SPECIFICATIONS FOR 60 HZ ROTARY FREQUENCY CONVERTER SYSTEM

1.0 GENERAL

1.1 This specifications describes and specifies requirements for the supply delivery, testing, commissioning, handing over in approved working order and providing service and maintenance during the Defects Liability Period of the whole 60Hz electrical supply system.

1.2 Each Converters shall comprise of a single shaft motor - generator housed in one block complete with controller system housed in a single floor standing self contained metal clad cubicle. The Converters shall be capable of maintaining a continuous output at not less than the rating specified in this tender at 0.8 lagging to 1.0 power factor, 440V, 3 phase, 60Hz supply 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. Tenderer shall submit together with his offer a dimensional drawing indicating the location of the major components of the Converters

1.3 All the frequency converters parts & components such as busbars, control cards, breakers, motor-generators & terminals etc. shall be fully treated in order to withstand the extreme salty air & sea side condition.

1.4 The Frequency Converter set must be provided with name plate bearing the serial number, rating, type of motor-generator, year of manufacture and other relevant data. In addition, name plate bearing the registered suppliers name, address and date of commissioning shall also be provided.

1.5 Tenderer shall submit together with his offer, relevant catalogues, descriptive literature explaining the principal operation of the system and detail schematic drawings indicating all major components of the FC system in addition to filling in Appendix A (Schedule of Technical Data and Guarantee) of this specifications. All data required in Appendix A shall be filled and answer such as TBA etc. will not be accepted. Offer without these literature and drawings will be rejected.

1.6 For ease of service and maintenance, the equipment offered shall be represented in Malaysia by a Local company with a qualified after sales service and spare-parts back-up. 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.

1.7 All information and data requested for must be submitted together with this tender. Offers submitted without this information will be rejected.

1.8 The operating conditions shall be:

a)	Total Barometric Pressure	:	750mm Hg
b)	Air Temperature	:	40 deg C
c)	Relative Humidity	:	95%

1.9 The entire Frequency Converter set system, including the motor generator shall be housed in a rugged sheet steel cubicle. The sheet steel shall be at least 2 mm thickness.

1.10 Each Frequency Converter set shall comprise of a rectifier, inverter and a synchronous motor-generator with all associated switchgears and control gears as further described herein shall be mounted and housed in a rugged sheet steel floor mounted cabinet of at least 2 mm. thickness.

1.11 The motor-generator shall be of the type designed with the windings of the synchronous motor and synchronous generator in alternate slots in the same stator and a common DC excited rotor.

1.12 The entire unit shall be designed for front and side access only for ease of servicing. All internal components including the motor-generator unit shall be accessible from the front with the doors or covers opened.

1.13 `Cooling for the motor-generator and all the associated switchgears and control-gears within the Converter set shall be provided by a suitably sized fan mounted on the shaft of the motor-generator. No electrical fan shall be used.

1.14 All power circuits within shall be isolated from the low voltage control circuits by removable sheet metal partitions.

2.0 ELECTRICAL OPERATION

The 50 Hz AC mains is converted into DC in the DC-link circuit via a 12-pulse three phase rectifier to reduce harmonics feedback. The rectifier voltage is fed to the inverter via DC link circuit chokes and an auto-transformer converts the incoming voltage to that required by the synchronous motor. The inverter converts the DC voltage to 60 Hz AC which is fed to the synchronous motor.

3.0 CODES AND STANDARDS

The frequency converters shall be manufactured to the highest standards and designed to conform with the latest edition of the following DIN, VDE and IEC standards.

DIN/VDE 0100		Erection of power installations with rated voltages up to 1000V
DIN/VDE 0100 pt.410	IEC 364-4-41 IEC 364-4-46 IEC 364-4-47	Erection of power installations with rated voltages up to 1000V protective measures; protection against electric shock
DIN/VDE 0100 pt. 430	IEC 364-4-43	Erection of power installations with rated voltages up to 1000V; Protective measures; protection of cable and cords against overcurrent
DIN/VDE 0100 pt. 510	IEC 364-5-51	Erection of power installations with rated voltages up to 1000V; Selection and erection of equipment; common rules
DIN/VDE 0100 pt. 520		Erection of power installations with rated voltages up to 1000V; Selection and erection of equipment; wiring systems
DIN/VDE 0100 pt. 540	IEC 364-5-54	Erection of power installations with rated voltages up to 1000V; Selection and erection of equipment; earthing arrangements, Protective conductors, equipotential bonding conductors
DIN/VDE 0100 pt.551	IEC 64(CO)212	Erection of power installations with nominal voltages up to 1000V; Selection and erection of equipment, low voltage generating-sets
DIN/VDE 0100 pt.560	IEC 364-5-56	Erection of power installations with nominal voltages up to 1000V; Selection and erection of equipment, supplies for safety services
DIN/VDE 0100 pt. 610	IEC 364-6-61	Erection of power installations with rated voltages up to 1000V; Initial verification
DIN/VDE 0100 pt. 725		Erection of power installations with rated voltages up to 1000V; Auxiliary circuits
DIN/VDE 0102		Short-circuit current calculation in three-phase AC systems

DIN/VDE 0106 pt. 1	IEC 536	Protection against electric shock; classification of electrical and electronic equipment
DIN/VDE 0108 pt. 1		Power installation and safety power supply in communal facilities;General
DIN/VDE 0108 pt. 2		Power installation and safety power supply in communal facilities;
DIN/VDE 0108 pt. 4		Power installation and safety power supply in communal facilities;
DIN/VDE 0110 pt. 1	IEC 664	Insulation co-ordination for equipment within low-voltage systems; fundamental requirements
DIN/VDE 0160		Electronic equipment for use in electrical power installation and their assembly into electrical installations
DIN/VDE 0298 pt. 4	IEC 364-5-523	Application of cables and cords in power installations; recommended values for current carrying capacity for sheathed and non-sheathed cables for fixed wirings, flexible cables and cords
DIN/VDE 0470 pt. 1	IEC 529 EN 60529	Degrees of protection provided by enclosures
DIN/VDE 0530 pt. 1	IEC 34-1	Rotating electrical machines; rating and performance
DIN/VDE 0530 pt. 2	IEC 34-2 IEC 34-2A	Rotating electrical machines; methods for determining losses and efficiency
DIN/VDE 0530 pt. 3		Rotating electrical machines; specific requirements for turbine-type synchronous machines
DIN/VDE 0530 pt. 5		Rotating electrical machines; classification of degrees of protection provided by enclosures for rotating machinery
DIN/VDE 0530 pt. 9		Rotating electrical machines; noise limits
DIN/VDE 0558 pt. 1	IEC 146	Semiconductor converters; general specifications and particular specifications for line-commutated converters
DIN/VDE 0660 pt. 500	IEC 439 EN 60439-1	Switchgear and controlgear; low-voltage switchgear and controlgear assemblies
DIN/VDE 0848 pt. 1		Hazards from electromagnetic fields, methods for measurement and calculation
DIN ISO 2373	IEC 34-14	Rotating electrical machines; mechanical vibrations of certain machines with shaft heights 56 mm and higher; measurement, evaluation and limits of the vibration severity
VBG 4		Electrical equipment and installations

4.0 SYSTEM DESIGN

The complete system shall be of 440V, 3 phase, 0.8 to 1.0 power factor, 50/60Hz Frequency Converter set complete with all necessary switchgears and shall be a fully digital controlled system. Starting, stopping, synchronising and load sharing for a load parallel system shall be fully automatic except for the first Converter which is to be manually started.

The entire system shall be fully automatic parallel load sharing and load dependent. The first Converter to be started can be chosen from any of the two units. Thereafter the second Converter will be automatically started should the load reach the level as further described herein.

Every Converter set shall be able to communicate with each other via digital Parallel Communication Bus and an Analogue Interface. Each Converter set shall be programmed to know the availability, load and hour-run of every other Converter and can therefore decide for themselves whether they are to be the next unit to be switched on or off based on their knowledge of each other's hour-run and the total load on the system.

Once any of the converter decides to switched on, the internal software logic for that particular Converter will ensure that the output voltage and frequency are matched with that of the output bus before closing its output breaker.

The system load shall be monitored constantly by all Frequency Converters via the Parallel Communication Bus and the decision to switch in another unit shall be load dependant as follows :-

If(system load)/(no. of units running)	= > 70% full load for one unit	…..then switch next unit ON
If(system load)/(no. of units running)	= < 63% full load for one unit	….....then switch next unit OFF

To avoid responses to transient load changes, the next unit to switch on shall be after a 30 second delay and the next unit to be switch off shall be after a 3 minute delay. These delays shall be programmed into the logic.

The next Converter to switch on shall always be the one with the lowest hour-run and which is available. If there are two Converters with the same hour-run, the next one to be switch on shall be the one with the lowest Remote

Device Control (RDC) Address and which is also available for operation.

The system shall automatically shut down if no load is connected to the systems after a 30 minute period.

Any one of the converters shall be capable of being isolated from the group even with the system running for maintenance or fault clearance.

5.0 INPUT CHARACTERISTIC

The FC shall be designed to operate with the following input characteristic.

5.1	Voltage	:	415V AC +10% -20%, 3 phase
5.2	Frequency	:	50Hz +/-5%
5.3	Power factor	:	0.8
5.4	Thyristor for input rectifier	:	12
5.5	Starting Current	:	< 50% of nominal input current
5.7	Input current THD	:	< 11%

6.0 OUTPUT CHARACTERISTIC

Each Frequency Converter shall be designed to carry its rated load continuously with the following output characteristic.

6.1	Rated power	:	as mentioned in BQ or drawings
6.2	Rated active power	:	as mentioned in BQ or drawings

6.3	Voltage	:	440 V, 3 phase
6.4	Voltage tolerance	:	+/- 1% static, for symmetrical load +/- 5% dynamic, for 50% load change
6.5	Frequency	:	60Hz +/- 0.1% static self controlled
6.6	THD	:	< 1.5% for linear load ph-ph < 2.5% ph-N
6.7	Overload	:	150% for 2 minutes 125% for 10 minutes 110% for 1 hour
6.8	Short circuit current	:	1400%
6.9	Unbalance load capacity	:	100%
6.10	Crest factor	:	10 : 1
6.11	Radio interference suppression	:	VDE 0875 Level N
6.12	Noise level	:	< 78dB(A) at 1 metre
6.13	Phase angle displacement	:	120deg +/- 1deg for balance load 120deg +/- 3deg for 50% unbalance load
6.14	Short circuit capabilities	:	14 times of nominal rating
6.15	Efficiency	:	> 90%

7.0 RECTIFIER

7.1 The rectifier shall be a 12 pulse rectifier. All rectifier control functions are carried out digitally by the rectifier controller board.

7.2 The rectifier controller board shall be interchangeable with the generator controller board and the thyristor controller board.

7.3 The rectifier shall be incorporated with a link circuit voltage regulator. The link circuit voltage regulator shall provide the D.C. link with a constant link circuit voltage of not more than 500V.

7.4 The rectifier shall be incorporated with a power walk in facility. This arrangement is to provide transient build up for the voltage regulator and prevent sudden loading of the mains or diesel system.

7.5 A differential current regulator shall be installed in order to obtain uniform current distribution of the rectifiers for the 12 pulse design.

8.0 INVERTER

8.1 The inverter shall consist of power thyristors and its module shall be withdrawable for ease of maintenance. No transistors shall be used.

8.2 The static converter shall operate as a machine-commutated inverter which draws the active power required to run the motor-generator from the Dc link circuit. The reactive power required for converter control and commutation is supplied by the synchronous motor. Speed control is via the generator controller board and trigger pulse control via the inverter control board.

8.3 As the motor is run at constant voltage, thyristors triggering shall be directly from the terminal voltage of the motor. The reactive power up-take of the system can be controlled in relation to the load by controlling

the thyristor turn-on phase. The control circuit shall be designed as a speed control loop with secondary current control.
For improved dynamic frequency/speed control the active component of the generator current is fed to the current control circuit as a disturbance variable. Apart from an excellent dynamic response, the secondary current control circuit also offers fast current limiting to protect the entire system. The phase control shall be automatically switched off in the event of excessive frequency deviation (+/- 0.3 Hz) in the mains supply. The set then shall run freely at nominal speed.

8.4 A pony motor shall be provided for starting the synchronous motor-generator and shall be mounted on the same shaft of the motor-generator. During starting, the triggering of the thyristors remains disabled until the motor-generator has reached its rated speed of 1800 RPM and the rated voltage appears at the motor and inverter. The triggering is then enabled and the inverter supplies power to the motor and the pony motor is disconnected.

9.0 MOTOR GENERATOR

9.1 The motor generator shall comprised of a synchronous motor and synchronous generator mounted on a single shaft to minimise mechanical losses in order to increase the efficiency of the machine. The rotor shall be DC exited and carries a damper winding to minimise current harmonics feeding back to the mains.

9.2 The motor generator shall be designed in such a way to reduce space requirement. It shall be in vertical design and housed in a single cubicle together with all associated switchgears and controlgears.

9.3 The complete motor generator unit shall be statically and dynamically balance to reduce any residual vibrations.

9.4 Starting of the motor-generator shall be by a pony motor mounted on the same shaft of the motor-generator set. The motor generator starting current shall be not more than the nominal input current.

9.5 Insulation shall be Class F and temperature rise shall be limited to Class F.

9.6 It shall be able to sustain a short circuit current of 14 times the full load current for a maximum of 10 m second to operate protective device.

9.7 The generator output shall be a 3 phase, 4 wire, wye with grounded neutral. The grounded neutral shall be solidly tied to the motor generator frame.

10.0 OUTPUT/PARALLEL OPERATION

10.1 Output of the Frequency Converter set shall be controlled by the Generator controller board which also controls the outgoing motorised circuit breaker and the parallel operation.

10.2 The Frequency Converter offered shall be able to be run in power parallel or load dependant operation without any limitations to the number of units.

11.0 INSTRUMENTATION AND CONTROLS

11.1 The frequency converter shall be incorporated with an user friendly state of the art 5.7 inches colour display touch panel for control. The touch panel shall incorporate as minimum the following indications and instrumentation mentioned hereafter:-
Mimic diagram display with clear symbols to allow all operating status to be seen at a glance.
Load bar chart.
Detailed information on the operating states of the frequency converter.
Visualisation system for rapid capture of all system parameters such as current, voltage, frequency and phase.
Interactive communication with built-in safety routines to prevent any unintentional switching operations.
Reset button.
Emergency off button

The contractor shall provide full information of the control panel.

11.2 The Frequency Converter set shall be equipped with an event memory which is able to record any event that occurs within the Converter unit. This is to provide support for the service engineer during malfunctions and thus reduce down time. The event memory shall have at least the capability to record 1200 events on a first in first out basis.

11.3 The Frequency Converter set shall incorporate 2 analogue channel and 3 digital channel Digital Storage Oscilloscope (DSO) for displaying measured and stored graphs within the Frequency Converter set. The momentary value and waveform of the current and voltage can be taken from the DSO via the RS 485 and displayed on a PC or laptop.

11.4 The Frequency Converter set shall be capable of being connected via a modem 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.

12.0 TESTING & COMMISSIONING

12.1 Prior to delivery and installation at site the following test shall be conducted on the Frequency Converter set at the manufacturer's works in the presence of the supervising officer or his representatives. The following test apart from the routine manufacturer's quality assurance test will have to be performed.

a) 100% load test
b) 100% unbalance load test
c) short circuit test
d) overload test
e) function test on all control

12.2 Certified test result as per above shall be submitted.

13.0 COMMISSIONING TEST

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

14.0 SERVICE AND MAINTENANCE

14.1 Under this contract, the Contractor shall be required to provide and carry out comprehensive service and maintenance of the Frequency Converter during the Defects Liability Period herein stated as a minimum requirement. A proposed schedule of comprehensive service and maintenance as per Appendix B (Schedule of Comprehensive and Maintenance) shall be submitted with this tender. The contractor shall also quote the price for the Comprehensive Service and Maintenance for five years after Defects Liability. The price quoted shall not be part of the tender but the Government reserves the right to signed a maintenance contract with the contractor or the Local agent based on the price quoted.

14.2 The contractor shall supply all the consumable materials as and when required for the comprehensive service and maintenance of the Frequency Converter system.

14.3 The contractor shall provide a service and maintenance record book for each Converter being maintained. Details of the service maintenance and repairs carried out shall be entered by the contractor into this book for checking purposes.

14.4 In addition, a full report in duplicate of each service and maintenance carried out and the condition of the Converter system shall be forwarded to the S. O's Representative.

15.0 RECOMMENDED SPARES

15.1 The Contractor shall complete Appendix C (Schedule of Recommended Spares) to this specifications and submit together with his tender. The list should contain the price and delivery period of each item of the spares recommended. The tenderer shall also recommend the quantity for each item to be stored for purpose of maintenance.

15.2 The prices of this spares shall not be included in the total Tender Price and the purchase of all or any of this spares listed shall be at the option of the S. O's Representatives.

15.3 These prices shall be valid for acceptance up to the end of the Defects Liability Period.

16.0 ITEMS TO BE SUPPLIED ON COMPLETION

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

a) Site plan
b) Installation of the FC
c) Location layout of earthing points with respect to the Converter location
d) Layout and schematic control wiring of the Converter control panel
e) Any other drawings deemed necessary by the S.O. 's

16.2 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 :

16.3 Each of above four sets of prints shall be filed in a stiff cover ring file together with the manuals stated hereinafter.

16.4 In addition to the above four sets prints submitted, one set of the following prints shall be framed

SCHEDULE "A" (SCHEDULE OF TECHNICAL DATA AND GUARANTEE)

NOTE : Certified test result for the FC shall be submitted together with tender document.

1.0	GENERAL	:
1.1	Brand	: _____
1.2	Manufacturer	: _____
1.3	Local Agent	: _____
1.4	Model	: _____
1.5	System	: _____
1.6	Standard of Compliance	: _____
1.7	Active Power	: _____kW (At 0.8 power factor)
1.8	Front/side access only	: _____yes/no
1.9	No. of events recorded	: _____
1.10	Noise level at 1 metre	: _____dB(A)
1.11	Efficiency	: _____% at full load
		: _____% at 75% load
		: _____% at 50% load
		: _____% at 25% load
1.12	Protection	: IP _____
1.13	Cooling system	: IC _____MG Fan / Other
1.14	No. of fans for ventilation	: _____
1.15	Type of fan	: _____
1.16	Air flow	: _____m3/h
1.17	Maximum back pressure	: _____Pa
1.18	Losses at nominal power	: _____Kw
1.19	Max. heat dissipation	: _____Kw
1.20	Special treatment	: _____
		_____
		_____
1.21	Dimension	: _____mm (width)
		: _____mm (depth)
		: _____mm (height)
1.22	Weight	: _____Kg
1.23	Floor loading	: _____Kg/m sq.
1.24	Colour	: _____
1.25	Type of controls	: _____
2.0	MOTOR GENERATOR	
2.1	Rating	: _____kW (main motor)
		: _____kVA (generator)
2.2	Type of Motor	: _____
2.3	Type of Generator	: _____
2.4	Construction/Arrangement	: _____
		_____
		_____
2.5	MG Configuration	: _____
2.6	Windings	: _____
2.7	Damper winding	: _____

2.8	Speed	: _____rpm
2.9	Exciter	: _____
2.10	Internal Impedance	: _____Ohm
2.11	Type of regulator	: _____
2.12	Motor Voltage	: _____V
2.13	Motor Current	: _____A
2.14	Starting Current	: _____A
2.15	Starting method	: _____
2.16	Motor Frequency	: _____Hz
2.17	Generator Voltage	: _____V
2.18	Generator Current	: _____A
2.19	Generator Frequency	: _____Hz
2.20	No. of phase	: _____
2.21	Connection	: _____
2.22	Excitation volt	: _____VDC
2.23	Excitation current	: _____A
2.24	Short circuit capabilities	: _____%
2.25	Starting system	: _____
2.26	Insulation	: Class _____
2.27	Temperature rise	: Class _____
2.28	No. of bearings/type	: _____
3.0	RECTIFIER /INVERTER (MAINS INPUT)	
3.1	Voltage	: _____V
3.2	Current (at –10% voltage)	: _____A
3.3	Voltage Tolerance	: +/- _____% static, balance load : +/- _____% dynamic, 50% load change
3.4	Frequency	: _____Hz
3.5	Frequency tolerance	: _____%
3.6	THD (Input current)	: _____%
3.7	Rectifier, no. of thyristors	: _____
3.8	Type of inverter	: _____
3.9	Commutation	: _____
4.0	CONVERTER OUTPUT	
4.1	Power	: _____KVA : _____KW
4.2	Current	: _____A
4.3	Voltage	: _____V
4.4	Voltage adjustment	: _____%
4.5	Voltage regulation (static)	: _____%
4.6	Voltage regulation (dynamic)	: _____% (at 50% load step)
4.7	Response time	: _____ms at 50% load step to +/- 2%
4.8	Frequency	: _____Hz
4.9	Frequency tolerance (static)	: _____%
4.10	Frequency tolerance (dynamic)	: _____%
4.11	Overload	: _____% for 2 minutes : _____% for 10 minutes

		: _____% for 1 hour
4.12	Short Circuit Current	: _____%
4.13	Max. Crest Factor	: _____times nominal
4.14	Phase Angle Displacement	: _____deg +/- ____deg Balanced load
		: _____deg +/- ____deg 50% Unbalanced load
4.15	Unbalanced Load Capabilities	: _____%

5.0 CONTROL PANEL

NOTE : Full information of the control panel shall be submitted together with tender document.

5.1	Touch panel	: _____
5.2	Load indicator	: _____
5.3	Mimic diagram	: _____
5.4	FC on/off push button	: _____
5.5	Memory event	: _____
5.6	No. of potential free contacts	: _____
5.7	Digital storage oscilloscope	: _____
5.8	Logic Signal Analyser	: _____
5.9	Transmission via modem	: _____

APPENDIX "B" (SCHEDULE OF COMPREHENSIVE SERVICE AND MAINTENANCE)

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	DESCRIPTION	FREQUENCY DURING D. L. P

COMPREHENSIVE SERVICE AND MAINTENANCE SCHEDULE OF PRICES

Comprehensive maintenance for first year after D. L. P RM_____/annum

Comprehensive maintenance for second year after D. L. P RM_____/annum

Comprehensive maintenance for third year after D. L. P RM_____/annum

Comprehensive maintenance for forth year after D. L. P RM_____/annum

Comprehensive maintenance for fifth year after D. L. P RM_____/annum

NOTE : The Comprehensive service and maintenance price quoted shall not be part of the tender price but the government reserves the right to signed a maintenance contract based on the price quoted.

_____ _____

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APPENDIX "C" (SCHEDULE OF RECOMMENDED SPARES)

The tenderer shall submit this schedule of recommended spares recommended by him. The prices for this spares shall not be included in the total tender price and the purchase of all or any of the spares listed shall be 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.

DESCRIPTION	QUANTITY	UNIT RATE	PRICE

Delivery Period : weeks

_____ _____

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