. The specified solid state frequency converter equipment shall be referred to as “SSFC.”

1.2 ACTION SUBMITTALS

A. The following submittals shall be required:

1. Manufacturers Data.
2. Connection Diagrams and Outline Drawings.
4. Spare parts list.
5. List of required Special Tools.
6. Operational and Maintenance Manuals.
8. Test Reports.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For frequency converter units to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain a service center capable of providing training, parts, and emergency on-site repairs in less than eight hours’ maximum response time. Provide training as outlined in section 2.14. Provide parts and emergency on-site repairs within 5 days of acknowledgement.

1.5 FIELD CONDITIONS

A. Environmental Conditions: Units shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability.
1. Operating Temperature Range: -40 to 125 deg F.
2. Relative Humidity Range: 0 to 98 percent, noncondensing.
3. Altitude: Sea level to 6,000 above sea level.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of design product: Cavotec

B. Alternate Manufacturers: Alternate manufacturers offering products may be incorporated into the Work subject to compliance with the requirements.
   1. Note that companies wishing to bid as an alternate will be required to obtain approval of equipment. Bidder will be responsible for all costs associated with approval by Owner. Costs may include sample unit and testing by independent laboratory; tests to be witnessed by Owner representative.

C. Source Limitations: Obtain frequency converter unit and associated components specified in this Section from a single manufacturer.

2.2 DESCRIPTION

A. This section covers designing, manufacturing, testing, furnishing of 60 Hz to 400 Hz Pulse Width Modulated (PWM) frequency converter to conform to MIL-STD-704E standard for aircraft ground power systems. Basis of design is PWM/IGBT technology. Only the following PWM configurations will be accepted: Sine PWM (Natural), Interactive PWM, Optimum PWM (Multiple Inversion), Flash PWM (optimum), Phase Shifted PWM. Step conversion and/or bi-polar transistors will not be acceptable. The SSFC shall be a standalone, self-contained unit capable of converting 50/60 Hz input power to 400 Hz output power for combinations of linear and nonlinear loads in aircraft electrical systems and avionic back shop facilities. The SSFC shall be of solid state electronic construction and contain no moving parts to accomplish the power conversion (Note: cooling fans shall be permitted). The SSFC shall be constructed of modular and easily replaceable subassemblies and components wherever possible. The SSFC enclosure shall be free standing with provision for floor mounting and shall be capable of being mounted with its back flush against a wall or structure without impeding ventilation or access for maintenance, repair or component service or replacement. The enclosure shall have hinged doors to provide access for maintenance, repair, and replacement of modular components and subassemblies. The SSFC enclosure shall be weatherproof for outdoor operation in accordance with NEMA 250 Type 4 and be designed for use in aircraft hangars. The SSFC shall have Built-In-Test-Equipment and alarm functions to continuously monitor, control, and provide diagnostics. Components of the SSFC shall be UL recognized or listed for their intended application whenever possible and the SSFC shall have a UL 1012 label covering the configuration defined herein. Additional features and capabilities shall be permitted unless otherwise indicated by this document.
2.3 APPLICABLE CODES AND STANDARDS

A. MIL-STD-704E  
   Aircraft Electrical Power Characteristics.

B. MIL-S-19500………………….Semiconductor devices.

C. MIL-STD-461………………….Electromagnetic emission and susceptibility requirements for the control of electro-magnetic interference.

D. DFS-400.  
   400 Hz aircraft ground power.

E. ST-20-1972(R-1978)……………Dry type transformer for general application.

F. IEEE 127…………………Aerospace equipment and frequency rating.

G. IEC 146………………….Semiconductor converters.

H. ISO-1540  
   Aerospace characteristics of aircraft electrical systems.

I. ATA-101…………………..Ground equipment technical data.

J. ARP-1940(1986)………………Solid state frequency converters.

K. ISO-6858 ……………………Aircraft ground support electrical supplies.

L. NFPA 70………………….National Electrical Code.

M. UL1012  
   Standard for Power Units Other Than Class 2

2.4 PRODUCTS

A. Provide frequency converter consisting of modular construction. Solid-state components for 60 to 400Hz conversion, input/output devices and ancillary control devices. The frequency converter shall be the manufacturer's latest design that complies with the specification. Only PWM design units (as identified in Section 1.1) are acceptable; units to be designed with switching devices using IGBT technology, a maximum of 12 switching elements shall be used. No step conversion or bi-polar transistor units will be considered. All frequency converters provided shall be products of the same manufacturer, complying with requirements as stated herein.

B. Provide 400HZ Aircraft Cable Assembly, single jacket, with 400HZ Aircraft Connector. 60 Feet in length.

1. Cavotec Cable no. N0001SC064035-060. 60feet with RVS.
2. Aircraft 400HZ Connector: Cavotec FLADUNG Connector Head.
   a. Confirm cable and connector requirements with NCANG prior to ordering.
2.5 INPUT-POWER

A. The SSFC shall operate with 3-phase, 4-wire, grounded, Alternating Current (AC) power input. Inrush current shall not exceed 150% of the rated full load current of the connected voltage.

B. INPUT VOLTAGE AND FREQUENCY

1. The SSFC shall be set at the factory to accept a 60 Hz, 480 volts AC (VAC) input. The SSFC shall be capable of accepting inputs from different voltage and frequency systems including:
   a. 60 (± 5%)Hz:
      1) 208 (±10%) VAC
      2) 480 (± 10%) VAC
   b. 50 (± 5%)Hz:
      1) 380 (±10 %) VAC

C. INPUT PHASE SEQUENCE

1. The SSFC shall accept any input power phase sequence.

D. INPUT POWER FACTOR

1. The SSFC shall accept input power having a power factor from 0.8 leading to 0.8 lagging.

2.6 OUTPUT POWER

A. The SSFC shall provide the output power characteristics listed below.

B. OUTPUT VOLTAGE AND FREQUENCY

1. The SSFC output steady state voltage shall be three phase, Wye configured with a grounded neutral and the SSFC output frequency shall be a sine wave form at 400 Hz (±0.1 %). The output voltage shall be user connectable for both 115/200 VAC and 230/400VAC. Output voltage shall be adjustable but shall be regulated to within ±1% at all settings from zero to full load. The direct current (DC) component in the output voltage shall not exceed ±0.1 volts. The crest factor shall be 1.31 to 1.51. The SSFC shall operate as specified with both Delta and Wye configured loads.

C. OUTPUT POWER RATING

1. The SSFC shall be capable of providing 100 kW continuously into loads with power factors ranging between 0.8 leading and 0.8 lagging. The output voltage shall be maintained within the stated tolerances under all load conditions within these limits.

D. OUTPUT PHASE SEQUENCE
1. The phase sequence of the SSFC output voltage shall be a positive sequence of A-B-C (AB-BC-CA).

E. OPERATIONAL CHARACTERISTICS

1. The SSFC shall operate continuously or intermittently at any load with the characteristics listed below.

F. AUTOMATIC AND MANUAL LINE DROP COMPENSATION

1. The SSFC shall provide both a manual output voltage adjustment (±10%) and an automatic output voltage adjustment to compensate for voltage drop associated with losses in the output power cable. Automatic line drop compensation (ALDC) shall be operable in both stand-alone and parallel modes of operation. If remote voltage sensing (RVS) is used for line drop compensation processing, the SSFC shall automatically revert to local (output terminal) sensing if a break occurs in the remote sensing circuit. The SSFC shall have a switch to manually select the compensation/adjustment method. The SSFC shall provide the specified voltage as required by MIL-STD-704F at the load connection end of the following cables:

   a. Single jacket, 260 amp rated cable equivalent to part number NR16-1005641960, with RVS.
   b. Single jacket, 260 amp rated cable equivalent to part number NR16-1005641915, with RVS.

2. A cable assembly equivalent to part number MS90328-28 as shown in SAE AS90328.

   a. For these cables, the SSFC ALDC circuit shall provide enough adjustment range to overcome voltage drop at a 300 Ampere load (overloaded) condition and shall maintain the steady-state output voltage at the load connection end of the power cable within the limits specified in paragraph 4.3 and Figure 3 of MIL-STD-704F. The steady-state output voltage amplitude limits for the 115/200 volts standard shall apply proportionally to the SSFC ALDC when connected for 230/400 volts output.

G. UNBALANCED LOADS

1. The SSFC shall be capable of supplying a 15% maximum unbalanced load. The unbalanced load of 15% shall be defined as any one phase at its full load condition and the remaining two phases at 85% of their full load condition.

H. PHASE ANGLE REGULATION

1. The displacement angle between adjacent voltages shall be 120 Degrees (±2 Degrees) for balanced loads and shall be 120 Degrees (±4 Degrees) for three phase 15% unbalanced loads.

I. NO-LOAD INPUT LOSSES

1. The SSFC no-load input losses shall not exceed 9% of the total output kW rating.
J. EFFICIENCY
   1. The minimum efficiency of the SSFC shall be at least 85% at 50% load condition and 88% at full load condition.

K. OVERLOAD/OVERCURRENT
   1. The SSFC shall not be tripped or sustain damage during the following overload/overcurrent conditions:
      a. % of Full Load Satisfactory Operating Time
         1) 110 % 60 Minutes
         2) 125 % 10 Minutes
         3) 150 % 2 Minutes
         4) 200 % 20 Seconds
         5) 300 % 6 Seconds

L. SHORT CIRCUIT
   1. The SSFC shall be capable of tripping the protective input and output devices on three phase, two phase, two phase to ground and single phase to ground short circuit fault conditions without sustaining damage.

M. OUTPUT TOTAL HARMONIC DISTORTION (THD)
   1. The THD (in accordance with IEEE 519) in the output voltage for the SSFC shall be as follows:
      a. Balanced Load Condition: THD shall not exceed 3% line-to-line and line-to-neutral. Maximum single harmonic distortion shall not exceed 2% of the fundamental at the nominal voltage.
      b. Unbalanced Load Condition: THD shall not exceed 4% line-to-neutral with a 15% unbalanced load applied.

N. INPUT TOTAL HARMONIC DISTORTION (THD)
   1. THD (as defined in IEEE 519) at the SSFC input power terminals at normal input voltages while operating at full rated output load shall not exceed 10%.

O. AMPLITUDE MODULATION
   1. The SSFC amplitude modulation shall not exceed 1% for no load to full load condition.

P. FREQUENCY STABILITY
   1. The SSFC frequency regulation shall be independent of load changes. The frequency stability of the SSFC shall be 400 Hz (± 0.5%) for all load conditions.

Q. TRANSIENT OUTPUT VOLTAGE AND FREQUENCY RECOVERY
1. The SSFC transient output voltage and frequency recovery shall be in accordance with MIL-STD-704F (Figures 3 and 5 respectively). The transient output voltage amplitude limits for the 115/200 volts standard shall apply proportionally to the SSFC when connected for 230/400 volts output.

R. AUTOMATIC PARALLEL OPERATION

1. The SSFC shall be capable of automatic parallel to other like units of the same kVA rating. The SSFC shall automatically synchronize and share load equally (within +/- 5%). Interconnection cables, if required to support parallel operation, shall be provided with each SSFC. Interconnection cables shall not be less than 20 ft in length or greater than 25 ft in length. Each SSFC shall include provisions for secure storage of the provided interconnection cables.

S. INPUT SURGE PROTECTION

1. The SSFC shall be capable of sustaining an input surge described in and tested in accordance with IEEE C62.41, location category B, and continue to operate with no alarms within the specified tolerance.

T. 28 VOLT DC (VDC) AIRCRAFT E-F PIN INTERLOCK CIRCUIT

1. The SSFC shall have a selector switch labeled as SSFC LOOP – BYPASS – AIRCRAFT LOOP to control the E-F pin interlock circuits. The SSFC shall contain terminal block points for the connection of two 12 AWG wires from the aircraft cable assembly for the interlock circuit.

2. In the AIRCRAFT LOOP mode, the SSFC shall close the output circuit breaker or contactor for a period of 4 to 5 seconds at start up. The SSFC shall receive a 28 VDC (nominal) interlock signal from the aircraft and loop it back to the aircraft via the E-F pin interlock circuit. The SSFC E-F interlock circuit shall not be polarity sensitive to the current flowing to/from the aircraft but an intermittent signal shall not be permitted. The interlock loop shall be monitored by the SSFC to determine if a 16 to 32 VDC signal is present and if current is flowing through the loop. When this voltage level and a current are present, the output circuit breaker or contactor shall remain closed. When current is not present or drops out, the output contactor or circuit breaker shall open within 50 milliseconds. While in the AIRCRAFT LOOP mode the SSFC shall be capable of accepting an unfiltered, noisy, poorly regulated, half-wave rectified 28 VDC interlock signal (Note that the signal peak voltage values may approach 64 volts.)

3. In the BYPASS mode the E-F pins shall be connected together but not monitored or grounded. The E-F pin circuit shall not be used to control the output contactor or circuit breaker in BYPASS mode. Any changes required to operate in the BYPASS mode shall be automatically implemented.

4. In the SSFC LOOP mode, the SSFC shall close the output circuit breaker or contactor for a period of 4 to 5 seconds at start up. The SSFC shall provide a filtered and regulated 28 V (+/- 1) DC interlock signal to the aircraft via pin E of the interlock circuit. This signal shall be monitored for current flow. If the current flow from the 28 VDC signal is looped back on pin F of the interlock circuit, then the output circuit breaker or contactor shall remain closed. If current is not present or the voltage is not present on pin F, then the output circuit breaker or contactor shall open within 50 milliseconds. The SSFC shall be
capable of providing not less than 10 Amperes for aircraft relay closing current and 2 Amperes steady-state current to the aircraft at 28 VDC via the E-F interlock circuit.

2.7 CONTROL AND MONITORING CHARACTERISTICS

A. The SSFC shall be designed to control, indicate, monitor, and display the functions listed below. All switches and controls shall be located together in a control panel in the front of the unit unless otherwise indicated. All controls and indicator devices shall be clearly marked as to their function, position and signal. Voltage and current meters shall have accuracy of +/- 2%, or better, full scale. Frequency meters shall be accurate to not less than +/- 0.5% full scale. Multiple function (multi-function) meters, displays and indicators shall not be used.

1. Start & stop push-button
   a. A start push-button shall be provided on the control panel to operate the internal operations of the SSFC; it shall not close the output control device. A stop push-button shall also be provided to shut off the internal operations of the SSFC.

2. Push-to-test button
   a. A push-to-test button or switch shall be provided to test the indicating light emitting diodes (LEDs), audible signals, and display panel for the SSFC.

3. Emergency stop push-button
   a. An emergency stop push-button shall be provided on the control panel to immediately turn off the input and output power and open the input and output control devices. The emergency stop push-button shall be a turn-to-release or pull-to-release design.

4. Input circuit breaker/contactor
   a. The SSFC shall be equipped with a device for control of input power. The device shall be manually operable and have shunt-trip and under voltage release features. If circuit breakers are used for this purpose they shall be fully rated heavy duty three pole breakers in accordance with UL 489.

5. Output circuit breakers/contactor
   a. The SSFC shall be equipped with a manual device for opening and closing the output control device. An interlock circuit shall prevent the output circuit breaker (or contactor) from closing without the input circuit breaker (or contactor) being first closed with power applied. An interlock circuit bypass switch or other device shall be provided to defeat the interlock by maintenance personnel while performing troubleshooting and maintenance activities. The output circuit breaker/contactor shall be automatically tripable by the SSFC abnormal alarm conditions. A device to open and close the output circuit breaker/contactor shall be provided on the control panel. The output circuit breaker/contactor shall be in accordance with UL 489. All devices operating at 400 Hz shall be designed for, or be derated for, 400 Hz operation.

6. System alarm
   a. An LED to indicate that fault conditions exist shall be provided on the SSFC control panel. This indication shall be latched in the ON position during alarm condition and shall remain ON until the alarm reset push-button is pressed.

7. Alarm annunciator
   a. The SSFC shall be capable of detecting and displaying the following abnormal conditions:
1) Input Overvoltage/Under voltage
2) Output Overvoltage/Under voltage
3) Output Overload
4) System Alarm
5) Control Logic Failure
6) Frequency Deviation
7) Over temperature
8) Logic Power Supply Failure

8. Audible alarm
   a. An audible alarm to sound the SSFC alarm conditions shall be provided on the control panel.

9. Alarm silence
   a. A push button to silence the SSFC audible alarm shall be provided on the control panel. This device shall not clear the fault or test failure indicators.

10. Alarm reset
    a. The SSFC shall be provided with a device to reset or clear all alarm or test failure indications. This device shall not prevent a fault from being displayed again if it is still valid.

2.8 DISPLAYS

A. The SSFC shall have as a minimum the displays or indicators listed below. All displays or indicators shall be located together on the control panel of the SSFC. All displays shall be discernable and all meters shall be readable in ambient light conditions ranging from darkness to bright sun lighted conditions. Display characters for digital displays shall be two inches in height.

1. Alarm disable
   a. An LED shall be provided on the control panel to indicate the alarm silence device is in the enabled position.

2. Input power available
   a. The SSFC control panel shall be equipped with an LED to indicate input power is available on the supply side of the input control device.

3. Input circuit breaker/contactor ON
   a. A LED to indicate that the SSFC input circuit breaker/contactor is ON shall be provided on the control panel.

4. Output power available
   a. The SSFC control panel shall be equipped with an LED to indicate that output power is available.

5. Output circuit breaker/contactor ON
   a. An LED to indicate that the SSFC output circuit breaker/contactor is ON shall be provided on the control panel.

6. SSFC parallel operation indicator
   a. A Master/Slave parallel operation LED shall be provided on the control panel to indicate when the SSFC is in either Master or Slave operation mode.

7. Aircraft interlock bypass indication
a. An LED to indicate that the Aircraft Interlock Circuit is bypassed shall be provided on the control panel.

8. Elapsed time meter
   a. An elapsed time meter to show the operating hours of the SSFC shall be provided on the control panel. The range of the elapsed time meter shall be 99,999 Hours.

9. Voltmeter
   a. A dedicated voltmeter with a selector switch to select Phase-to-Neutral voltages and Phase to Phase voltages shall be provided on the SSFC control panel. The voltage selector switch shall also have an OFF position. The voltmeter shall display true Root-Mean-Squared (RMS) voltages.

10. Ammeter
    a. A dedicated ammeter with a selector switch to select line currents shall be provided on the SSFC control panel. Ammeter selector switch shall also have an OFF position. Ammeter shall display true RMS current.

11. Frequency meter
    a. A dedicated meter shall be provided on the control panel to indicate the output frequency of the SSFC. The meter shall have an ON-OFF switch and a range of 390-410 Hz.

12. Built-in-test-equipment
    a. The SSFC shall be provided with Built-in-Test-Equipment which will monitor both primary circuits and protective circuits for the unit. All the controls needed to operate or perform manual functions for the Built-in-Test-Equipment features shall also be included.

2.9 SAFETY CHARACTERISTICS

A. The SSFC shall be designed so that all electrical components are enclosed and access is not required during normal operation. Further, the SSFC shall be designed to safely permit access to internal components that may be required during troubleshooting for failures or other special needs. All exposed parts that are a hazard to personnel shall be insulated, enclosed, or guarded without impairing the function of the parts. The SSFC design shall not contain any system safety mishap risk categories greater than medium in accordance with Table A-IV of MIL-STD-882D.

B. Input under/over voltage protective circuit
   1. The input Undervoltage or Overvoltage protective circuit shall trip and alarm the SSFC when the voltage is out of the specified range. A clear visual indication to notify the operator of the tripped status shall be provided on the SSFC.

C. Output under/over voltage protective circuit
   1. The output Under voltage or Overvoltage protective circuit shall trip and alarm the SSFC when the voltage is out of the specified range. Output voltage limits of the SSFC shall be in accordance with MIL-STD-704F.

D. Loss of input power or phase
1. The SSFC shall trip and alarm when one or more phases of the input power is out of the specified range or drops out altogether. The loss of input power phase shall trip and alarm the SSFC.

E. Door and panel interlock

1. When any access door or panel cover is open, the door interlock protective circuit shall open the 50/60 Hz input device and the 400 Hz output device and shall not allow the SSFC to close either device while any access door or panel cover remains open. A bypass switch for maintenance purposes shall be provided to defeat each access door or panel cover interlock circuit.

F. Output overload

1. The output protective circuit shall trip the output circuit breaker/contactor when the output of the SSFC is above the limits set forth in Section 2.6-K of this specification.

G. Automatic capacitor discharge

1. The SSFC shall be designed so that when the unit is turned off under normal procedures or the Emergency Stop switch is activated all capacitive devices are discharged to prevent hazardous voltages from remaining in the unit. The discharge rate shall be selected to prevent damage to the components. No voltage greater than 15 volts shall exist on the load side of the input control device fifteen minutes after the unit is turned off.

2.10 ENVIRONMENTAL CHARACTERISTICS

A. Operating environment

1. The SSFC shall be capable of satisfactory operation from no load to full load under the following conditions:
   a. Operating Temperature (ambient): -25±F to 125±F
   b. Rain: Up to 4 inches per hour at angle from vertical to 45 Degrees Relative Humidity: 0% to 95% non-condensing
   c. Ambient Pressure (altitude): 0-6,000 ft

2. The SSFC shall not draw ventilation or cooling air from within 18 inches of the unit’s floor mounting points. The SSFC shall be designed to operate safely outside a minimum 25 ft radius of aircraft or other fueled equipment.

B. Non-operating environment

1. The SSFC shall not be degraded or damaged by storage or transportation in the following conditions:
   a. Temperature (ambient): -40±F to 165±F
   b. Rain: Up to 5 inches per hour at angle from vertical to 45 Degrees Relative Humidity: 0% to 98% non-condensing
   c. Ambient Pressure (altitude): 0-15000 ft
   d. Vibration: 5g’s (0-2000Hz)
C. Construction of enclosure shall provide complete protection of live or moving parts. Protection against harmful deposits of dust and protected against splashing liquids from any direction.

1. IP54 rated as a minimum.

2.11 PHYSICAL CHARACTERISTICS

A. Input and output terminations.

1. The SSFC shall have designated areas on the top and on the side of the enclosure for input power connection. The SSFC shall have a designated area on either side of the enclosure for output power cable connection. The areas shall provide space and support for incoming electrical conduit and associated hardware installation and clearances to accommodate routing and bending radii in accordance with NFPA 70 for the largest conductor sizes accepted by the input and output power terminals. The output power cable area shall provide for cable strain relief, space and support for electrical cable connectors and associated hardware installation. Input and output power terminal blocks shall be provided and marked for making the proper connections. The input and output terminals of the SSFC shall be sized accordingly to conduct the currents for the largest conductor(s) required for each phase. Input neutral and ground terminals shall be sized in accordance with NFPA 70. Output neutral termination shall be sized to properly terminate the neutral conductors for the cables listed in E and F pin sensing terminals shall be 5/16 inch stud. The output shall include a safety interlock protection and looped E/F mode for control.

B. Neutral-to-ground bond

1. The SSFC shall come from the manufacturer with a removable neutral-to-ground bonding jumper sized in accordance with the National Electrical Code, NFPA 70.

C. Treatment and painting

1. The SSFC components shall be treated and painted to prevent corrosion. For ferrous structures a zinc rich primer, non-water reducible (Type 1), 350g/l VOC (Class A) followed by a smooth topcoat of polyurethane, high solids formulation (Class H), 420g/l VOC (Type 1) shall be used. For Aluminum or mixed Aluminum and Ferrous structures an epoxy primer, strontium chromed based corrosion inhibitor (Class C), standard pigments (Type 1) followed by a smooth topcoat of polyurethane, high solids formulation (Class H, 240g/l VOC (Type 1) shall be used. Colors used shall be in accordance with Section 2.11-I.

D. Lifting and tie down provisions

1. Lifting, tie down, and forklift provisions shall be provided in accordance with commercial industry standards. Forklift guides shall be placed on the bottom of the unit and lifting eyes shall be placed at the top corners of the unit.

E. Size
1. The maximum height, depth, and width of the SSFC are limited to not more than 76 inches high by 40 inches deep by 60 inches wide respectively. The weight of the SSFC is limited to not more than 4,000 pounds.

F. Markings

1. All external devices (i.e. cautions, lifting, tie down, center of gravity, etc.) which require an operational or maintenance interface shall be clearly marked. SSFC Unique Identification (UID) information and any SSFC components meeting UID criteria shall be permanently affixed near the respective identification plate(s). All markings shall be located and applied in accordance with MIL-STD-130N.

G. Identification plate

1. The identification plate shall contain the following information: input and output voltages, frequencies, rated kW and kVA and power factor, current, phase, serial number, part number, date of manufacture, manufacturer’s name, cage code, date of warranty expiration, and national stock number. The SSFC identification plate shall be mounted at a conspicuous place on the exterior of the unit.

H. Workmanship and wiring

1. The SSFC shall be free from defects. All the wiring shall be secured, properly and neatly routed and terminated, permanently marked and each wire must be uniquely identified.

I. Painted color

1. The color of the SSFC shall be in accordance with FED-STD-595C, semi color, semigloss gray, color 26173. Chemical Agent Resistant Coating (CARC) shall not be used. Painted markings shall be one-inch-high block letters unless prohibited by available space. In such cases the markings shall be the largest size possible, but shall not be less than one-half inch high. Colors used shall be as below:

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>FED-STD-595</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior Finish</td>
<td>26173</td>
<td>Gray</td>
</tr>
<tr>
<td>Markings, Informational / Caution</td>
<td>37038</td>
<td>Lusterless Black</td>
</tr>
<tr>
<td>Markings, Warning / Danger</td>
<td>31136</td>
<td>Lusterless Red</td>
</tr>
</tbody>
</table>

J. Surface transportability

1. The SSFC shall be transportable via all modes of surface shipment: rail, sea, road, etc. and shall be capable to withstand mechanical shock and vibration characteristics of rail, sea, and road transport.

K. Human engineering
1. The SSFC shall be designed in accordance with MIL-STD-1472F for ease of operation, inspection, and maintenance. All operations of the SSFC shall be accomplished using bare hands and while wearing: Work gloves, cold weather (arctic) mittens and Mission-Oriented Protective Posture (MOPP) Level 4 Chemical Warfare Gear.

L. Electromagnetic interference/electrostatic discharge

1. The SSFC shall meet the requirements listed in MIL-STD-461F for Radiated Emissions, RE102; Conducted Emissions, CE102 and Radiated Susceptibility, RS103. The SSFC design shall also preclude equipment damage due to Electrostatic Discharge (ESD), protect personnel from electrical shock due to static charging, and prevent ignition of explosive atmospheres due to sparking.

M. Acoustical noise

1. The maximum acoustical noise of the SSFC shall be 72 dBA at full load measured at 6.5ft horizontally from the center to each side of the SSFC at 5 feet above the floor.

N. Service life

1. The SSFC shall be designed for a minimum service life of 20 years/20,000 hours, without a need for major overhaul or repair. Service life does apply to wear items such as fans, etc. Accomplishment of manufacturer recommended and defined service tasks and intervals shall maintain output performance in excess of 90% of design through the entire service life. Additionally, the SSFC shall be constructed for extended storage in a warehouse environment for 20 years.

O. Materials

1. SSFC components and materials shall be selected for the purpose defined herein with consideration given to the minimum acceptable service life and the environmental conditions stated herein. The use of recovered or recycled materials is highly encouraged. The use of composites or light weight material is also highly encouraged. Magnesium alloys, wood products, polyvinylchloride (PVC) products, polyester, or RTV which yields acetic acid shall not be used. Materials in accordance with Class 1 or Class 2 Ozone Depleting Compounds/Substances (ODC/ODS) shall not be used. Materials used in construction of the SSFC shall not be nutrients for fungi unless these materials have been treated with an anti-fungal coating which will last for the service duration life of the component. Unless protected against galvanic corrosion dissimilar metals and materials, in accordance with MIL-STD-889B Change 3, shall not be in direct contact with one another. Metal plating or metal spraying of dissimilar base metals to provide electromotive compatible abutting surfaces is acceptable. The use of dissimilar metals only when separated by suitable insulating material is permitted, except in systems where bridging of insulation materials by an electrically conductive fluid can occur. Sealants or gel type gasket materials shall be used between faying surfaces and butt joints.
2.12 FACTORY TESTS

A. A factory Test Report shall be furnished for each frequency converter including test results, instrument used, test procedures, and final conclusions. Each Test Report shall be dated and signed by authorized personnel and shall be neat, readily legible and self-explanatory.

B. Factory testing shall be witnessed by two (2) Owner’s representatives. Bidder shall include all costs of Owner witness in their price.

C. Manufacturer shall submit proposed factory acceptance test for review a minimum of 60 days before original unit test is scheduled. Factory testing is not to be done until procedure is approved by Owner’s representative. Delay in shipment due to delay in submittal of an acceptable test procedure shall be the responsibility of the contractor.

D. Each converter shall be tested at no load and full load conditions and shall be given a "burn-in" test for at least 24 continuous hours.

E. In addition to load tests the following tests shall be performed:
   1. OUTPUT VOLTAGE WAVE FORM
   2. TRANSIENT VOLTAGE RECOVERY TIME (for 50% and 100% load shocks).
   3. OUTPUT VOLTAGE REGULATION.
   4. EFFICIENCY TEST at 100% load
   5. OUTPUT VOLTAGE BALANCE.
   6. OUTPUT FREQUENCY REGULATION.
   7. OVERLOAD CAPABILITIES.
   8. OPERATION OF SAFETY AND CONTROL DEVICES.
   9. LDC CIRCUIT.
   10. INPUT CURRENT HARMONICS
   11. OPERATION WITHOUT FANS @ 90°F

2.13 WARRANTY SERVICE AND PARTS

A. Manufacturer shall warrant that its products and work shall meet all applicable specifications, codes and other specific product and work requirements (including those of performance) and shall be free from defects in material and workmanship for a period of one year from commissioning or eighteen months from shipment, whichever occurs first. Upon submittal of a warranty claim, Contractor shall repair or replace items necessary to restore the GPU to satisfactory condition. This warranty does not include consumables. The terms and stipulations of the warranty period shall be submitted with the proposal.

B. In addition to the proposal for fabrication, delivery and installation of systems, the Proposer shall provide a recommended spare parts list, the cost for each part, the extended cost, the consigned cost, and any terms and conditions applicable to this proposal.

2.14 OPERATION AND MAINTENANCE MANUALS AND TRAINING

A. Manual Content
1. A complete manual in a protective binder or cover shall be provided for each converter and shall contain the following information:
   a. Converter description, theory of operation and specification.
   b. Installation and maintenance procedures.
   c. Starting, Operation, Maintenance and Troubleshooting instructions.
   d. Schematics and Connection wiring diagrams.
   e. Recommended Spare Parts list.

B. Operation and Maintenance Manuals

1. Shall follow the intent of the Air Transportation Association (ATA) Specification 101 or acceptable manufacturer’s standard. Included in the manuals shall be preventative maintenance requirements and problem solving procedures.

C. Operator training and maintenance training

1. Shall be provided at scheduled times during commissioning prior to beneficial use. Training shall include a combination of over-the-shoulder and classroom training. 24-Hours of classroom training are to be provided at the job site. Owner shall provide classroom space and training tools as required by Manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. All equipment, wiring and installation shall be in accordance with current, applicable codes and per current industry standards.

B. Packaged frequency converters

1. The frequency converters shall be delivered to the site completely assembled and tested. The site shall provide all necessary concrete pad and electrical connections for mounting and electrically connect the SSFC and accessories.

C. Final Connections

1. The Contractor shall make final electrical connections from the pre-wired utility connections on the SSFC and make sure all accessories are connected accordingly. Arrange frequency converter units to provide adequate access to equipment and circulation of cooling air.

D. Equipment Mounting:

1. Install frequency converter units on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
E. Identify equipment and install warning signs according to Section 26 05 53 "Identification for Electrical Systems."

3.2 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

B. After the installation is complete, operate each unit to verify performance compliance relative to output voltage, control functions and operating controls. Remove malfunctioning units, replace with new units, and retest as specified above.

C. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

D. Prepare test and inspection reports.

E. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

F. Adjust frequency converter units to provide optimal voltage to equipment served throughout normal operating cycle of loads served. Record input and output voltages and adjustment settings, and incorporate into test results.

END OF SECTION 26 32 26