ATTACHMENT “E”

Guide Specification
for Fixed 400Hz Central Power System
1.0 SCOPE

1.1 INTRODUCTION
This proposal describes and defines the requirements for a fixed, 400Hz central system to provide ground power to aircraft parked at 20 positions at Hobby Airport. The proposal scope includes the detailed design, supply, installation, test, and complete acceptance of the system, all of which shall be performed by proposer.

1.2 GENERAL SCOPE OF WORK
The work covered by this proposal shall include the following general tasks to provide HAS with a complete system operating in accordance with the requirements specified herein:

A.) System design, including interface requirements, calculations, drawings for approval by the HAS, installation details and shop drawings, catalog cuts, test procedures, spares lists, and certification that all equipment meets standards compliant.

B.) Manufacturing and procurement of all equipment and material required for a complete operating system as defined herein.

C.) Testing of all functional equipment.

D.) Project management through all phases.

E.) Installation of all equipment and materials, including the central system, gate equipment and accessories, conduit, and cable.

F.) Complete documented acceptance testing of the installed system and all gates.

G.) As-built drawings of the completed installation.

H.) A formal operating and maintenance training course for the Owner's personnel at the site.

I.) Operating and maintenance manuals.

1.3 FACILITY DESCRIPTION
The fixed 400Hz central system equipment room shall be located and the access for equipment placement from grade-level shall be as specified by HAS. Elevations, obstructions, ceiling-mounted equipment, columns, and drain locations are as shown and accounted for in the design and installation plan. No additional space in this room or in the access to it will be made available.

Passenger boarding bridges will be installed as specified by HAS.
1.4 GENERAL DESCRIPTION OF FIXED 400Hz CENTRAL SYSTEM

The fixed 400Hz central system shall be designed to support aircraft parked at the gates of the terminal. 400Hz power at 200 volts nominal shall be distributed 3-phase, 3-wire from a single vertical synchronous motor generator (automatically parallelable, if required), to each pit location via feeders contained in non-ferrous conduit. Each of these branch circuits shall emanate from a distribution panel located in the central equipment room with the motor generators.

2.0 CODES/STANDARDS

The following codes and standards form a part of this specifications to the extent specified herein. Where a conflict between documents exists, the order of precedence is as follows: this specification, the latest version of the Proposer's proposal accepted by the Owner, and the standards. It is not the intent of this specification to define every element of the system or of the interfaces. An omission of an item in this specification which is required for proper system operation shall not relieve the Proposer of supplying same unless this specification define the item as "by others" or equivalent.

All equipment, materials, construction and installation supplied or performed by the proposer shall be in accordance with the applicable requirements of the following codes and standards, of latest issue in effect on the date of contract:

NFPA 70 – National Electric Code
NEMA – National Electrical Manufacturer's Association
ANSI – American National Standards Institute
OSHA – US Government, Occupational Safety and Health

All codes, regulations and ordinances in effect by authorities having cognizance over the construction site.

3.0 SYSTEM PERFORMANCE REQUIREMENTS

The following section defines the performance requirements of the fixed 400Hz central system to be met as a minimum. Proposer's proposal shall identify additional performance features included in this system. No system shall be accepted which has not had its major design features and equipment demonstrated in similar prior fixed, centralized aircraft ground power systems.

3.1 GENERAL REQUIREMENTS

The fixed 400Hz central system shall be capable of providing all ground power and control requirements as specified herein for the simultaneous occupation of all gates as indicated.

3.2 AMBIENT DESIGN CONDITIONS

All bridge and other outdoor- mounted equipment shall be capable of withstanding the following climate conditions without damage or failure.

Temperature: -20°F to +105°F
Humidity:  10% to 99% relative, including compensation.

Precipitation:  Rain, dust, combined with wind.

Wind:  Up to 55 mph; gusts to 85 mph. Equipment not expected to operate in higher winds, but must withstand up to 125 mph with no physical damage.

General Environment:  Airborne hydrocarbons resulting from jet fuel fumes as expected at an airport.

All equipment for indoor installation must be suitable for continuous operation in a ventilated room where ambient temperature is between +50°F and +90°F, with excursions to +105°F for periods of up to 2 hours per day.

3.3 SYSTEM VOLTAGE REGULATION TO AIRCRAFT

a. Steady State Regulation:  The steady state voltage regulation at each aircraft plug/receptacle interface (at the end of the specified length of flexible aircraft service cable) shall remain within the low and high limits of 112.0 volts and 118.5 volts (line to neutral) between all conditions of no load and full specified load, all temperature changes within the design ambient, and all input 60Hz voltage swings to the MG sets. The voltage regulation shall apply under the entire range between the following load, line, and ambient temperature conditions:

- No load at any or all pits.
- 90 kVA load at 0.8 lagging power factor applied and removed at any or all gates.
- Unbalanced load of up to 30% difference between line currents, within rated current at any one gate.
- Input 415V 50Hz nominal input power to MG’s ranging between 200/115V.
- Outdoor ambient temperature varying between -20°F and +105°F.
- Indoor ambient in MG location varying between +40°F and +110°F.

b. Transient Voltage and Recovery:  With a single motor generator on line acting as the 400Hz power source, the transient voltages at the aircraft plug/receptacle (at the end of the specified flexible service cable) shall drop no lower than 102 volts line to neutral or rise no higher than 130 volts line to neutral upon sudden application or removal of a 90kVA transient step load with a 0.8 lagging power factor at all gates. Transient voltages shall recover to the limits of the steady state regulation band within 180 milliseconds.

3.4 SYSTEM DESIGN LOAD RATING

The central system shall be capable of supporting a total continuous system load rating of 200 kva with one MG Set operating, at 0.8 power factor; the continuous load rating at each plug shall be 90kva.
The central system shall be able to support a total load of 10% overload beyond the continuous load rating at a power factor of 0.8, for a period of at least one hour before any system-level circuit protective elements cause a trip, shut-down, or other system action other than a warning lamp. In the same way, the central system shall also be able to deliver 25% overload for 5 minutes and 50% overload for 1 minute before central protective devices trip the MG.

### 3.5 INTERFACES WITH EXISTING FACILITIES OR WITH FACILITIES TO BE PROVIDED BY HAS.

#### 3.5.1 Electric Power:
The motor generators shall each operate from 480 volts, 3-phase, 60Hz, electric power. This power shall be made available for connection to the motor generators in the central equipment room and rated to provide a minimum of 450 amps to each motor generator.

#### 3.5.2 Central System Space:
The central system shall be installed in the area designated by HAS. No other space shall be available. The central equipment room shall be constructed by others and be complete with equipment pads, lighting, and with ventilation by others.

#### 3.5.3 Aluminum Conduit System:
Aluminum conduits from stubouts in central room wall near or above 400Hz distribution panel, to each gate including pull boxes in each conduit run as required. NEMA 3R junction boxes at the base of each bridge shall be installed (by others).

### 4.0 EQUIPMENT, INSTALLATION AND MATERIAL REQUIREMENTS

The system equipment, components, materials, and installation shall be new, of highest quality for the intended function, and selected by the Proposer to enable system operation in accordance with Section 3 of this specification. The below specifications are to set forth minimum standards. Where the term "or approved equal" is used, Proposer shall submit proposed alternates, if any, along with justification and details of the proposed alternate for the Owner's consideration and approval.

#### 4.1 MOTOR GENERATOR SET

The motor generator set shall be of the vertical shaft type with the shaft supported by angular contact thrust bearing operating in an oil sump located at the bottom of the assembly, or by two bearings, one at the bottom and one at the top. The motor generator set shall be mounted with its control cabinet on a common rigid steel frame support base with the rotating vertical section, with provisions for forklift handling.

The motor generator set, when operated by itself, shall have a mean-time-between-failure (MTBF) which exceeds 80,000 hours. It shall be configured for automatic paralleling operation while under load in combination with one other motor generator set whose design, rating and electrical characteristics are identical. When operating in parallel, the MTBF of the combination shall exceed that of a single unit by the number of on-line units. No servicing or maintenance requiring shutdown shall be required at intervals more frequent than one per year. However, where dust may collect, periodic cleaning may be required. The motor generator set shall be designed for indoor fixed installation.
4.1.1 Motor Generator Assembly: The motor generator assembly shall consist of a motor, generator and exciter with voltage regulator, motor starter and logic controlled protective devices, instrumentation and paralleling accessories contained in the control cabinet as specified herein.

4.1.2 Type: The motor and generator shall be the synchronous brushless type. The unit shall be self-ventilating and of drip-proof construction, suitable for indoor operation. Motor shall be of the series-parallel winding type to reduce inrush starting current to 150% or less of full-load running current.

4.1.3 Load Rating: The 400Hz load rating for each motor generator set shall be 160 KW/200KVA, defined as ‘full load rating’. Without exceeding either the kw or the kva parameter, continuous load may be supplied at any power factor from -.6 to unity, and +.6 to unity.

4.1.4 Motor Input Requirements: Input nominal voltage shall be 415V, 50 hz, 3-W plus ground. Input voltage range shall be 374V to 456V.

Motor Power Factor: The power factor of the synchronous motor shall be automatically and continuously controlled by the common voltage regulator/exciter and shall remain between 0.9 leading and unity for all loads between 50% and 100%.

Motor Starting Inrush: Inrush current during motor starting shall be limited to a maximum of 150% or nominal full load operating current of amps.

4.1.5 Output Requirements

a. Generator Voltage Build-Up: Voltage build-up shall be automatic.

b. Output voltage: Line to line voltage from the generator shall be nominal 200/115 volts, 3-phase, 4-wire output with undistributed grounded neutral.

c. Output Frequency: Output frequency shall be precisely 400Hz when operating from a 60 Hz source of input power.

d. Voltage Adjustment Range: Output voltage shall be adjustable over a plus or minus 10% range from nominal voltage with maximum voltage steps of plus or minus 0.05%.

e. Voltage Boost: An automatic adjustable open loop voltage boost circuit shall be provided to boost generator output voltage in proportion to load current, up to a maximum 5%, to overcome voltage drop in output cables to load distribution bus.

f. Long Time Voltage Drift: Voltage regulation at either the generator output terminals or the remote common bus shall remain within ±0.5% over any 30 day time interval and over temperature range of 40°F to 105°F.

g. Voltage Transient Limits: Sudden application or removal of full rated load shall not cause more than ±25% excursion in voltage from preset level or ±12.5% for a 50% load step.

h. Voltage Recovery Time: Following the sudden application or removal of rated load, the output voltage shall recover to ±0.5% of preset value within 0.20 seconds.

i. Voltage Unbalance for Balanced Load: Under conditions of no load, 50% of rated load, and 10% rated load, the output voltage shall remain balanced to within ±1.0% from the average preset value of line-to-line voltage.
j. Voltage Unbalance for Unbalanced Loads: With one-third rated current in any phase and no load on the other two phases, or any similar condition of one third load unbalance, the maximum deviation of any phase voltage from the average of the 3-phase voltages shall not exceed 4%.

k. Modulation: Voltage modulation shall not exceed 0.25% for any load condition.

l. Voltage Harmonics: Output voltage harmonics at the generator output terminals shall not exceed (1.5% L-L) of fundamental RMS or steady state operation, for all conditions of balanced load, and shall not exceed 4% with one-third rated current in any phase and no load on the other two phases or any similar condition of one-third load unbalance.

m. Overload Capacity: The motor generator set shall be capable of operation at 125% of rated load for five (5) minutes after sustained full load operation, without exceeding the temperature rating of insulation materials or tripping generator protective devices.

n. Short Circuit Current: The motor generator shall be capable of delivering at least 250% of rated current into a 3-phase short circuit until the system protective devices are actuated.

o. Electromagnetic Interference: The conducted and radiated EMI of the motor generator shall be sufficiently low to cause no interference to normal operation of adjacent or commonly connected equipment.

p. Efficiency: The motor generator efficiency shall be 92% minimum at 160KW resistive load, and 90.25% minimum efficiency at 200 KVA, 0.8 PF load and nominal input voltage. No-load losses shall not exceed 15 KW.

q. Temperature Rise: Motor, generator and exciter windings shall use Class H insulation material, and equivalent impregnation in accordance with NEMA Standard MG-1. Temperature rise shall be limited to 80°C over a 40°C ambient.

4.1.6 Mechanical — Motor Generator

a. Construction: The rotor of the motor, generator, and common exciter shall all be mounted on the same shaft. The shaft shall be vertically supported. Operation shall be at 1500 RPM. The rotor assembly shall be statically and dynamically balanced to a maximum permissible unbalance of 0.002 inches double amplitude T.I.R.

b. Main Bearings: Bearings shall be of the angular contact type or approved equal, providing the necessary thrust and radial load support of the vertically mounted rotor shaft. The bearings shall be selected to provide a minimum calculated life of 150,000 hours when properly lubricated.

c. Oil Reservoir(s): Oil reservoir(s) shall be a part of the main bearing assemblie(s) and shall have sufficient oil capacity to provide the cooling action necessary to keep the bearing temperature at levels below that of grease lubricated bearings. Each reservoir shall be fitted with an oil level sight gauge, filler and drain ports. The location and design shall be such that no failure mode will permit oil to come into contact with electrical parts.

d. Shaft Stabilizing Top Bearing (if used): This bearing shall be of the cylindrical roller type, with inner race locked on vertical rotor shaft and outer race mechanically locked in place in bearing housing. Vertical rotor shaft shall be free to move axially to compensate for the effect of differential thermal expansion between rotor shaft and stator frames.
e. Varnish Process: All windings shall be given a minimum of two dips and bake cycles with a clear baking varnish plus a coat of fungus resistant varnish. In addition, motor stator winding shall, prior to fungus resistant varnish coat, be given a third dip and bake with a flexible sealing type of varnish.

f. Surge Protection: Motor stator end turns shall be bonded to prevent movement of coils during the mechanical stresses produced by the starting current.

g. Rotating Rectifiers: Rotating rectifiers shall be of the silicon diode type, 3-phase, full wave, mounted on heat sinks of sufficient area to insure proper cooling of the diodes.

4.1.7 Control Cabinet

The motor generator set control cabinet shall consist of two enclosed sections that effectively isolate all power control devices and connection points from the low voltage control components. The mounting may be side by side or any other approved arrangement that effectively isolates the 480V, 575V, 120V, and all voltages above 70V, from the control and logic level voltages present in the digital control circuitry.

a. Main Control Cabinet Enclosure: The main enclosure shall contain the following:

- Motor running and starting contactors
- 400Hz output circuit breaker
- Control voltage power supplies, fuses, etc.
  - Relays and controls related to 120V control levels
  - Overloads, current transformers
- Control wire terminal connection boards into and out of the MG set
- Independent wireways for incoming 60Hz power and outgoing 400Hz power cables
  - All other devices or points carrying voltages in excess of 70 volts AC or DC

b. Logic and Low-Voltage Section. This sub-enclosure shall contain the following:

- Digital meters and Data Readouts (with low-voltage inputs)
  - Digital controls, logic, regulator circuitry, printed circuit cards, etc.
  - Adjustment and alignment points
  - Control pushbuttons, indicator lamps, alarms
  - Output voltage adjust potentiometer
  - Connection points for hand-held alignment device or analyzer, if required

c. Construction: The all steel control cabinets shall be mounted on the same base with the motor generator set and designed in accordance with NEMA ICS6 Type 2 and of indoor construction. Hinged door assemblies shall be provided for front access to all control components. All seams shall be continuously welded. The interior of the control cabinet enclosure shall be finished in baked enamel. All surfaces shall be treated and primed prior to painting. Doors shall be lockable with padlock.

4.1.8: Controls

a. Input disconnect: A 3-pole, 600 VAC, molded case, disconnect circuit breaker with a shunt trip shall be provided in the control cabinet of the motor generator. The breaker handle shall be manually operable through a cutout in the front panel. The shunt trip shall operate the trip
mechanism of the breaker based on signals generated by ground fault circuitry within the control cabinet to automatically open the input breaker.

b. Input Contactors: The motor starter configuration shall be of the ‘series/parallel’ type, to limit input starting inrush to 150% maximum, of the rated full-load running current. The contactors shall be rated for 600 VAC, 3-phase operation and rated by the manufacturer for the application intended.

c. Motor Input Protection: 3-phase overload running protection shall be provided for the motor, in conformance to NFPA-70-1981, Article 430-32. Motor winding starting transition timing shall be determined by adjustable solid-state relay timing devices preset at factory. Motor starter contactors shall be designed for expected starting inrush currents and continuous operation at full load with intermittent operation while at no load during paralleling sequence. All contactors shall be electrically interlocked to preclude wrong winding transition during motor starting. Input phase failure protection shall be provided to de-energize the input circuit to the motor.

d. Generator 400 Hz Output Circuit Protection: Operation of any circuit protective function monitor, including long-time, short-time, and instantaneous short-circuit, shall cause the main output circuit breaker to be opened.

e. Over and Undervoltage Protection: Over and undervoltage protection on the 3-phase, 400Hz output shall be provided by a solid-state sensing device. Operation of the overvoltage circuit shall remove the excitation from the 400Hz generator, open the output breaker and light a fault indicator. Overvoltage trip shall be adjustable from 107% to 120% of nominal AC voltage with an inverse time voltage characteristic, with adjustable time delay slope. Operation of the undervoltage circuit shall open the output breaker and light a fault indicator. The trip point shall be adjustable from 80% to 90% of nominal voltage with an inverse time versus voltage characteristic, with adjustable time delay slope. The action of the undervoltage circuit and alarm shall be suppressed during startup of the motor generator.

f. Overload: Overload protection on the 3-phase, 400Hz output shall be provided by a solid-state circuit with output current sensing transformers suitable for the purpose. Operation of the overload circuit shall open the output breaker and light a fault indicator. The trip point shall be factory set to 125% of full load current and open the output breaker after 5 minutes operation at this load. These settings shall be user variable without the requirement for a load bank for calibration. Long-term overload shall be factory set at 110% for 2 hours, but shall be adjustable between 30 minutes and 8 hours.

g. Reset: When a fault occurs and the summary fault indicator is lighted, the set shall be tripped and locked out. The "Reset" switch shall unlock the set and permit the fault indicator to extinguish.

h. Summary Fault Indicator: A fault indicator lamp shall be provided along with circuitry to latch "On" until the "Reset" switch is pushed. Light shall operate in conjunction with the digital fault code indicator displays and the protective functions described above in a. through f.

i. Indicator Test Pushbutton: A pushbutton to test switch shall be provided to test operating condition of all indicator light emitting diodes.

j. On-Off Control: Operation of the set shall be initiated by pushbutton switches for motor start/stop. The output of the generator shall be connected to the load bus with a motor-operated
circuit breaker, controlled with a close/open pair of pushbuttons. Logic controls shall not allow the breaker to be closed unless the proper conditions are met for paralleling with any other MG set on the output bus. Status of the motor running contactor (motor “on”) and output circuit breaker (“generator output closed”) shall be displayed with indicator lamps on the panel.

The output breaker shall be tripped off and opened when any of the aforementioned alarm fault conditions occur and when the motor is turned off for any reason. The motor shall be tripped off when any of the conditions attributable to motor related faults occur.

k. Voltage Regulator: All circuits shall be solid-state. Components shall be conservatively rated to meet the overall reliability objectives; no vacuum tubes or vibrating contacts shall be used. The voltage regulator shall be integrated with load and parallel sensing devices to automatically load share as required, and maintain an output regulation band of +/- 0.5% for all combinations of balanced no load to full load, input voltage within its tolerance range, ambient temperature, and long-term drift. The regulator shall also have a user-adjustable ‘boost compensation’ feature responsive to load current, such that at full rated load, the output voltage is boosted by up to 5% (0 to 5% adjustable at full load) to compensate for voltage drop in cables from the MG output to the common distribution bus.

l. Digital Metering: A digital readout with 5/8” minimum digit size shall be provided for metering output parameters:
   - Selector switch(es) or pushbutton(s) to allow selection of voltage phase-to-phase or phase-to-neutral, and phase current in each phase;
   - Voltage readout shall be accurate to within +/- 0.5%, four-digit.
   – Current readout shall be accurate to within +/- 2% or +/- one digit, three digit.
   – Elapsed time, whenever motor is running, 0 – 99,999 hours.

m. Fault Indicator and Alignment Display and Controls: The front of the control panel shall be provided with a liquid crystal digital display that initially displays a fault code for a single fault and/or stores sequentially any other faults that may have occurred after the first. The display shall be provided with a display advance pushbutton to enable the fault display to be advanced to the next fault code. Fault code history shall be maintained for up to 30 days via internal battery. The same display and control buttons shall be utilized for setting up user-adjustable parameters such as overvoltage/undervoltage and overload amplitudes and time settings, as well as automatic paralleling settings as described in 4.1.8.

4.2 400HZ DISTRIBUTION CABINET

This cabinet shall provide 400Hz, 200V power for the required number of branch circuits.

4.2.1 Input Bus:

3-phase line bus and ground bus shall be provided in cabinet. Bus shall be copper, 98% conductivity, with bolted connections and transitions. Lugs shall be suitable for compression type fittings. Phase bus shall be rated for current capacity of ____ amps. Ground bus shall be rated 25% minimum of ampacity of phase bus. Ground bus shall be electrically and mechanically bolted to the enclosure. Phase bus shall be insulated from enclosure and rigidly supported to withstand the forces produced by fault and short circuit current. Phase bus shall be identified and constructed with phases A, B, C left to right and top to bottom, respectively.
4.2.2 Incoming disconnects:

Incoming circuit breaker(s) connecting the motor generator output(s) with the 3-phase line bus shall provide the means to isolate the motor generator(s) from the bus. The circuit breaker(s) shall be of the non-automatic type and 600 VAC molded case construction and in an appropriate frame size to support the full load, overload and fault currents of which the motor generator(s) is/are capable. The circuit breaker(s) shall be operable from the front panel of the distribution panel.

4.2.3 Branch Circuit Protection:

Each outgoing branch shall be protected by a 3-phase, 600 VAC molded case type automatic circuit breaker with shunt trip and manually operable through cutouts in front panel. Circuit breaker shall be calibrated and certified for use at 400 Hz.

4.3 GATE SERVICE CABINETS AND GATE CONTROL

The gate service cabinet shall be contained in a modified NEMA 4 weatherproof ventilated enclosure designed for mounting on the bridge at the aircraft end and shall serve as the termination point for the incoming 200V, 400Hz power conductors and the outgoing 115/200V, 400Hz power and 28VDC control conductors.

The gate service cabinet ("gate box") shall include an input non-automatic circuit breaker with shunt trip, optional line drop compensator, step, contactor(s) and controls. The continuous rating of the transformer/contactor assembly and optional LDC shall be 90 kVA with intermittent operation at 125% of specified rating for five minutes at 0.8 lagging power factor.

a. Input disconnect: This device shall be 3-pole, 600V, non-automatic circuit breaker with shunt trip, current-rated equal to or higher than branch circuit over current protective breaker. The breaker shall be externally operated from front panel of enclosure with handle interlocked to enclosure door.

b. Optional LDC: If required, shall conform to 4.3.2.

4.3.1 Transformer: The transformer shall receive input power from a branch circuit output located in the motor generator room. Distribution to the delta primary of the 400Hz step down transformer shall be by a 3-wire system at 575V nominal L-L.

a. Turns Ratio: The L-L/L-N transformer turns ratio shall be 5:1 with a turns ratio tolerance of +0.1%. Primary shall be delta connected. Secondary shall be wye connected and grounded. With an AC input voltage of 575V applied to the primary, the open circuit secondary line to neutral voltage shall be 115V +0.1%.

b. Temperature Rise: The maximum temperature rise shall not exceed 115°C over 40°C ambient under conditions of full rated load with rated input voltage, as measured by the resistance change method.

c. Overload: The transformer shall be capable of five minutes of operation in 40°C ambient temperature under a load of 125% of rated current, with rated voltage applied, without exceeding the temperature rating of the insulation.
d. Short Circuit Impedance: The short circuit impedance of the transformer shall be less than 1.99% with maximum reactance of 1.88% and maximum resistance of .58% as related to the absolute value of nominal load impedance. The values are for 400Hz and measured with the secondary short circuited, and voltage applied to the primary. Values are line to neutral.

e. Insulation: Insulation shall be Class H as defined in MIL-E-917. A moisture barrier to ground shall be provided as required in MIL-E-917. The insulation system shall be capable of passing the following tests:

- Primary High Potential Test: 4000VAC, 60Hz primary to core for one second.
- Secondary High Potential Test: 1200VAC, 60Hz secondary to core for one second.

f. Windings: The winding shall be of copper wire only, insulated and supported to withstand the test requirements specified herein.

4.3.2. Line Drop Compensator

Reactive line drop compensators, if required, shall be rated for 90kVA continuous load and capable of compensating for branch distribution inductive reactance as required by system parameters, but in no case less than 16%. The LDC shall be adjustable in the field to compensate for actual installed cable reactance by use of tap setting, with no more than 2.5% adjustment in voltage (at full rated load) for each tap. This compensation shall compensate for inductive reactances in the step down transformer, the 575V, 400Hz branch circuit conductors, and the aircraft service cable that connects 400Hz power to the aircraft. Current rating of the line drop compensator shall match the step down transformer primary current rating and shall be capable of sustaining a 125% overload at 0.8 PF for five (5) minutes.

a. Temperature Rise: Magnetic components shall have a maximum temperature rise of 80°C over a 40°C ambient under rated load operation. Capacitors shall have a maximum temperature rise of 20°C over a 40°C ambient temperature.

b. Insulation: Magnetic components shall be Class H as defined in MIL-E-917. A moisture barrier to ground shall be provided.

c. Cooling: Line drop compensators shall be convection cooled.

d. LDC Protection: In the event of circuit short circuit, an over-voltage device shall be set to prevent the voltage across the line drop compensator capacitors from exceeding their maximum working voltage and shall instantaneously actuate the shunt trip of the input circuit breaker.

4.3.3 Contactor: Contactor shall be rated same as transformer secondary full load current and capable of reactive load switching at 0.8 lagging P.F. and fault interrupting. Contactor shall be electrically held, 3-pole, rated 250 VAC minimum at 400Hz.

4.3.4 Control Components: Input to control voltage source shall be derived from step down transformer secondary. A control voltage transformer shall supply power to rectifier and filter for low voltage and solid state control elements. The following control functions and elements shall be provided:

a. Local and remote contactor open/close.
b. "E&F" interlock relay circuit 28VDC to prohibit contactor latch circuit unless aircraft plug is engaged and 28VDC signal is received from the aircraft between jumpered E/F pins and neutral. This circuit shall not draw more than 50 ma from the aircraft.

c. Long time and short time overload, factory set at 115% and 150% respectively, with user adjustable level and time delay settings without the need for a load bank. With fault LED inside cabinet.

d. Unbalanced load current circuitry, opens load contactor after 3 second delay (adjustable) whenever unbalanced current exceeds 60% (adjustable) of full balanced load current. With fault LED inside cabinet.

e. Common Summary Fault light and Reset button.

f. Power available light, indicates presence of 575V in cabinet.

g. Overvoltage, any one or more phase, factory set at 130V, 1 second, adjustable for level and time delay.

h. Undervoltage, any one or more phases, factory set at 95V, 1 second, adjustable for level and time delay.

4.3.4 Remote Control Box: A remote control weatherproof pushbutton station shall be provided at each gate. It shall contain the following pushbutton switch functions:

- Contactor "On" button with guard.
- Contactor "Off/Reset" button with guard.
- Output power "On" light (contactor closed).
- (if used) Cable Hoist up/down control switches

Remote control box shall be mounted on or near the fixed portion of the bridge lift column and shall be of rugged, watertight construction.

4.4 RELATED COMPONENTS

Each unit shall be supplied with the following related components:

1. Input power cable for connection to input junction box. Junction box to be supplied and installed by PBB Manufacturer.

2. Tunnel mounted cable hoists with brackets

A. Provide a cable hoist assembly to raise the flexible aircraft cable (connected to the converter mounted on the passenger loading bridge) to a stowed position along the side of the bridge out of the path of moving vehicles. Provide operator controls via remote pushbutton to allow raising and lowering the cable to power aircraft at the gate.
B. The hoist shall be designed for mounting on top of or on the side of the bridge.

C. The hoist cabinet shall be welded number 10 gauge steel. The finish shall be two coats of primer and one coat of white polyurethane paint. The unit shall be rated NEMA 3R. The hoist shall be constructed with removable or hinged cover for ease of maintenance and access to major components.

D. Motor

1. Provide an electric open drip proof gearmotor rated at ½ HP, 480VAC, 60 Hz, 3PH. The gear reducer shall be NEMA rated Class D.

2. Provide a magnetic disc brake to prevent the wire rope drum from unwinding when the hoist is shut off.

E. Controls:

1. A 600V, 3 pole 10 amp manually operated disconnect isolation switch shall be provided.

2. Provide a reversing contactor and control circuitry.

3. Provide a 24 volt adjustable counter to control the IN and Out limits of the wire rope.

4. A step down transformer shall be provided for the low voltage circuits.

5. Provide a single drum with flanges to contain the wire rope.

6. Provide 3/16 inch diameter nylon coated stainless steel braided wire rope of sufficient length to raise the aircraft cable level with the underside of the bridge.

7. Provide two cast aluminum cable saddles and clamps to attach to the aircraft cable. One clamp is to be attached about 14 feet from the cable head and the second approximately 18 feet from the cable attachment on the bridge. This will allow the aircraft cable to be festooned on the side of the bridge.

8. During the “down cycle”, the hoist lowers the aircraft cable to a ground handling position. The operator uncouples both swivel clamps from the saddles which allows the aircraft cable to be extended and attached to the aircraft.
9. The return of the aircraft requires the operator to pull the cable back to a position where the cable clamps can be reattached to the hoist wire rope. The “raise” push button on the aircraft cable head or the lift column returns the aircraft cable to the stowed position.

10. The cable hoist counter disconnects power from the motor when the travel limit, “raise” or “lower”, has been reached.

3. Remote pushbutton station for mounting on PBB lift column. Unit to include On/Off/Up/Down controls.

4. Aircraft cable assembly
   A. The 400 Hz Aircraft Cable shall be of a banded configuration suitable for nominal 200/115 volt, 3 phase, 4 wire, 400 Hz power. Cable shall include E&F control wiring as required for aircraft applications.
   B. Cables shall included a molded head with replaceable nose section.
   C. Cables shall include On/Off and Raise/Lower pushbuttons in the cable head.
   D. Weight shall not exceed 2 pounds per foot.
   E. Acceptable Manufacturers
      INET Airport Systems
      Approved Equal

5. All required connectors and other things required to completely install equipment and related components.

4.5 FINISHES
All outdoor equipment shall be finished to match the color of the nearby existing surfaces, to be approved by HAS. All steel shall be phosphatized prior to application of primer and a minimum of two coats of exterior enamel. Indoor equipment shall be suitably finished in the manufacturer's standard color.

5.0 SYSTEM INSTALLATION
The complete system installation shall be designed by, performed by, and under the direction of the proposer as part of this Proposal, except for those items specifically defined as "by others".

All installation labor shall be performed by subcontractors licensed in and approved by the HAS, who meets all insurance and bonding requirements. The installation includes all construction permits or other approvals required under a master permit.
Where bridges are existing and in service, all bridge related work shall be scheduled with the owner to minimize disruption of service, including nighttime hours if no short time bridge shutdown is possible during daytime hours.

The central equipment room will be available to the Proposer on a full time basis with no interference from other trades or Proposers, in accordance with the milestones of the contract schedule.

6.0 SYSTEM TESTING

6.1 FACTORY TESTS

Each functional assembly shall be inspected and tested prior to shipment. HAS or his representative shall have the right to witness these tests, for which purpose a 5 day notification shall be given prior to performance. Complete test reports shall be submitted.

Test procedures shall be submitted by the Proposer at least 30 days prior to the scheduled tests for review by HAS.

6.2 SITE ACCEPTANCE TESTS

Following checkout and inspection by the Proposer, a complete acceptance test shall be made of the central system and gate subsystems with a load bank capable of providing a 90kVA load at 0.8 lagging power factor when connected to the plug end of the aircraft cable. Load bank shall provide incremental loads above this level to verify the overload and unbalanced load current protective circuit settings.

Tests as a minimum shall comprise those derived from the requirements of Paragraphs 3.3 through 3.3.2 and delivered in the approved test procedure. Complete test reports shall be submitted within 10 days of completion of the actual tests. Test reports shall contain suitable data reduction and calculation to verify the goals of the test plan and the system capacity.

7.0 DRAWINGS AND MANUALS

7.1 APPROVAL DRAWINGS

If requested two sets of design drawings, calculations, catalog cuts, and equipment installation drawings shall be submitted to HAS for approval. Detailed installation shop drawings and catalog cuts shall be available for submittal to HAS for approval. All drawings shall be approved by HAS or such approval waived in writing prior to beginning construction. The purpose of the Owner's approval is not to concur and accept the Proposer's calculations or equipment selection, but to indicate that HAS has not discovered violations in the submittals of codes and his agreement of critical interfaces.

7.2 AS-BUILTS

As-built drawings shall be submitted within 30 days after system acceptance.
7.3 RECOMMENDED SPARES LIST

A set of recommended spares lists shall be submitted covering all items of equipment and categorized accordingly, with current unit prices as well as recommended lot price.

7.4 MAINTENANCE AND OPERATING MANUALS

Six (6)-sets of complete and bound maintenance and operating manuals shall be provided at least 10 days prior to site acceptance. As a minimum, manuals shall consist of the following:

A.) One section defining the overall operation of the system, start-up and shut-down and adjustment procedures, overall preventative maintenance charts, flow charts, and a listing of major system components, with a guide to finding detailed information on these components in other sections.

B.) One section containing maintenance and operating details of the 400Hz system equipment with theory of operation, control diagrams, schematics, troubleshooting charts, complete alignment instructions, PM details, parts lists, all in the general format and intent of ATA-101 as adapted for fixed facility equipment.