

# TENDER ENQUIRY

Appendix-I

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## TECHNICAL SPECIFICATION OF THE 8 KW PMS MOTOR

### 1.8 ELECTRICAL SPECIFICATION OF 8KW PMS MOTOR

| Sl. | Parameters   | Values  |
|-----|--|---|
| 1.  | Type of motor  | Permanent magnet synchronous motor (PMS) motor  |
| 2.  | Power source for the motor   | Inverter drive  |
| 3.  | Input dc voltage to the drive from the battery   | 120 - 200VDC  |
| 4.  | Number of motor shafts   | Single shaft  |
| 5.  | Number of shaft ends   | One (for drive end only)  |
| 6.  | Rated power output   | 8 kW (minimum) at the output shaft at 150VDC bus to Inverter drive  |
| 7.  | Rated output torque  | 219 Nm at 350 rpm   |
| 8.  | Peak torque  | 255 Nm  |
| 9.  | Duration of operation  | Continuous operation  |
| 10. | Rated shaft speed of the motor   | 350 rpm when 150 VDC (min) is fed to the Power Electronic Drive and under full speed command  |
| 11. | Coupling to the load   | Direct coupling   |
| 12. | Nature of load   | Propeller   |
| 13. | No. Of operational / service cycles  | 15 minimum  |
| 14. | Starting of motor  | The motor is to be started based on START command from OBC. Current must be kept within tolerable limit.  |
| 15. | Running of the motor   | The motor has to be controlled by speed and torque loops in closed loop control   |
| 16. | Acceleration of the motor  | Motor should accelerate to 8kW Shaft power from 0kW within a time span of 5 -6 seconds when fed with 150V DC to the Inverter Drive.                         |
| 17. | Speed variation  | Step-less   |
| 18. | Stability of set speed   | +/- 5 RPM   |
| 19. | Rated motor efficiency   | 92 % (minimum)  |
| 20. | Number of phases   | 3 (minimum)   |
| 21. | Insulation resistance between any live point of the motor with respect to the motor body by a 500V Megger. | 100 Meg. Ohm (minimum)  |
| 22. | Break down voltage for insulation  | 1.5 kV (minimum) for 30 sec (<10 ma)  |
| 23. | Insulation class   | Class C (min)   |
| 24. | Configuration  | Permanent Magnet rotor inside and wound stator outside  |
| 25. | Terminals  | Fixed male terminals on the non-drive end of the motor with matching female sockets on the Inverter Drive side  |
| 26. | Demagnetization  | Should not happen during over load or start up or during accelerating phases. Demagnetization should not happen in any specified operational circumstances. |
| 27. | Stator winding connection  | Star  |
| 28. | Magnets  | High energy rare earth magnets embedded in the rotor for smooth surface.  |
| 29. | Direction of rotation  | CW or CCW as required (when viewed from drive end)  |
| 30. | Winding impregnation   | Vacuum Pressure impregnation as per standards   |
| 31. | Motor speed control  | By voltage control using pulse width modulation and using torque & speed loops in closed loop mode.   |
| 32. | Motor cooling  | Natural cooling   |



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## TENDER ENQUIRY

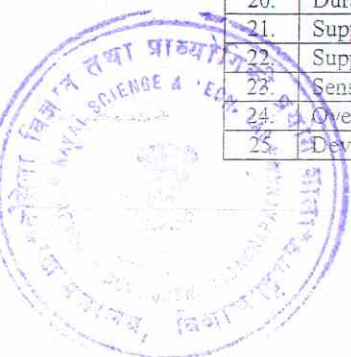
Appendix-I

## 2.0 MECHANICAL SPECIFICATION OF 8 KW PMS MOTOR

| Sl. | Parameters                                     | Values   |
|-----|--|--|
| 1.  | Motor mounting                                 | By horizontal mounting lugs in the end shields   |
| 2.  | Rotor mounting                                 | Bearing supported  |
| 3.  | Maximum length of the motor                    | As per guidance drg. HEAUV/EE/8K/GA/01   |
| 4.  | Maximum diameter of the motor                  | As per guidance drg. HEAUV/EE/8K/GA/01   |
| 5.  | Shaft end configuration                        | Involute spline (internal)   |
| 6.  | Spline configuration                           | As per NSTL drg. HEAUV/EE/8K/GA/01   |
| 7.  | Maximum weight of the motor                    | 50kg (excluding the motor shell)   |
| 8.  | Level of dynamic balancing for                 | G1.0 (for rotor)   |
| 9.  | Location of the center of gravity of the motor | To be indicated by the firm  |
| 10. | Type of bearings                               | Double-shielded life lubricated bearings of ultra low-noise type (bearing service life to be indicated by the firm)      |
| 11. | Storage condition                              | To be specified by the firm  |
| 12. | Space for routing of signal cables             | Provision for three 15mm diameter cables have to be provided along the motor outer periphery from NDE to DE of the motor |
| 13. | Motor shell                                    | As per Dwg. HEAUV/EE/8K/GA/01  |

## 3.0 ELECTRICAL SPECIFICATION OF THE INVERTER DRIVE

| Sl. | Parameters  | Values  |
|-----|---|---|
| 1.  | Control strategy  | Close loop control with PWM technique (with torque & speed loops)   |
| 2.  | Power source for the power electronic drive   | Battery   |
| 3.  | Rated input voltage to the power electronic drive   | 120 – 200 VDC   |
| 4.  | Power electronic drive power output   | As required to drive the above 8 kW motor   |
| 5.  | Current that the battery is required to supply to the power electronic drive for getting motor output of 8 kW | To be specified by the firm. However, the current must not exceed 80A (max.) For 5 sec. At 150 VDC  |
| 6.  | O/P voltage variation (low to high & high to low)   | 0 – 100 % & 100 % to 0 by PWM   |
| 7.  | Nature of control   | DSP based power electronic drive  |
| 8.  | Nature of load  | Above PMS motor   |
| 9.  | Type of devices   | Case insulated IGBTs  |
| 10. | Number of power electronic drive phases   | Three   |
| 11. | Quadrant of operation   | Forward motoring  |
| 12. | Auxiliary supply for the power electronic drive electronics   | 65VDC Nominal battery tapping with operating range of 50VDC to 110VDC   |
| 13. | Insulation resistance between any live point and shell body   | 100 mega ohm at RH : 85 %, Temperature 40 deg. C  |
| 14. | Electronics assembly  | Modular type using SMDs or SOCs   |
| 15. | Speed commands from on-board computer   | MIL1553B communication using std. DDC   |
| 16. | Running of motor  | During or after the initial start-up phase, speed command may be issued to the power electronic drive over 1553B Bus. Once received, the corresponding speed value is to be maintained by the power electronic drive. A programmable option to implement a predefined running sequence post the initial start-up, phase also has to be provided as part of an optional logic. |
| 17. | Deceleration time of the motor  | To be specified for by the firm. But reverse voltage generation into the DC bus is not acceptable.  |
| 18. | Condition for shutdown  | Power electronic drive needs to shut down with alarm indication on 1553B Bus or internal fault.   |
| 19. | Power electronic drive efficiency at all load condition   | 94-96 %   |
| 20. | Duration of operation   | Continuous operation  |
| 21. | Suppression of harmonics in input current   | By using suitable filter capacitors   |
| 22. | Suppression of harmonics in input current   | By using suitable filter capacitors   |
| 23. | Sensing of motor current, voltage   | By non-contact hall-effect sensors  |
| 24. | Overload capacity   | Not more than 110% of FL for 5 sec  |
| 25. | Device heat sinking   | Shell integrated  |





# TENDER ENQUIRY

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## 3.0 ELECTRICAL SPECIFICATION OF THE INVERTER DRIVE (CONTINUED...)

| Sl. | Parameters   | Values  |
|-----|--|---|
| 26. | Allowable temperature rise of the device case  | To be designed considering sea-water temperature as 27° C   |
| 27. | Shielding against emission   | To be provided for radiated and conducted noises.   |
| 28. | Class of insulation  | Class- H  |
| 29. | Internal connection  | To be provided with proper routing, securing and with identification numbers. Power connections are to be made with durable material with proper protective & long-lasting coating. Bi-metallic connections must be avoided.  |
| 30. | Insulation resistance between any live point and shell body  | > 100 mega ohms with a 500 v megger under normal local climatic condition prevailing at the tropical coastal area of India  |
| 31. | Electronic assembly  | Modular type using SMDs   |
| 32. | Switching frequency  | To be chosen suitably not exceeding 16 kHz to achieve:<br>-high overall efficiency<br>-low switching loss   |
| 33. | Signal communication within the power electronic drive   | By opto-coupled signals   |
| 34. | DC link capacitors   | To be provided for filtering in the input.  |
| 35. | Self diagnostic test   | Diagnostic mode option shall be provided for conducting diagnostics and NVRAM data download   |
| 36. | Recording for off-line analysis  | Input voltage, input current, duty cycle in %age, speed of the motor, on-board computer command echo, alarm conditions, contactor status have to be sent on MIL1553B BUS for recording. The same data has to be recorded internally by the power electronic drive by its NVRAM. The data sampling rate has to be 100msec minimum. |
| 37. | Watchdog timer   | To be provided in the control logic   |
| 38. | Flash memory   | To be provided for the DSP programming  |
| 39. | Test programme /simulator  | To be supplied by the firm with VB based GUI interface. The information in connection with this has to be provided  |
| 40. | Provision of<br>a). 750VDC, 150 ADC latching contactor<br>b). 20A, 100VDC non-latching relay       | To be provided by the firm in the power electronic drive. Item (a) will be used for main DC bus battery braking and making and item (b) will be used for braking and making of electronics current  |
| 41. | Conditions against which the system should be tolerant and issue alarms in out of range conditions | 1. Di/dt & short circuit by vce(sat) monitoring<br>2. Dv/dt by snubber<br>3. DC under voltage<br>4. DC over voltage<br>5. Over current<br>6. Over temperature of winding and IGBTs  |
| 42. | Type of commands from OBC  | Actions of power electronic drive   |
|     | A) power electronic drive 'START' by OBC   | Power electronic drive will start the motor and controls its speed as per the speed command from OBC  |
|     | B) power electronic drive 'STOP' by OBC  | Power electronic drive remains ON but does not execute speed command  |
|     | C) Speed command by OBC  | Power electronic drive executes speed variation as per commands if (b) is not present   |
| 43. | Modes of power electronic drive operation  |   |
|     | A) power electronic drive in normal mode   | A) as explained at sl. 42 above   |
|     | B) power electronic drive's internal fault   | B) shutdown and 'fault' intimation to OBC   |
|     | Connection to the external systems   | By MIL grade circular connectors and BJT77 connectors.  |
| 44. | Shielding  | Mu-metal shielding as required  |

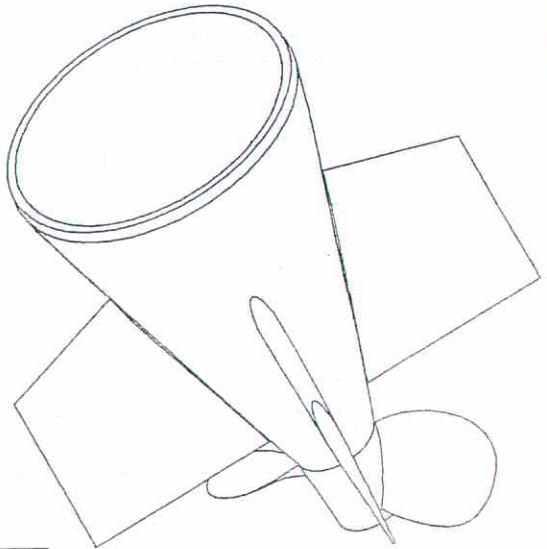
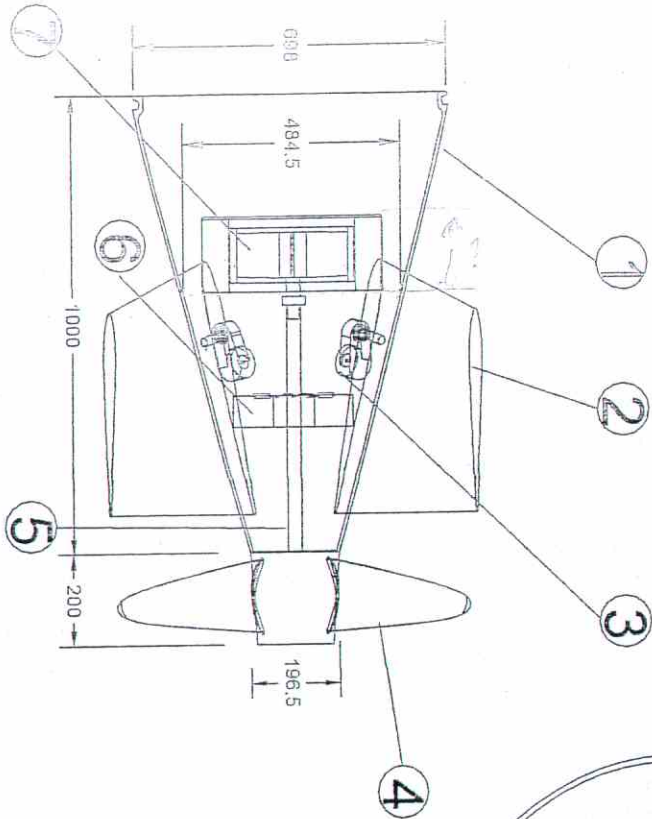


# TENDER ENQUIRY

(2/2)

DRG.No. HEAVY/EE/BK/GA/01

ALL DIMENSIONS ARE IN mm



| Details                  |
|--------------------------|
| 1 Propulsion Comp. shell |
| 2 All Movable Fins       |
| 3 Actuators              |
| 4 Propeller              |
| 5 Propulsion Shaft       |
| 6 Servo Controller       |
| 7 PMS Motor              |

| P. No.   | DRG.No.    | DESCRIPTION | QTY       | REMARKS |
|--|------------|-------------|-----------|---------|
| ALL SHARP EDGES AND CORNERS TO BE ROUNDED OFF<br>THREADS TO CONFORM TO IS:4218 |            |             |           |         |
| DGN  | DATE       | NAME        | MATERIAL: |         |
| DRN  | 16/10/2024 | Asst. Dir.  | -         |         |
| CHD  | 16/10/2024 | Asst. Dir.  | -         |         |
| TRD  | 16/10/2024 | Asst. Dir.  | -         |         |
| COMP   | 16/10/2024 | Asst. Dir.  | -         |         |
| SCALE :- 1:10  |            |             |           |         |
| Schematic Diagram of Propulsion Comp.  |            |             |           |         |
| DRG. NOT TO BE SCALED  |            |             |           |         |
| DATE   |            |             |           |         |

PERTAINS TO:

| R.No. | DATE | ZONE | BRIEF RECORD | INITIALS |
|-------|------|------|--------------|----------|
|       |      |      |              |          |
|       |      |      |              |          |
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|       |      |      |              |          |





## COMMERCIAL / TECHNO-COMMERCIAL TERMS

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### 1.0 LIST OF DELIVERABLES

#### 1.1 The contractor will supply the following items to NSTL:

| Sl. no. | Description of Item               | Qty.    |
|---------|-----------------------------------|---------|
| 1.      | 8kW PMS Motor with Inverter Drive | 07 nos. |
| 2.      | Manufacturing drawings            | 01 set. |

#### 1.2 Free issue of material, if any: Nil

### 2.0 DELIVERY SCHEDULE

Delivery schedule is planned tentatively as given below.

| Sl.No. | Detailed of activities                               | Duration of each activities | Total duration |
|--------|--|-----------------------------|----------------|
| 1      | Supply order / contract                              | ---                         | Start          |
| 2      | Fabrication of Motor                                 | 4 Months                    | 4 Months       |
| 3      | Fabrication of Controller                            | 4 Month                     |                |
| 4      | Assembly of Motor and controller                     | 1 Month                     | 5 Months       |
| 5      | Functional test, load test and acceptance as per ATP | 1 Month                     | 6 Months       |

07 systems shall be supplied in staggered manner and payment will be made on pro-rata.

#### Note:

- Firm should have prior proven experience of making MIL application grade similar kind of Motors
- Firm should be an Indian OEM and have prior proven experience of developing high power BLDC/PMS Motors of >200Nm torque minimum
- Firm should have a prior proven experience of developing high power vector control drives
- Firm should be able to deliver Motors in 6 Months
- The firm shall have in-house design know-how. Documentary evidence in support of such claim shall be attached with techno-commercial bid.
- Pre-bid meeting will be arranged at NSTL one week before due date for the submission of quotation
- ETs and ESS will be firm's scope
- Non-compliance to the any of above terms, firm's offers will not be considered.

### 3.0 Miscellaneous (Technical)

| Sl. No. | Description                    | Details   |
|---------|--------------------------------|---|
| 1.      | Test equipments and facilities | The firm shall furnish and maintain all necessary test equipments and facilities and shall provide personnel for performing necessary tests at firm's premises. The test equipments shall be of sufficient accuracy and calibrated by a reputed authority approved by the Government  |
| 2.      | Compliance                     | Each of the specifications along with the parametric values as indicated in Appendix-I must be commented upon categorically in respect of acceptance / deviation. <u>Incomplete quotation will not be considered.</u><br>Compliance once confirmed becomes binding on part of the firm and no request for dilution / deviation of any of the specified parametric values will be entertained. Non-compliance in respect of any of the parametric values as indicated in appendix-I, II & III, if found existing in the first set of Electrical 8kW PMS Motor with Inverter Drive during conduct of FAT, and if the contract fails to rectify the same, NSTL will reserve the right to cancel the order. |
| 3.      | Supply of spares               | The contractor has to support and supply necessary spare components after warranty period on payment as and when required by NSTL for maintenance of the motor and drive.   |
| 4.      | FAT intimation                 | The contractor has to send intimation to NSTL regarding readiness for FAT at least one week in advance.   |
| 5.      | Identification number          | The contractor has to assign part no. / model no. for the Electrical 8kW PMS Motor with Inverter Drive and all the components used in them. A detailed bill of materials is to be furnished as part of the documentation. This is mandatory for future procurement.   |
| 6.      | Application-                   | The contractor is required to supply all the application-specific tooling, dies etc.  |

