



**SPECIFICATION FOR  
THREE PHASE 50/400HZ  
FREQUENCY  
CONVERTER AND  
ASSOCIATED  
AUXILLIARY EQUIPMENT  
(L-S25)**

**JKR 20300-0124-23**

**CAWANGAN KEJURUTERAAN  
ELEKTRIK**

## **SPECIFICATION FOR THREE PHASE 50/400HZ FREQUENCY CONVERTER AND ASSOCIATED AUXILLIARY EQUIPMENT**

### **1.0 GENERAL**

- 1.1 This section of the specification describes and specifies requirements for the supply, delivery, testing and commissioning of 50/400Hz Rotary Frequency Converter Sets, handing over in approved working order and providing service and maintenance during the Defects Liability Period as specified thereafter for the period stated in the Conditions of contract.
- 1.2 The Frequency Converter shall be of the rotary type and capable of maintaining a continuous output of not less than the rating specified as per drawing and Bill Of Quantities at 0.8 power factor, 200V, 3 phase, 4 wire, 400Hz, 3000 rpm and under the operating conditions specified hereafter and within a guaranteed range of frequency and voltage tolerances after making full allowances for all internal losses and power consumed by ancillaries.
- 1.3 For ease of service and maintenance, the equipment offered shall be represented in Malaysia by a Local company. Letter of appointment as a local agent from the manufacturer shall be submitted. Reference list must be submitted indicating installations in Malaysia for the past three (3) years.
- 1.4 The Frequency Converter shall be fully computerised control and shall be complete with a system controller to monitor the correct operation of the system and thus protect both the converter and the connected load against possible damage.
- 1.5 The converter shall comprise of an asynchronous motor and a synchronous generator of brushless design, combined on a single horizontal shaft within one common stator housing of the monoblock design. The complete motor generator unit shall be statically and dynamically balanced to reduce any residual vibrations and mounted on the chassis at the bottom of the cabinet. All switchgears, control units and terminal strips shall be mounted onto the upper chassis inside the cabinet whereas the control panel shall be mounted onto the hinged front doors of the cabinet. The cabinet shall be completely wired up making the complete unit a self-contained type where only input and output cables need to be connected. Connections for remote signalling have to be made where specified.
- 1.6 The cabinet with the motor-generator and switchgear within shall be designed for front access only.
- 1.7 Suitable rollers shall be provided at each footmounting of the motor-generator unit for easy removal during maintenance. For this purpose, lifting gears shall be provided at the appropriate points for lifting of the motor-generator unit within the cabinet.
- 1.8 The cabinet shall be capable of reducing overall sound level to not more than 65 dBA measured at 1 metre distance overall.
- 1.9 The Frequency Converter shall be designed in such a way that only the motor generator's fan is sufficient to cool the frequency converter.
- 1.10 The converters shall be fitted with automatic standby heating for both the machine and cubicle. The heater shall remain on until the set is started up and is reconnected when the set is switched off.

- 1.11 The operating conditions are as follows :-  
 Total barometric pressure : 750 mm Hg  
 Ambient temperature : 40 deg C  
 Relative humidity : 95%
- 1.12 Both the alternator and the motor must be provided with name plates bearing serial numbers, ratings and other relevant data. In addition, name plate bearing the registered supplier's name and address and date of commissioning shall also be provided.
- 1.13 Tenderer shall submit together with his offer, relevant catalogues, descriptive literatures and design layout drawings of the supply system in addition to filling in Appendix 'A1' (Schedule of Technical Data and Guarantee) and Appendix 'A4' (Schedule of Compliance) of this specifications. Offer without these relevant documents may be rejected.

## 2.0 **STANDARDS**

- 2.1 The converter sets and their associated switchgear, control and switchboard shall conform to the following standards, unless specified otherwise.

BS 2G219 : 1983 :	General Requirement For Ground Equipment
ISO 6858-1982	Support Electrical Supplies For Aircraft.
BS 3G 173-1972 :	Performance and Interchangeability Requirements. For Plugs and Sockets for Ground Electrical Supply To Aircraft.
MIL STD 704D : 1980:	Aircraft Electric Power Characteristics.
Euro-Standard DFS 400 :1982	
Part I :	Electrical Connection Conditions
DIN/VDE 0530 :	Rotating Electrical Machines
DIN 40050:	IP-protection types
DIN/VDE 0160 :	Configuration of power circuit plants with electronic operating material.
DIN/VDE 0660/Part 500 :	Low voltage switchgear combinations
DIN/ISO 2373 :	Mechanical vibrations of rotating electrical machines.
VBG 4 :	Electrical plants and operating materials. Explanations and indications for the working practitioner.

## 3.0 **DESCRIPTION**

- 3.1 Each converter set is connected between the mains supply and the load and supplies the load with the appropriate voltage and frequency and also acts as a line conditioner, smoothing out mains fluctuations.
- 3.2 Both motor and alternator shall have 3 phase auxiliary windings. The auxiliary winding of the generator shall be connected to a 3 phase bridge rectifier incorporated in the voltage regulator and the auxiliary winding in the motor shall be connected to a rectifier on the exciter. Both DC terminals are then connected in parallel.

- 3.3 When the motor is energised the excitation voltage from the auxiliary winding of the motor is rectified and fed to the exciter of the generator. When the motor has reach synchronous speed, excitation is activated. When the terminal voltage of the generator has reached a set amount below its rated value, the voltage of the generator becomes predominant such that the exciting current, controlled by the automatic electronic voltage regulator is supplied by the respective rectifier.
- 3.4 The excitation system of the converter shall be capable of sustaining the generator voltage for a min. of 10 milliseconds when the mains voltage has collapsed.
- 4.0 **MOTOR**
- 4.1 The motor shall be of the 2 pole asynchronous, screen-protected, drip- proof type and suitable for operation on a mains input of 415V +/-5%, 3 phase, 50Hz and shall comply in all respects to VDE 0530.
- 4.2 Degree of protection shall be IP23 and the method of cooling shall be IC01.
- 4.3 Insulation shall be class F and temperature rise shall be limited to class F.
- 4.4 The rated output of the motor shall be not less than that required by the alternator for the specified output under the specified operating conditions taking into account allowance for all internal losses and power consumed by auxiliaries.
- 4.5 The power factor shall maintain between 0.8 lagging and unity for all loads between 15% and 100%.
- 4.6 The motor shall be started via a pony motor for ratings above 50KVA and choke start for ratings below 50KVA and the maximum starting current shall not exceed 1.5 times the normal full load current of the motor.
- 4.7 Protection shall be provided to safe guard the motor against overheating and overloads.
- 5.0 **ALTERNATOR**
- 5.1 The alternator shall be a 16-pole synchronous A.C generator of the screen protected, drip-proof, brushless revolving field type, fitted with an exciter and complying in all respects to VDE 0530.
- 5.2 Insulation shall be class F and temperature rise shall be limited to class F.
- 5.3 Degree of protection shall be IP23 and the method of cooling shall be IC01.
- 5.4 The rotor or armature shall be of the one piece, with lamination pressed and keyed to the shaft.
- 5.5 The stator shall be of the multiplicity type for high or low voltages in "Star" or "Delta" connections. Damper windings shall be provided in the pole faces.
- 5.6 **Rating**  
The alternator of brushless design shall be continuously rated not less than the manufacturer's rated KVA specified at 0.8 power factor lagging when wound for a 200/115 Volts as specified 3 phase, 4 wire, 400Hz supply under the specified conditions.

- 5.7 Overload Rating  
The normal overload rating of the alternator shall be 110% of rated full load at 0.8 p.f., for 1 hour in every 6 hours cycle and 125% for 5 minutes.
- 5.8 Short Circuit Rating  
It shall be capable of sustaining a 3 phase short circuit current of 3 times the full load current for a minimum of 3 seconds and a max. of 8 seconds to operate protective devices.
- 5.9 Nominal Voltage Rating  
The alternator output shall be a 3 phase, 4 wire, star system with ungrounded neutral having a nominal voltage of 200/115V.
- 5.10 Voltage Adjustment Range  
The output voltage shall be capable of being adjusted from minus 8% to plus 8% of the nominal.
- 5.11 Phase Rotation  
The phase rotation shall be ABC clockwise.
- 5.12 Voltage Regulation  
Voltage regulation at steady state for all loads up to rated load and power factor between 0.8 lagging to unity shall be  $\pm 1\%$  for unbalanced load up to  $1/3$  of rated current on one phase and no load on the other 2 phase the maximum difference between individual voltages shall not exceed 4%.
- 5.13 Voltage Regulator  
The voltage regulator shall be of the solid state design and sensing three phase averaging.
- 5.14 Voltage Waveform  
The voltage waveform shall be sinusoidal with the crest factor lying between 1.31 and 1.414,  $\pm 0.05$ .
- 5.15 Total Harmonic Content  
Total harmonic content shall not exceed 1.5% of the fundamental (RMS) at no load to rated KVA. At  $1/3$  rated current unbalanced load, the total harmonic content shall not exceed 3% of the fundamental (RMS).
- 5.16 Voltage Transient  
The voltage transient shall not be more than  $\pm 15\%$  on applying and removing rated load. The voltage transient shall recover to and stay within  $\pm 1\%$  of the nominal voltage within 200 millisecond with full rated load applied or removed from the unit.
- 5.17 Voltage Modulation  
The voltage modulation shall not exceed 1% at any steady state conditions. The frequency of voltage modulation shall not exceed 100Hz.
- 5.18 Phase Angle Symmetry With Balance Load  
The maximum phase angle symmetry with balanced load shall not exceed 120 deg  $\pm 1.5$  deg.
- 5.19 Phase Angle Symmetry With Unbalance Load  
The maximum phase angle symmetry with  $1/3$  rated current unbalanced load shall not exceed

120 deg +/- 20 deg.

- 5.20 Phase Voltage Displacement With Unbalance Load  
The maximum phase voltage displacement with 1/3 rated current unbalanced load shall not exceed 120 deg +/- 4 deg.
- 5.21 Frequency Tolerance  
The frequency shall be maintained within the limits of 390 to 410 Hz.
- 5.22 Frequency Drift  
Variations of the controlled frequency level due to drift shall not exceed +/-5Hz and the rate of frequency drift shall not exceed 15Hz per minute.
- 5.23 Frequency Regulation  
The frequency regulation at steady state shall not exceed +/-2Hz maximum.
- 5.24 Frequency Transient Recovery  
At 30% change of rated load, the output frequency shall recover to and stay within +/-15Hz in 2 seconds.
- 5.25 Frequency Modulation  
The frequency modulation shall not exceed 4Hz. The rate of frequency modulation shall not exceed 10Hz per second.
- 5.26 Electromagnetic Interference Suppression  
Conducted and radiated electromagnetic interference shall be sufficiently suppressed so as not to interfere with normal operation of communications and electronic equipment to meet with VDE 0875 grade N standard.

## 6.0 INSTRUMENTATIONS AND CONTROLS

- 6.1 The Frequency Converter shall be complete with a control panel. The control panel shall incorporate as minimum the following indications and instrumentation mentioned hereafter:-
- a) Mimic diagram c/w LED indications. The current status shall be represented in the mimic diagram by different coloured LEDs.
  - b) Load bar chart.
  - c) 4 line, 80 character LCD.
  - d) Frequency Converter ON/OFF push button.
  - e) 400Hz Output ON/OFF push button.
  - f) ON/OFF confirmation button
  - g) LCD Input/output/scroll button.
  - h) Reset button.
  - i) Emergency Off button.
  - j) Digital readout for input : Voltage  
Current  
Frequency  
KVA
  - k) Digital readout for output : Voltage  
Current  
Frequency  
KVA  
KW

- 6.2 The Frequency Converter shall be able to store at least 200 history events in a first in first out basis. This is to facilitate trouble shooting and fault finding and thus reduced down time.
- 6.3 Unless otherwise specified the Frequency Converter shall be complete with 6 potential free contacts for connection to a remote indication panel if required in future.
- 6.4 The frequency converter shall incorporate a 2 channel Digital Storage Oscilloscope (DSO) and a 3 channel Logic Signal Analyser (LSA), a graphic program for displaying measured and stored graph within the frequency converter. The DSO shall be able to display via a PC or laptop computer connected to the frequency converter all measured input/output voltage/current waveforms etc. and all digital signals. Copies of the DSO graphs must be submitted together with this tender.
- 6.5 The frequency converter shall be capable of being connected to a modem and shall be able to transmit all data from its microprocessor to the manufacturer's or local agent's service centre to ensure prompt back-up service via remote diagnostics.
- 7.0 **SYSTEM PROTECTIONS**
- 7.1 Under any of the following fault conditions the frequency converter set will be electrically disconnected from the 400Hz load network.
  - 7.1.1 When any line to neutral voltage exceeds 130V $\pm$ 1V for 0.5 second.
  - 7.1.2 When the average line to neutral voltage drops below 100V  $\pm$ 1V longer than 3  $\pm$ 1 second.
  - 7.1.3 When the alternator frequency drops below 380Hz  $\pm$ 2Hz longer than 3  $\pm$ 1 seconds.
  - 7.1.4 When the alternator frequency exceeds 420Hz  $\pm$  2Hz for 3  $\pm$ 1 second.
  - 7.1.5 When the alternator output exceeds 125% rated current for 5 minutes. Overload protection must have an inverse time characteristic and should operate instantaneously under short circuit conditions.
- 8.0 **POWER SUPPLY POINT (TRANSFORMER STATIONS)-PSP**
- 8.1 Unless otherwise specified, the output from the frequency converter set shall be distributed in a ringline network to the PSPs as indicated in the drawings.
- 8.2 Each PSP shall be capable of supplying the specified KVA rating or requirement at full load.
- 8.3 The transformer shall be rated as specified KVA rating, 200/115V, 400Hz continuous. The primary shall be Delta connected and the secondary shall be Wye connected with the star-point brought out as the neutral. The transformer shall be of the two winding dry isolation type, convection cooled with class F insulation. An electrostatic shield shall be provided between the primary and secondary and grounding terminal.
- 8.4 The transformer shall have a short circuit of 3% maximum of the full absolute load impedance referred to the secondary and a voltage regulation of 1% maximum at full load, 1.0 p.f. Values are line to neutral.
- 8.5 Turns ratio - with line to line voltage applied to the primary, the line to neutral voltage at the secondary shall be 115V  $\pm$ 2.6%.

- 8.6 The transformer shall be rated at 125% nominal load @0.8 lagging p.f. for 5 minutes.
- 8.7 An suitably rated output contactor shall be located in the output circuit on the secondary side of the transformer.
- 8.8 An earth fault device comprising of a voltage monitoring relay between neutral and potential earth shall be incorporated.
- 8.9 PSP which is meant for aircraft ground power supply system shall be complete with electrical interlock system to prevent the output contactor to be energised unless the aircraft ground power socket is inserted to the aircraft external power plug.
- 8.10 Controls and indications shall comprise of the following :-
1. Indication lamp for "400Hz available"
  2. Indication lamp for "400Hz On"
  3. Push-button for "400Hz Off"
  4. Indication lamp for "fault in system"
  5. Push-button for "400HzOn/Output On"
  6. Voltmeter c/w selector switch
  7. Ammeter c/w selector switch
  8. Frequency meter
  9. Normal/Bypass switch for "E/F interlock" (Only for PDC which is meant for aircraft ground power supply unit)

#### 9.0 **SPECIFICATIONS FOR 400HZ CABLES**

- 9.1 All cables proposed for this tender shall be suitable for a 400Hz supply system.
- 9.2 Unless otherwise specified, the cables for carrying the 400Hz supply shall be of the 7 core arrangement and adhere to the following specification or such specifications as recommended by the manufacturer/agent or as otherwise directed by the Government Engineer.

Type	:	As above
Maximum permissible conducting temperature	:	70 deg. Celsius.
Minimum permissible conducting temperature	:	5 deg. Celsius.
Outer diameter	:	40 mm
Minimum bending radius	:	230 mm
Weight	:	3350 Kg/Km
Copper No	:	2.352
Rated voltage Uo/U	:	600/1000V
Maximum permissible operating voltage	:	1150V
High voltage test	:	4000V
Reactance of phase conductor	:	0.262 Ohm/Km (at 20 deg. Celsius.)
Operating inductance of phase conductor	:	0.113 mH/Km
Operating inductance of neutral conductor	:	0.199 mH/Km
Phase-phase capacitance	:	0.132 uF/Km
neutral - neutral capacitance	:	0.070 uF/Km
Operating capacitance	:	0.466 uF/Km

#### 10.0 **SOCKET OUTLETS FOR AIRCRAFT**

- 10.1 The socket outlet shall be of a 6 pole AC flange socket outlet, 200V, 400Hz. The insert and contacts shall conform to BS 4G 173:1985 Fig. 6, ISO 461 - Fig. 6. complete with matching



plug and socket coupling cable as further describe hereon.

- 10.2 The socket outlet shall be designed with a spring loaded hinged cover with neoprene gasket to ensure a weatherproof seal to IP54 when closed. Provisions shall be made on the cover for padlocking of the outlet.
- 10.3 The housing and cover shall be manufactured in cast aluminium alloy conforming to LM25M to BS1490:1988 finished in electro static epoxy spray, colour orange to BS 381C.557.
- 10.4 The inner assembly shall be manufactured in moulded Nitrile PVC with machine copper power and control tubes, silver plated to reduce resistance.
- 10.5 All tubes, shall be spring loaded to ensure good electrical contact.
- 11.0 **FLEXIBLE COUPLING CABLE**
- 11.1 The flexible coupling cable shall be of 4 nos # 1/10 single core stranded copper conductor and 1 no. # 12 twin core stranded copper conductor PVC insulated to MIL-C-5756 or equivalent 4 nos single core 50 sq mm and 1 no 2 core 4 sq mm rubber insulated flexible copper cable of 12 metres length, banded together at approx 600mm intervals using non-metallic cable bands.
- 11.2 The AC plug shall be rated for 200/115V 400Hz 6 poles (3 phase, neutral and 2 control poles) conforming to BS 4G 173:1985 - Fig 5 and ISO 461 - Fig 5.
- 11.3 The AC socket shall be rated for 200/115V 400Hz 6 poles (3 phase, neutral and 2 control poles) conforming to BS 4G 173:1985 - Fig 6 and ISO 461 - Fig 6.
- 11.4 The plug and socket shall be of the heavy duty type with rubber housing and case made from moulded Nitrile PVC to resist moisture and chemicals and to withstand severe wear and tear during handling.
- 11.5 All power and control tubes and pins shall be of machined copper, silver plated to reduce contact resistance.
- 11.6 All socket tubes, both power and control shall be spring loaded to ensure good electrical contact.
- 11.7 The plug and socket shall be design for easy access to the pins of tubes for terminating of cable. The pin and tubes assembly shall be separated from the rubber housing. Pins shall be used to retain the socket tubes and plug pins in the rubber nose housing. The front and rear assemblies are then locked together by two mild steel, cadmium plated screws, nuts and clamp plates. Two stainless steel hose type clips shall be used to secure the plug or socket to the cable.
- 12.0 **400HZ SWITCHED SOCKET OUTLET AND PLUG FOR INSTRUMENT**
- 12.1 The switched socket outlet shall be shuttered 5 round pin type for 3 phase and 3 round pin type for 1 phase complete with cover. Even with the cover open, live parts of the socket outlet shall be totally inaccessible except to a plug that matched the socket.
- 12.2 The terminal shall be spring loaded type and fitted with silver nickel butt contact to prevent loosening of the conductor due to vibration or thermal cycling. Sleeve type terminal shall be used.

- 12.3 The contacts shall be designed to make or break regularly without any danger up to 300% their rated current and 110% of their rated voltage.
- 12.4 The switched socket outlet shall be mechanically interlocked to prevent the switch from being turned on if the plug is not inserted into the socket outlet.
- 12.5 The switched socket outlet and plug shall be made of high quality thermoplastic material with the excellent characteristic of good electrical insulation, dimensionally stable, highly resistant to wear, extremely resistant to abrasion, stabilised to resist ageing, resistant to oil, petrol and sea water.
- 12.6 The switched socket outlet and plug shall be green colour coded.
- 12.7 The switched socket clock hour position shall conform to the international electrical engineering and practice.
- 12.8 The switched socket outlet shall be designed to IP44 standard of protection or better.
- 12.9 Standard of compliance shall be to IEC 309 Part 1 and IEC 947 Part 3 or any equivalent standard approved by the Government.
- 13.0 **EARTHING SYSTEM**
- 13.1 Independent earthing system shall be provided for the converter set. Earthing to earth resistance not exceeding one ohm shall be effected by 3mm x 25mm copper tape and 16mm diameter copper jacketed steel core rods. The copper jacket shall be of minimum thickness 0.25mm and shall be metallically bonded to the steel core to ensure that the copper jacket and steel core are not separable. Earth chambers and covers used for earthing rods shall be reinforced concrete type. Each converter set earthing point shall be identified by permanent label legibly marked with words "CONVERTER EARTH" permanently fixed to the point of connection of every earthing conductor and the electrode.
- 14.0 **DRAWINGS**
- 14.1 The Contractor shall submit all necessary drawings to support his offer. However the drawings submitted maybe modified if necessary, as recommended by the manufacturer or otherwise by the Supervising Officer.
- 15.0 **WORKS TEST**
- 15.1 Prior to delivery and installation at site the following tests shall be conducted on the converter set at the supplier's workshop or manufacturer works in the presence of the Supervising Officer or his representatives. The following test procedures will be performed:-
- a) Routine manufacturer quality assurance.
  - b) Markings - grounding plate,  
labels of identification  
designation of terminals  
designation of parts  
warning and instruction plates  
designation of wires  
type plate
  - c) Visual check on all connections.
  - d) Resistance of windings.
  - e) High voltage test for insulation of all circuit in accordance with VDE 0530 and VDE 0160.

- f) Megger test to VDE 0100 for insulation resistance of circuits against each other and against ground.
- g) Wave shape of voltage to be measured in comparison with VDE 0530.
- h) Asymmetry voltage of generators to be measured in comparison with guaranteed data.
- i) Static response of voltage of generator to be measured in comparison with guaranteed data.
- j) Dynamic response of voltage of generator to be measured in comparison with guaranteed data.
- k) Static response of frequency converter to be measured in comparison with guaranteed data.
- l) Short circuit test on capability of generator to VDE 0530.
- m) 50% overload testing for two minutes duration in accordance to VDE 0530.
- n) Heat run with nominal load (100%).
- o) Distortion factor to be measured.
- p) Voltage modulation at rated load to be measured in comparison with guaranteed data.
- q) High voltage tests on insulation of all circuits in control cabinet.
- r) Megger tests on insulation resistance of circuits against each other and against ground.
- s) Function tests on all controls.

15.2 Certified test results as per above shall be submitted. If above tests are carried out outside Malaysia, the Supervising Officer reserves the right to send two representatives and the Contractor shall bear the cost of food, accommodation, transport and travelling expenses for the representatives to witness the test.

#### 16.0 **COMMISSIONING TESTS**

16.1 On completion of plant erection, tests comprising of starting, stopping and running on load shall be carried out.

16.2 Simulation tests on the operation of all protective devices shall also be carried out. All instruments and labour necessary for the test shall be provided by the Contractor.

#### 17.0 **SERVICE AND MAINTENANCE**

17.1 Under this contract, the Contractor shall be required to provide and carry out comprehensive service and maintenance of the converter set during the Defects Liability Period herein stated as a minimum requirement. A proposed schedule of service and maintenance as per Appendix 'A2' (Schedule of Comprehensive Service and Maintenance) shall be submitted with this tender.

#### 18.0 **RECOMMENDED SPARES**

18.1 The Contractor shall complete and submit Appendix 'A3' (Schedule of Recommended Spares) together with the tender. The spares shall be as per manufacturer's recommendation. The list should contain the price and delivery period of each item of the spare recommended.

#### 19.0 **ITEMS TO BE SUPPLIED ON COMPLETION**

19.1 As installed drawings.

Within three calendar months after practical completion of the project, one set of true to scale negatives (155/165 g./sq.m. ISO size OA or A1) and four sets of prints for each of the following drawings shall be submitted :

- a) Site plan
  - b) Installation of the frequency converter
  - c) Location layout of earthing points with respect to the frequency converter
  - d) Layout and schematic control wiring of the frequency converter set control panel
  - e) Layout and schematic wiring of the frequency converter switchboard
  - f) Any other drawings deemed necessary by the S.O.'s
- 19.2 All drawings submitted by the Electrical Contractor shall be properly stencilled and shall have at the lower right hand corner the Electrical Contractor's name and address, date of commissioning, scale , drawing number (to be obtained from S.O.'s Representative), titles and the following particulars :-
- JKR :
  - Contract No :
  - Tender No :
- 19.3 Each of the above four sets of prints shall be filed in a stiff cover ring file together with the manuals stated hereinafter.
- 19.4 In addition to the above four sets of prints submitted, one set of the following prints shall be framed up in the frequency converter room.
- a) Location layout of earthing points with respect to the frequency converter location.
  - b) Layout and schematic control wiring of the frequency converter set control panel.
  - c) Layout and schematic wiring of the frequency converter switchboard.
- 20.0 **MANUALS**
- 20.1 The Electrical Contractor shall provide four sets of the following manuals and documents for each frequency converter set installed :-
- a) Operation, service and maintenance manual
  - b) Parts list
  - c) Product data and catalogue of equipment
  - d) Test certificate and test results
- 20.2 Only original copies of the above manuals and documents will be accepted. Each of the four sets submitted shall be filed in a stiff cover ring file together with the as-installed drawings.
- 20.3 The following particulars shall be printed on the cover of each file :
- a) Name of the project
  - b) Tender number
  - c) Contract number
  - d) Name, address and telephone number of the Electrical Contractor

**APPENDIX 'A1' (SCHEDULE OF THE TECHNICAL DATA AND GUARANTEE)****1.0 400 Hz 200 V FREQUENCY CONVERTER SET**

<i>ITEM</i>	<i>DESCRIPTION</i>		
1.1.1	Manufacturer		
1.1.2	Country of Manufacture		
1.1.3	Local Agent		
1.1.4	Standard of compliance		
1.1.5	Type		
1.1.6	Model		
1.1.7	Rated output	kW	
1.1.8	Rated frequency	Hz	
1.1.9	Overall dimensions (WxDxH)	mm	
1.1.10	Total weight	Kg	
1.1.11	Construction features/arrangement		
1.1.12	Noise level at 1 metre	DB(A)	
1.2.0	<b>MOTOR</b>		
1.2.1	Type of motor		
1.2.2	Rated voltage	V	
1.2.3	Voltage tolerance	%	
1.2.4	Nominal current	A	
1.2.5	Rated full load current	A	
1.2.6	Type of starter		
1.2.7	Rated speed	RPM	
1.2.8	Rated frequency	Hz	
1.2.9	Insulation		
1.2.10	Enclosure		
1.2.11	Cooling		
1.2.12	Radio interference suppression		
1.2.13	Overload capacity for 1 hr	%	
1.2.14	Overload capacity for 10minutes	%	
1.3.0	<b>GENERATOR</b>		
1.3.1	Type of alternator		
1.3.2	Rated power	kW	
1.3.3	Power factor		
1.3.4	Insulation		
1.3.5	Enclosure		
1.3.6	Cooling		
1.3.7	Radio interference suppression		
1.3.8	Phase rotation		
1.3.9	Rated voltage	V	
1.3.10	Voltage tolerance regulation	V	
1.3.11	Voltage tolerance dynamic	V	

<i>ITEM</i>	<i>DESCRIPTION</i>		
1.3.12	Voltage setting range	V	
1.3.13	Type of voltage regulation		
1.3.14	Rated current	A	
1.3.15	Rated speed	RPM	
1.3.16	Rated frequency	Hz	
1.3.17	Frequency tolerance, static	%	
1.3.18	Frequency tolerance, dynamic	%	
1.3.19	Short circuit capability	%	
1.3.20	Overload capacity for 1 hr	%	
1.3.21	Overload capacity for 10minutes	%	
1.3.22	Total harmonic content	%	
1.4.0	<b>INDICATION &amp; CONTROLS</b>		
1.4.1	Mimic panel c/w LED		
1.4.2	Load bar chart		
1.4.3	LCD		
1.4.4	History event		
1.4.5	Potential free contact		
1.4.6	Remote diagnostic via modem		
1.4.7	Digital Storage Oscilloscope		
1.4.8	Logic Signal Analyser		

## 2.0 **400HZ FLEXIBLE COUPLING CABLE**

<i>ITEM</i>	<i>DESCRIPTION</i>		
2.1.0	<b>FLEXIBLE CABLE</b>		
2.1.1	Manufacturer		
2.1.2	Country of Manufacture		
2.1.3	Local Agent		
2.1.4	Standard of compliance		
2.1.5	Type/Model		
2.1.6	Voltage designation	V	
2.1.7	Conductor material		
2.1.8	Insulation material (power)		
2.1.9	Insulation material (control)		
2.1.10	Sheath material (power)		
2.1.11	Sheath material (control)		
2.1.12	No./size of main conductor		
2.1.13	No./size of control conductor		

2.2.0	<b>AIRCRAFT AC SOCKET</b>		
2.2.1	Manufacturer		
2.2.2	Country of Manufacture		
2.2.3	Local Agent		
2.2.4	Standard of compliance		
2.2.5	Type/Model		
2.2.6	Voltage designation	V	
2.2.7	Current rating	A	
2.2.8	Insulation body material		
2.2.9	No./Type of terminals		
2.3.0	<b>AIRCRAFT AC PLUG</b>		
2.3.1	Manufacturer		
2.3.2	Country of Manufacture		
2.3.3	Local Agent		
2.3.4	Standard of compliance		
2.3.5	Type/Model		
2.3.6	Voltage designation	V	
2.3.7	Current rating	A	
2.3.8	Insulation body material		
2.3.9	No./Type of terminals		

### 3.0 **POWER SUPPLY POINT (PSP)**

<i>ITEM</i>	<i>DESCRIPTION</i>		
3.1.0	<b>400Hz PDC</b>		
3.1.1	Manufacturer		
3.1.2	Country of Manufacture		
3.1.3	Local Agent		
3.1.4	Standard of compliance		
3.1.5	Type/Model		
3.1.6	Test Certificate/Authority		
3.1.7	E & F Interlock		
3.1.8	Rated voltage	V	
3.1.9	Rated current	A	
3.1.10	Rated Frequency	Hz	
3.1.11	Transformer rating	kVA	
3.1.12	Transformer type		
3.1.13	Transformer connection		

<i>ITEM</i>	<i>DESCRIPTION</i>		
3.1.14	Transformer insulation		
3.1.15	Transformer cooling system		
3.1.16	Earth fault device		
3.1.17	Main component		
a	4 pole MCCB		
b	Earth fault relay		
c	4 pole contactor		
d	28VDC 100VA rectifier		
e	Pilot light		
f	Voltmeter		
g	Ammeter		
h	Current transformer		
I	Selector switch		
3.2.0	<b>400HZ FLANGE SOCKET (AIRCRAFT)</b>		
3.2.1	Manufacturer		
3.2.2	Country of Manufacture		
3.2.3	Local Agent		
3.2.4	Standard of compliance		
3.2.5	Type/Model		
3.2.6	Voltage designation	V	
3.2.7	Current rating	A	
3.2.8	Body housing material		
3.2.9	No./Type of terminals		

#### 4.0 400 HZ SOCKET OUTLET & PLUG

<i>ITEM</i>	<i>DESCRIPTION</i>		
4.1.0	<b>3 PHASE, 5 PIN, 400 Hz</b>		
4.1.1	Manufacturer		
4.1.2	Country of Manufacture		
4.1.3	Local Agent		
4.1.4	Standard of compliance		
4.1.5	Model/type (Socket outlet)		
4.1.6	Model/type (Plug)		
4.1.7	Terminals		
4.1.8	Voltage	V	
4.1.9	Current	A	
4.1.10	Frequency	Hz	
4.1.11	Earth pin position		



<i>ITEM</i>	<i>DESCRIPTION</i>		
4.1.12	Interlock		
4.1.13	Colour		
4.2.0	<b>1 PHASE 400 Hz S.O/PLUG</b>		
4.2.1	Manufacturer		
4.2.2	Country of Manufacture		
4.2.3	Local Agent		
4.2.4	Standard of compliance		
4.2.5	Model/type (Socket outlet)		
4.2.6	Model/type (Plug)		
4.2.7	Terminals		
4.2.8	Voltage	V	
4.2.9	Current	A	
4.2.10	Frequency	Hz	
4.2.12	Earth pin position		
4.2.13	Interlock		
4.2.14	Colour		

**APPENDIX 'A2' (SCHEDULE OF COMPREHENSIVE SERVICE AND MAINTENANCE)**

**400 Hz 200 V FREQUENCY CONVERTER SET**

The tenderer is required to submit his proposed Schedule Of Comprehensive Service And Maintenance to be carried out during Defects Liability Period (D.L.P).

Item	Schedule of Service and Maintenance	Frequency during DLP

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## APPENDIX 'A3' (SCHEDULE OF RECOMMENDED SPARES)

### **400 Hz 200 V FREQUENCY CONVERTER SET**

The tenderer shall submit this Schedule Of Spares recommended by him. The prices for these spares shall not be included in the Total Tender Price and the purchase of all or any of the spares listed shall at the option of the S.O.'s Representative. These prices shall be valid for acceptance up to the end of Defects Liability Period of the project.

Item	Description & Part No.	Qty	Unit Rate	Price

Delivery :                      ex-stock                      weeks                      Total price                      : RM

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Tarikh

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T.T & Cop pemborong