



**BHARAT HEAVY ELECTRICALS LIMITED**  
HEAVY POWER EQUIPMENT PLANT,  
RAMACHANDRAPURAM  
HYDERABAD - 502032.

**TC65659**

**REV NO: 00**

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## **1. GENERAL:**

### **1.1. Scope:**

This specification covers design, manufacturing, assembling & testing of INTERFACE/GOVERNOR PANEL. The scope of supply envisaged in general with the following items mounted on the panel.

- a) Dual Redundant Electronic Governor with Panel Mount HMI - 1 no (Vendor scope)
- b) Speed Measuring Units - 6 nos (Vendor scope)
- c) 24 V DC Redundant 10A power supply (For Actuator, etc) - 1 no. (Vendor scope)
- d) Panel accessories like illumination tube lights, door limit switch, Foundation bolts, Cable glands etc.

**1.2.** This Specification gives the requirement of Dual Redundant Electronic Governor, Electronic speed measuring units etc.. for steam turbine generator of marine application. The scope of bidder shall include Design, Selection, Manufacture, assembly, Testing, Packing, Supply, documentation, training and supervision of commissioning of complete Electronic Governor control and Electronic speed measuring units package for Steam Turbine.

**1.3.** Bidder is solely responsible for engineering, procurement, and supply with documentation, submission of drawings/ datasheets, and dispatch the material along with O&M manuals.

**1.4.** It is the responsibility of the vendor for engineering of the complete Electronic Governor Control and Electronic speed measuring units package along with detailed Bill of material and model selection. If there is shortage or mismatch of any items identified at any stage up to commissioning the complete Electronic Governor and Electronic speed measuring units package, vendor shall rectify/replace/supply the items without any commercial or delivery implications.

## **2. TECHNICAL REQUIREMENTS:**

### **2.1. Electronic Governor**

- a) The electronic governor system shall Dual Redundant type.
- b) The number of teeth on pole wheel is 40.
- c) It should be possible to program the electronic governor to operate the steam turbine from zero speed to rated speed with ramp rates, idle speeds, critical speeds for Hot, Cold and Warm conditions as per the start up curves to be furnished during detailed engineering.
- d) The governing valve characteristics shall be programmed in the Electronic governor for linearization.
- e) The electronic governor should be capable of operating in Auto & manual modes.
- f) The electronic governor shall be capable of operating in Speed control/Frequency control, load control and inlet pressure control.
- g) Signal isolators to be considered as per the requirement.
- h) Panel Mount HMI shall be considered.
- i) Governor IO list is attached.

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**2.2. Electronic speed measuring units:**

- a) Three numbers of Electronic speed measuring units (for speed measurement) shall be supplied and assembled in panel. Make shall be Braun (Emecon) & Model number shall be D224.11U3M-G3.
- b) Three numbers of Electronic speed measuring units (for speed measurement & direction of rotation) shall be supplied and assembled in panel. Make shall be Braun (Emecon) & Model number shall be D225.11U3M-G3.
- c) For each speed measuring unit one number repeater to be considered. Speed analog value shall be duplicated with repeater to customer DCS.
- d) Three number of digital contacts for direction of rotation shall be duplicated in panel and six numbers shall be hooked to customer DCS.

**2.3. Speed Probes:**

- a) Three numbers of Speed probes of model A5S09T94-5M(Braun make) is supplied by BHEL for hooking to Electronic speed measuring units (for speed measurement) of model number D224.11U3MG3. If offered governor does not accepts Hall effect sensor or 4-20mA as input, required speed probes(6(3 main and 3 spare) with matching of thread details shall be supplied by panel vendor.
- b) Three numbers of Speed probes of model A5S32T94-5M (Braun make) is supplied by BHEL for hooking to Electronic speed measuring units (for speed measurement & direction of rotation) of model number D225.11U3M-G3. This is for information.

**3. Design & Fabrication:**

The panel accessories shall be designed and fabricated in accordance with the applicable Marine standards of practices. The panel with all the hardware shall meet the requirements stipulated in this specification. The required customer environmental specifications attached as annexure. The complete panel with assembly of all components shall meet the customer environmental specifications attached as annexure.

**4. Mechanical Construction:**

- 4.1 Maximum allowed panel dimension is 1450(H)X650(L)X500(D)mm.
- 4.2 Panel shall be made out of SS316 and shall meet all customer environmental specifications.
- 4.3 Panel shall have bottom entry with removable gland plates for all the power/ control/ signal cables. Cable glands are in panel supplier's scope. (Size 1 1/2"ET-30Nos. & 1"ET-25Nos.) Cable OD sizes shall be furnished during detailed engineering. Cable gland material shall be SS316 and gland shall be provided with check nuts.
- 4.4 Lifting eyebolts shall be provided for each panel.

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4.5 The panel shall confirm to IP 23 as minimum.

**5. Panel Layout:**

Generally the equipment layout shall be carried out keeping in view the following:

- a) Functional requirements
- b) Aesthetics
- c) Utilization of space
- d) Accessibility & ease of maintenance

**6. Painting:**

6.1. As per customer environmental specifications & shall be discussed with customer after award of PO.

**7. Electrical System:**

**7.1. General:**

- a) All items of 1(a), 1(b), 1(c) and 1(d) shall be duly wired to terminal strips within the panel.
- b) All wiring shall be carried out with PVC 1100V grade single core multistrand copper conductor. The conductor cross section shall be 1 Sq. mm.
- c) All wiring shall be routed in PVC troughs (to the extent possible). No trough shall be more than 70% full.
- d) Open terminals shall generally be avoided. Terminal strips shall be of Phoenix/Wago' or equivalent type.
- e) Cooling fans shall be provided.
- f) Panel shall be provided with ample lighting inside the panel in addition to the two-hand lamp outlet at convenient points. Doors shall be provided with door switch for inside lighting. Double leafed type doors shall be provided with lock and key.
- g) At least 10% spare space, 20% spare terminals, 20% additional power feeders each provided with Switch fuse unit, 20 % spare cable entry points shall be provided.
- h) Wiring Colour code shall be as follows:
 

1) Power supply hot	- Red
2) Power supply neutral	- Black
3) Ground	- Green
4) Signal (non-IS)	- Orange

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5) Control & Interlock - Yellow

- i) The internal panel layout shall be designed considering proper approach for instruments, terminals and other accessories for maintenance, easy removal and on-line calibration. No instrument, terminals, power distribution box etc. shall be mounted on the panel side plates inside the panel.
- j) It shall be possible to switch off incoming power to panel from inside the Panel.
- k) The panel shall meet customer environmental specifications.
- l) Illumination by florescent lamp by door-operated micro switch shall be provided.

**7.2. Panel Wiring:**

- a) Open terminals shall generally be avoided. Terminal strips shall be of Klippon or equivalent type and shall be mounted in an enclosure.
- b) Wires carrying measurement signals and associated low-level signals shall be routed in separate wire ways and not along with power cables.

**7.3. Power supply:**

**7.3.1.** Panel shall be provided with necessary arrangement for receiving and distribution of following power supplies:

- a) 220 VAC UPS Phase to Phase (Two feeders(redundant) from customer).

**7.3.2.** Redundant 24 V DC power supply shall be derived from 220V AC UPS by vendor. The rating shall be 10 Amps.

**7.3.3.** Spare power supply feeders (20%) shall be provided for each supply.

**7.4. Grounding:**

**7.4.1.** Panel shall be provided with an earthing lug and shall be grounded to an earth bus bar (50X6 ) Cu at two places.

**7.4.2.** Panel vendor to provide a separate insulated instrument circuit ground bus. This shall be electrically isolated from panels, structure, equipment, incoming cable trays, armour etc. All circuit grounds of electronic instruments, shields and ground wires of signals cables, barrier earth etc. shall be

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connected to this ground. This ground shall be typically 8mm thick and 37.5mm wide and of copper. Both ends of this bus bar shall have suitable terminals for further connection to ground electrode provided by purchaser. Creation of multiple grounds in a loop shall be avoided.

**7.5. Identification & Marking:**

- a) Each wire will be identified at both ends with its identification cross ferrules.
- b) All terminals & terminal strips shall be identified by their individual identity.

**8. Name plates:**

- a) All panel-mounted instruments shall be provided with nameplates.
- b) The nameplates shall be made out of black-white-black (1.6mm thick) phenolic laminate.
- c) All equipment in the panel shall be provided with identification.

**9. Documentation:**

Documentation shall be in three steps, during offer submission as response to BHEL Enquiry stage, drawing approval stage, and during delivery of items stage (as-built). All the documents shall be preferably in A4 size shall be used for submission. The documentation aesthetics shall be in line with international standards. Incomplete data, without title blocks, name of the item, document number, revision number, page number etc. will not be acceptable. Bidder shall be responsible for creating, making and arranging complete documentation as per BHEL requirements at all stages.

**9.1. During Technical offer submission: Two copies of following**

- a. GA & Bill of material.
- b. Deviation list as per clause 13 if any.

**9.2. During drawing approval after PO placement: Three (3) copies of the following within 3 weeks of order placement**

- a. Panel General Arrangement and Bill of Material
- b. Electrical Schematics and Wiring diagrams.
- c. Terminal Schedule
- d. Test and Calibration certificates
- e. Schematic drawings of all electronic modules.
- f. Quality plans of individual items.
- g. 3D Model preparation with detailed Engineering.
- h. Analysis of Shock and Vibration requirements of panel.
- i. Analysis of Heat & Air flow (CFD).
- j. Functional and type testing (IP & Environment test etc).
- k. Type test certificates.

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9.3. It is the responsibility of the vendor to review the documents for total compliance with all the BHEL specifications furnished with the inquiry before submitting to BHEL.

9.4. The data sheets will be forwarded by BHEL to Customer/Consultant for approval, comments if any from Customer/Consultant shall be clarified and revise the data sheets if required by the vendor in line with BHEL specifications furnished with the inquiry.

9.5. It is Vendors responsibility for obtaining approvals on drawings/documents from BHEL/Customer within period and dispatch material in time to project site office as per purchase order delivery schedule. Further vendor requests for any clarifications or approvals for delivery extensions etc. are not entertained at any stage.

9.6. 4 Sets of documents shall be submitted for approval. 10 copies of as built hard copies and a softcopy on CD for 9.2(a) through 9.2(d) shall be supplied along with the panel. After the panel is commissioned, one set of as commissioned (commented) copy for 9.2 (a) through 9.2 (c) shall be given to the vendor. Vendor shall incorporate the changes & submit the as-built documents for 9.2 (a) through 9.2 (c) in 4 sets.

**10. Inspection & Testing:**

Vendor shall furnish quality plan for the panel for BHEL approval. BHEL / CUSTOMER shall do final inspection.

- a) The Inspection of panel shall include the following as a minimum.
- b) Dimensional check of the whole panel.
- c) Panel layout, accessibility, mounting connected materials etc.
- d) Checking of wiring.
- e) Completeness in the supply of all the items.
- f) Functional & type tests as per customer environmental specifications.

**11. Packing:**

- a) All the items shall be packed in very good quality packing; the packing shall be such that the items should not be damaged during loading, unloading and transportation, the packing shall be suitable for 6 months of outdoor storage from the date of shipment.
- b) The operation and maintenance manuals of all the items 2 copies shall be included in the packing.
- c) One copy of the packing list shall be fixed on the packing with suitable protection to with stand loading, unloading, transportation and rain.
- d) Adequate amount of silica gel or equivalent shall be provided in each box before dispatch for the removal of moisture till installation.
- e) All safety instructions for storage and handling shall be indicated on external surface of each box.
- f) Each device shall be identified with the following information as a minimum.
  - i. OEM name or identity
  - ii. Manufacturer's model and /or serial number

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iii. Tag no.

The above information shall be in a permanent form on a stainless steel nameplate and permanently attached to the device/equipment.

**12. Commissioning Assistance:**

Commissioning assistance at site for the above equipment shall be provided by vendor for commissioning of the dual redundant electronic governor and speed measuring units.

**13.** Vendor shall confirm clause-wise compliance to this specification. Deviations, if any, shall be brought out giving technical reasons.

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**ANNEXURE-A**

**PRICE SCHEDULE**

**(TO BE FILLED BY VENDOR AND SUBMITTED ALONG WITH OFFER)**

SL. NO.	DESCRIPTION	QTY	PRICE
1.	Complete panel with Dual Redundant Electronic governor, Electronic Speed Measuring Units, etc as per BHEL material code TC9765659016	1 no.	
2.	Commissioning assistance charges (Including travel, boarding and lodging)	12 days(with minimum 4 visits)	
	<b>OPTIONAL</b>		
3.	Recommended spares for 2 years operation Vendor to list out the recommended spares.		Unit prices shall be quoted against each item.

**Notes:**

1. For un-priced bid vendor to fill 'Quoted' for each item and submit.
2. Total (sum of Sl.no.1+2) will be considered for L1 evaluation.
3. The optional item (Sl.no.3) will not be considered for L1 evaluation. However, the same may be ordered in future if required.
4. Vendor shall quote for all the above items any deviation in this regard is not acceptable.

(Signature and stamp of vendor with date)

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**ANNEXURE-B**

**CHECK LIST**

**(TO BE FILLED BY VENDOR AND SUBMITTED ALONG WITH OFFER)**

<b>SL. NO.</b>	<b>DESCRIPTION</b>	<b>Supplier confirmation</b>	<b>Comments / Remarks</b>
1.	Offer for panel with Dual Redundant Electronic governor, Electronic Speed Measuring Units, etc as per BHEL specification TC65659		
2.	Clause wise confirmation/deviation to BHEL specification TC65659 included in the offer.		
3.	Technical catalogues of all the items offered.		
4.	Annexure-A (Filled in un-priced Price schedule) is included in the technical offer.		

(Signature and stamp of vendor with date)

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GOVERNOR IO DETAILS								
SL	Name of Signal	Device	Signal	Signal Type	Schematic	Field Tag No.	Remarks	Power Consumption
<b>ANALOG INPUTS TO GOVERNOR</b>								
1	TAF TURBINE SPEED	SPEED ACTUAL FROM INTERFACE/GOVERNOR PANEL	4-20mA			SE-311A	SPEED ACTUAL	
2	TAF TURBINE SPEED	SPEED ACTUAL FROM INTERFACE/GOVERNOR PANEL	4-20mA			SE-311B	SPEED ACTUAL	
3	TAF TURBINE SPEED	SPEED ACTUAL FROM INTERFACE/GOVERNOR PANEL	4-20mA			SE-311C	SPEED ACTUAL	
4	TA MW INPUT	SIGNAL FROM MPPCS TO INTERFACE/GOVERNOR PANEL	4-20mA			TA MW1	MW ACTUAL	
5	TA MW INPUT	SIGNAL FROM MPPCS TO INTERFACE/GOVERNOR PANEL	4-20mA			TA MW2	MW ACTUAL	
6	FEEDBACK OF POSITION TRANSMITTER-1	POSITION TRANSMITTER	4-20mA			TAT-1-ZT151	POSITION FEEDBACK	
7	FEEDBACK OF POSITION TRANSMITTER-2	POSITION TRANSMITTER	4-20mA			TAT-1-ZT152	POSITION FEEDBACK	
<b>ANALOG OUTPUTS FROM GOVERNOR</b>								
1	POSITION SET VALUE TO SERVO VALVE	SERVO VALVE	4-20mA			TAT-1-AA051(Xw_a)	POSITION SET VALUE	
2	POSITION ACTUAL VALUE TO SERO VALVE	SERVO VALVE	4-20mA			TAT-1-AA051(Xs_a)	POSITION FEEDBACK TO SERVO VALVE	
<b>DIGITAL INPUTS TO GOVERNOR</b>								
1	TAF START SIGNAL AT INTERFACE/GOVERNOR PANEL	HARDWIRED DIGITAL CONTACT FROM INTERFACE/GOVERNOR PANEL TO MPPCS	NO	POTENTIAL FREE		TAF-START		
2	TAF STOP SIGNAL AT INTERFACE/GOVERNOR PANEL	HARDWIRED DIGITAL CONTACT FROM INTERFACE/GOVERNOR PANEL TO MPPCS	NC	POTENTIAL FREE		TAF-STOP		
3	TA SPEED INCREASE COMMAND	HARDWIRED DIGITAL CONTACT FROM TA-LCP TO INTERFACE/GOVERNOR PANEL	NO	POTENTIAL FREE		TAF-SPEED-INC		
4	TA SPEED DECREASE COMMAND	HARDWIRED DIGITAL CONTACT FROM TA-LCP TO INTERFACE/GOVERNOR PANEL	NO	POTENTIAL FREE		TAF-SPEED-DEC		
5	STATUS FREQUENCY UP LIMIT	HARDWIRED DIGITAL CONTACT FROM INTERFACE/GOVERNOR TO TA-LCP PANEL	NO	POTENTIAL FREE		TAF-FRQ-INC		
6	STATUS FREQUENCY LOW LIMIT	HARDWIRED DIGITAL CONTACT FROM INTERFACE/GOVERNOR TO TA-LCP PANEL	NO	POTENTIAL FREE		TAF-FRQ-DEC		
7	SPEED > 90% COMMAND	HARDWIRED DIGITAL CONTACT FROM INTERFACE/GOVERNOR TO TA-LCP PANEL	NO	POTENTIAL FREE		TAF-SP-90%		
8	TA B CLOSED (SECOND TA RUNNING FOR LAOD SHARE)	HARDWIRED DIGITAL CONTACT FROM TA-LCP TO INTERFACE/GOVERNOR PANEL	NC	POTENTIAL FREE		TAF-GB	GENERATOR BREAKER CONTACT	
9	SERVO VALVE FAILURE	SERVO VALVE	NO	POTENTIAL FREE		TAT-1-AA051(Dsv_a)	SERVO VALVE FAILURE FEEDBACK	
10	LIMIT SWITCH 0% POSITION OF STOP VALVE	LIMIT SWITCH	NO	POTENTIAL FREE		TAT-1-CY001	LIMIT SWITCH FEEDBACK	
11	LIMIT SWITCH 100% POSITION OF STOP VALVE	LIMIT SWITCH	NO	POTENTIAL FREE		TAT-1-CY002	LIMIT SWITCH FEEDBACK	
<b>DIGITAL OUTPUTS FROM GOVERNOR</b>								
1	POWER SUPPLY TO START UP SOLENOID VALVE	START UP	NO	24VDC		TAT-1-AA102	WET CONTACT, 24VDC TO BE POWERED FROM INTERFACE/GOVERNOR PANEL	1.8A
2	GOVERNOR TRIP/FAULT STATUS	HARDWIRED DIGITAL CONTACT FROM INTERFACE/GOVERNOR TO TA-LCP PANEL	NO	POTENTIAL FREE		TAF-GOV-FAULT		
<b>24V DC POWER SUPPLY FROM GOVERNOR PANEL</b>								
1	POWER SUPPLY TO POSITION TRANSMITTER-1	POSITION TRANSMITTER	24VDC PS	24VDC		TAT-1-ZT151(PS-Ta)	SUPPLY TO TRANSMITTER	0.3A
2	POWER SUPPLY TO POSITION TRANSMITTER-2	POSITION TRANSMITTER	24VDC PS	24VDC		TAT-1-ZT152(PS-Tb)	SUPPLY TO TRANSMITTER	0.3A
3	POWER SUPPLY TO SERVO VALVE	POSITION TRANSMITTER	24VDC PS	24VDC		TAT-1-AA051(PS-Wa)	SUPPLY TO TRANSMITTER	3A

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## ENVIRONMENTAL SPECIFICATIONS: P82

SL.	Parameter	Value
1	Outside Air	+5°C to +40°C RH : Up to 98%
2	Sea Water Temperature	-2° to 32°C. (a) Maximum temperature during surface operation not exceeding 32°C. (b) No adverse impact in machinery operation and performance due to sharp change in sea water temperature due to diving
3	Sea Water Density	1.015 to 1.030 t/m <sup>3</sup>
4	Internal Conditions	(a) Machinery spaces and hold areas 35-40°C at RH 50-70%. Temperatures can go upto 50°C during emergencies. (b) Living, medical spaces and enclosures 25±1°C at RH 50-70%. Temperatures can go upto 40°C during emergencies. (c) Sanitary spaces 27°C max at RH 50-70%. Temperatures can go upto 40°C during emergencies. (d) 5°C to 50°C during refit/laid up condition.
5	Operating Temperature	+5°C to + 55°C. RH up to 98% JSS 55555. High Temp- Test No 17 Procedure 5 Test Condition G. Low temperature- Test No 20 Procedure 4 Test Condition H with temperature as +5°
6	Equipment Surface Temperature	Maximum surface temperature of an equipment (Control Equipment, Operating Panels, Consoles, Electrical/Electronic Racks, Cabinets etc) should not exceed 43°C (under internal conditions specified at SI 4).  The normal operating skin temperature of the thermal insulation on high temperature equipment/pipes should be between 38-40°C. The thickness of insulation needs to be estimated for the above temperature.  The non-metallic lagging material, if applied for reduction of surface temperature should qualify non-metallic testing at DEBEL as per SI 32 and 33 (Non metallic materials emission test and Non metallic material toxicity & smoke index).
7	Damp Heat	40°C. RH 95%. JSS 55555 Test No.10
8	Internal Pressure	Continuous operability to be ensured in the range 900 – 2200 mbar. Critical equipment related to safety and survivability should specify higher values as specified in their SORs.
9	Heel/List	Constant Heel ± 15° Temporary Heel ± 30° (up to 3 minutes)

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SL.	Parameter	Value
10	Trim	Constant Trim $\pm 15^\circ$ Temporary Trim $\pm 30^\circ$ (up to 3 minutes)
11	Roll	Up to $\pm 45^\circ$ (Period 7 to 9 sec)
12	Pitch	Up to $\pm 15^\circ$ (6 to 8 sec)
13	Hull Distortion	Max. 10.1 mm, relevant only for equipment which are directly attached to the pressure hull and having alignment requirements.
14	Vibrations	Root Mean Square Vibration acceleration levels in 1/3 <sup>rd</sup> octave bands in the frequency range of 5 Hz to 10 kHz with a reference acceleration of $1 \times 10^{-5} \text{ m/sec}^2$ , when measured in three mutually perpendicular directions in accordance with NTD 1212.360050.011 on top of shock absorbers and also at pipelines/flexible inserts should not exceed the straight line joining the values as specified in SORs.  In addition, the vibration spectra are also to be recorded in narrow band on top of shock absorbers, Flanges of pipelines/Flexible inserts & at bearing locations of prime mover & driven equipment.
15	Electromagnetic Environment	All electrical equipment should provide satisfactory operation in presence of electromagnetic emission prevalent in the vicinity of the equipment. EMC specification DND/SDG/EMC-1 dated 04 Dec 24 (latest in force) be referred for applicability of relevant emission and susceptibility tests for a particular equipment/sub system/ system, test limits, test procedures etc.
16	Magnetic Induction	The value of magnetic field strength for equipment design be considered as follows :-  (a) All Equipment located inside Pressure Hull are to be designed to withstand magnetic field strength of 400A/m (RS06 testing to magnetic field strength of 400 A/m).  (b) All Equipment located outside the Pressure Hull which contain components potentially sensitive to magnetic fields e.g. Cathode ray tube, photo multipliers, sensitive hall effect devices and moving coil meters etc. are to be designed to withstand magnetic field strength of 1200A/m in de-energised state.
17	Air Borne Noise	Levels of sound pressure in 1/3 <sup>rd</sup> octave frequency bands in frequency range 25 Hz – 10 KHz with reference to 20 $\mu\text{Pa}$ are to be measured in accordance with NTD 1212.360050.011. The average sound pressure levels over the measured surface in 1/3rd octave band should not exceed the values specified in SOR of the equipment. In addition, overall sound pressure levels in A weighted scale and sound pressure levels in octave band in frequency range 31.5 Hz – 8 KHz are also to be measured.
18	Vibration Resistance	Equipment should be tested for vibration resistance in frequency range of 3 Hz to 33 Hz in accordance with NTD B-03.

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SL.	Parameter	Value			
19	<b>Pressure for Components in Direct Contact with the Sea</b>	(a) For Sea Water Systems (pumps, equipment, hull valves, hull fittings etc, subject to pressure build up due operation at test depth) Working pressure =40 kg/cm <sup>2</sup> Test pressure for leak-tightness = 52 kg/cm <sup>2</sup> Test pressure for strength = 60 kg/cm <sup>2</sup>  (b) For Cables, Connector and Other Equipment exposed to Sea Water (subjected to no pressure build up due operation of equipment)  Working pressure =40 kg/cm <sup>2</sup> Test pressure for leak-tightness = 50 kg/cm <sup>2</sup> Test pressure for strength = 60 kg/cm <sup>2</sup>			
20	<b>Quality of Electrical Supply</b>	<b>AC Source</b>	<b>AC Consumers</b>	<b>DC Source</b>	<b>DC Consumers</b>
	Prolonged variations of Voltage	± 1.5%	± 5%	----	----
	<b>Quality of Electrical Supply</b>	<b>AC Source</b>	<b>AC Consumers</b>	<b>DC Source</b>	<b>DC Consumers</b>
	Repeated short Time deviations of Voltage	-7% to +4%	-13% to +8%	± 6%	-13% to +8%
	Short time deviations of voltage	-20% to +9%	-25% to 13%	±8%	-25% to +8%
	Prolonged Deviations of Frequency	± 2%	-4% to +2%	----	----
	Repeated short Deviations of Frequency	+/- 4%	-5% to +4%	----	----
	Short time deviations of Frequency	-6% to +4%	-7% to +4%	----	----
<b>Note:-</b> Short time deviations are for duration of upto 3 sec, repeated short time deviations between 3 to 5 sec and prolonged deviations for more than 5 sec.					

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SL.	Parameter	Value
21	<b>Class of Insulation</b>	Class of insulation for all electrical machinery class 'H' or 'F' with Vacuum Pressure Impregnation (VPI).
22	<b>Protection for motor/electrical equipment</b>	
	Electric motors	Designed to minimum IP 23/44/55 based on location as indicated in respective SORs.
	Terminal blocks of AC/ DC motors	Designed to minimum standard of IP 44
	Main switch boards/ auxiliary switch board/ local control panels/ electrical distribution centres, Starters, Electrical and Electronic Cabinets	Designed to IP 21/23/44/55 based on location as indicated in respective SORs.
	Electro-mechanical devices	Designed to IP 43/44.
23	<b>Components in direct contact with sea water</b>	Suitable for use in areas where fuel, lubricating fluids and detergents are present.
24	<b>Components in direct contact /close proximity with batteries in battery pits</b>	Suitable for use with corrosive atmosphere (due to presence of acid)
25	<b>Shock Strength</b>	The equipment is installed on shock mounts or rigidly as indicated in statement of requirements (SOR) of equipment. The shock requirements are to be specified in accordance with NTD.B-02 and are to be tested in accordance with NTD.B-01 :- (a) The equipment when installed on shock mounting or rigidly should have adequate strength and be capable of trouble free operation at shock loads in the form of a single wave of sinusoidal pulse. The specific values of the amplitude and pulse duration above mountings in three mutually perpendicular directions X, Y and Z axes – "X" axis being longitudinal axis, "Y" axis being transverse axis and "Z" axis being vertical axis) are specified in SORs. (b) The strength and operational capability of equipment >200 kg under shock are to be verified by calculations and Finite Element Analysis or by testing in test bed, with shock pulse stipulated in SORs.

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SL.	Parameter	Value
		(c) The strength and operational capability of equipment up to 200 kg under shock are to be verified on m/c K-200 Impact Tester (hammer drop table type test bed). (d) In case of testing on drop table, an equivalent half sine pulse with amplitude & duration with same damage potential as that of the full sine pulse needs to be considered. (e) In case of FE analysis, transient dynamic analysis with shock loads as a full sinusoidal pulse is to be considered." (f) Large equipment weighing > 200 Kg is permitted to be tested component wise on drop table machine if testing of complete equipment is not feasible.
26	Tolerances	<u>Tolerances and surface finish on equipment feet.</u> Tolerances and surface finish for equipment feet are to be as follows (i.a.w ISO 286) : (a) Tolerances on length, width and height of the feet : +/- IT 14/2 (b) Tolerances on distance between centers of feet : +/- IT 14/2 (c) Max gap between a feet and horizontal surface : 0.1 mm (d) surface finish of the mating surface of the feet : Ra 1.6- 3.6 (e) Surface finish of internal surface of holes : Ra 1.6 (f) Tolerance on diameter of hole : H7
27	Sealing	Test to be carried out for hermetically sealed equipment only Ref JSS 55555 Test No 23
28	Tropical Exposure	JSS 55555 Test No 27
29	Mould growth	JSS 55555 Test No 21
30	Corrosion (salt/ salt Fog)	JSS 55555 Test No 9
31	Bump Test	JSS 55555 Test No 5 (to be undertaken for Electronic and Electrical equipment)
32	Non metallic materials emission test	Gas emission test to be undertaken by DEBEL for all non-metallic materials exposed to submarine internal environment. Emission test is to be undertaken for qualification of non metallic items at 35°C and 80°C for 120 days.
33	Non metallic material toxicity & smoke index	To be qualified by DEBEL based on IMO Resolution MSC307(88) for all non metallic materials exposed to submarine internal environment.
34	Equipment Paint Scheme	As per Aakanksha letter 1/U/VSL /S5/Paint Scheme dated 09 Nov 2020 and 26 Aug 25

### 1. SHOCK MOUNT SCHEME:

Equipment/BOM ID	Wet Weight (Kg)	Fitment	Shock-Mount Type	Shock Mount Qty
Interface and Governing Panel (LP627.15)	400	-	AKCC-85M	Load Bearer: 06 Thruster: 02

### 2. SHOCK RESISTANCE

The equipment should be able to Withstand shock loads of full sine wave in all three directions and should be capable of trouble-free operation during and after being subjected to shock. The shock pulse need not be considered to occur simultaneously in all three directions, the equipment should withstand the following shock loads: -

Equipment	Wet Weight (Kg)	Direction	Shock value(g)	Time period, Full sine wave(ms)
Interface and Governing Panel (LP627.15)	400	X	3.56	139
		Y		
		Z		
		Y		
		Z		

### 3. VIBRATION LEVEL

RMS Vibration acceleration levels of the equipment in 1/3 Octave band in frequency range from 5 Hz to 10 KHz with a reference to  $1 \times 10^{-5} \text{ m/sec}^2$ , when measured on top of shock absorbers in three mutually perpendicular direction in accordance with NTD.1212.360050.011 should not exceed the straight line joining the values as specified below: -

Equipment	5Hz	10Hz
Interface and Governing Panel (LP627.15)	48 dB	81 dB

In addition, the RMS Vibration acceleration levels at pipelines/flexible inserts connected with equipment are also to be measured in three mutually perpendicular directions in 1/3 Octave band in frequency range from 5 Hz to 10 KHz with a reference to  $1 \times 10^{-5} \text{ m/sec}^2$ . (This para is applicable only for Vibro-Active equipment).

#### 4. AIRBORNE NOISE

Sound pressure levels of equipment in 1/3<sup>rd</sup> octave frequency bands within a range of 25 Hz to 10 kHz measured in dB (in accordance with NTD.1212.360050.011) wrt zero threshold of 20  $\mu$ Pa at 1 m distance from the external outlines of the equipment shall not exceed the values bounded by the straight line that pass through the values given below:

Equipment	25Hz	10KHz
Interface and Governing Panel (LP627.15)	48 dB	48 dB

In addition to the above, the following values also need to be measured: -

(i) Sound pressure levels of equipment in octave frequency bands within a range of 31.5 Hz to 8 kHz measured in dB (in accordance with NTD.1212.360050.011) wrt zero threshold of 20  $\mu$ Pa at 1 m distance from the external outlines of the equipment

(ii) Sound levels of equipment measured in A weighted scale dBA (in accordance with NTD.1212.360050.011) wrt zero threshold of 20  $\mu$ Pa at 1 m distance from the external outlines of the equipment.

**NOTE:**

- 1/3<sup>rd</sup> octave measurement of ABN is required for UWN estimation of platform.
- Octave measurement of ABN is required for Compartment noise estimation.
- Equipment ABN must be within these three types of ABN limits. If the ABN level meets 1/3<sup>rd</sup> octave limit then it will also meet octave and overall A-weighted limit, not vice versa.

#### 5. VIBRATION RESISTANCE

The equipment should be capable of trouble-free operation under the influence of vibration caused by propeller. The vibration resistance is to be tested in accordance with Standard - B03 by following three tests:

(i) Test for detection of Resonance. The test is carried out by mounting equipment on vibration test stand and subjecting the equipment to vibrations of frequencies ranging from 3-33 Hz with amplitude of platform 0.1 to 0.15 mm at sweep rate < 5Hz/min to identify the resonant frequencies.

(ii) Vibration Resistance at Resonance. The equipment shall be operated for 02 hours on vibration test stand at most hazardous resonant frequencies with amplitude of oscillation as given below:

3-5 Hz      - 1.0 mm

5-33 Hz - 0.23mm +/- 0.05mm

(iii) Vibration Resistance. The equipment shall be made to perform its function while mounted on a vibro-test stand for a cumulative duration of 02 hours gradually increasing the frequency of oscillations from lower to higher and vice-versa as given below:

Frequency Sub-range	Amplitude of test stand platform (mm)	Duration	
Up to 10Hz	2.5	>2 min	Total 6 hours, (2 hours in each direction)
>10-20Hz	0.63	>2 min	
>20-25 Hz	0.40	>2 min	
>25-30 Hz	0.28	>2 min	
>30-33 Hz	0.23	>2 min	

In case of resonance the vibration amplitude is to be reduced to half of above-mentioned values in range 0.7-1.4 time of the resonant frequency.

(iv) The equipment is considered to have passed the above tests if no mechanical failure, damages, slackening of joints, false operation and parameters of equipment measured during and after the tests lie in range of specified allowance.