

**Encl. to Tender No. EKM/OS/019/SHAFT LINES/10-11, Dt. 10. 08.2010**

**ENCLOSURE - 1**

**WORK PACKAGE FOR ALIGNMENT, MACHINING, INSTALLATION, TESTING AND TRIALS OF SHAFT LINES, COMPONENTS, MAIN MOTOR, ECO MOTOR & RESERVE MOTOR ON BOARD INS SINDHUKIRTI**

**A) TECHNICAL SPECIFICATION**

**SCOPE OF WORK**

1. **Activity:** Carryout alignment, assembly, installation, pressure testing, Trials and Commissioning of shaft lines/components, Main Motor, Eco motor, Reserve motor and pneumatic couplings as per drawing/ repair manual. Main Motor, Eco-motor & Reserve motor Electrical trials are not covered in this scope of work. Carry out manufacturing of couplings and shaft guard covers, all installation fasteners, shims, Compensating washer, fit bolts/ fit pins (as required) for all bearings, Main Motor/ Eco-Speed motor/ Reserve motor foundation, Bed bedding, Reaming holes, machining (as required), polishing, clearances of mating components, spray-painting and pressure Testing. Optical sighting (Preliminary alignment and final alignment), assembly, Installation of Main Motor, Eco-speed motor, Reserve motor, all internal and external Shafts with bearings/ components and trials of Main and Reserve Shaft lines. The assembly/ installation drawings and repair manuals are to be guide lines for assembly and installation of shaft lines & components, Main Motor, Eco motor, Reserve motor and pneumatic couplings in appendix-1.

2. **Spares and materials:** All raw materials required for manufacturing the shims, Compensating washer, loose & fit bolts/ pins, taper pins/ bolts (for installation), electrodes, consumables like gaskets, gas, compressed air, oil, Paint etc. will be supplied by HSL at HSL Stores. All fasteners and spares required for assembly the components in situ will be supplied by HSL and other fasteners, gaskets etc required for testing will be under contractor scope. Contractor should make arrangements to cut the materials from Rounds/ Plates as required for manufacturing the shims, loose & fit bolts/ pins, jigs and fixture. All cleaning and working materials like rag, Kerosene, wire brush, Persian blue, hydraulic jack, sling wire, various sizes of shackles, chain block pulley, rope pulley, ratchet chain block etc. will have to be arranged by the contractor. The contractor should submit detailed list of raw materials required for manufacturing the shims and loose & fit bolts within 10 days of placement of order. The list of spares/materials required for installation and trials should be submitted within 20 days of placement of order.

3. **Tools & Appliances:** All tools including reamers, instruments and appliances required for manufacture, assembly/ installation, trials and inspection are to be arranged by the contractor. Instruments must be of high precession quality and to be procured from branded company and acceptable by inspection agency (WOT), calibration when ever required must be carried out. The Optical Instrument and available targets for carrying out sighting & alignment checks will be provided in Engineering Division. Additional targets/ target holder if required and all other minor tools required for Shaft to Shaft alignment checks are to be arranged by the contractor at his cost.

4. **Checks, Testing and Inspections:** All the checks and tests are mentioned in the drawing/ repair manual/ approved QAP by WOT, are to be offered for inspection by the team of HSL and WOT as required and the data to be record. The Inspection Report recorded data are to be bound and submit in triplicate to HSL-QC.

5. **Description of main components:** The following main components of Port, Stbd. & Centre shaft lines for installation and manufacturing are covered in this Work Package.

a) Main Shaft Line (Centre) following Shafts/Bearings/Components for installation as below:-

| <u>Equipments</u>                 | <u>Frame No.</u> | <u>Qty.</u> |
|-----------------------------------|------------------|-------------|
| i) Main motor                     | (63-72)          | 01          |
| ii) Shaft turning gear.           | (71-72)          | 01          |
| iii) Pneumatic Coupling. (11 WMC) | (72-73)          | 01          |
| iv) Air Distributor Shaft         | (73-74)          | 01          |
| v) Air Distributor Bearing.       | (73-74)          | 01          |
| vi) Plummer bearing.              | (74-76)          | 01          |
| vii) Intermediate Shaft No.1.     | (74-81)          | 01          |
| viii) Bulkhead Gland.             | 76               | 01          |
| ix) Eco-Motor III-140.            | (77-80)          | 01          |
| x) Flexible coupling.             | (80-81)          | 01          |
| xi) Half coupling.                | 81               | 02          |
| xii) Thrust Shaft                 | (82-85)          | 01          |
| xiii) Thrust Bearing.             | (82-84)          | 01          |
| xiv) Brake                        | (84-85)          | 01          |
| xv) Tachometer.                   | (84-85)          | 01          |
| xvi) Intermediate Shaft No.2      | (84-85)          | 01          |

|  |           |     |
|--|-----------|-----|
| xvii) Propulsion shaft with Semi-coupling.                               | (85-108)  | 01  |
| xviii) Propulsion Shaft Seal YTB-260(Stern gland) with compensating ring | (87-88)   | 01  |
| xix) Fore Bossing Bearing.   | (88-89)   | 01  |
| xx) Intermediate Bossing Bearing.  | (96-98)   | 01  |
| xxi) Aft Bossing Bearing.  | (105-108) | 01  |
| xxii) Propeller with fairing.  | 109       | 01  |
| xxiii) Shock absorbers.  | --        | 58  |
| xxiv) Cylindrical shock mountings.                                       | --        | 06  |
| xxv) Fit bolts.  | --        | 22  |
| xxvi) Loose bolts.   | --        | 350 |
| xxvii) Shims.  | --        | 100 |

**(b) Reserve Shaft Line (Port, Stbd.) following Shafts/Bearings/Components for installation as below:-**

| Equipment  | Frame No. | Qty. |
|--|-----------|------|
| i) Reserve propulsion Electric Motor II Γ-168                            | 82-84     | 2    |
| ii) Flexible half-coupling/ Elastic Semi Coupling.                       | 84        | 2    |
| iii) Thrust Bearing.   | 84-85     | 2    |
| iv) Thrust Shaft.  | 84-86     | 2    |
| v) Tachometer Generator.   | 85-86     | 2    |
| vi) Intermediate Shaft.  | 86        | 2    |
| vii) Propulsion Shaft Seal YTB-140 (Stern gland) with compensating ring. | 87-88     | 2    |
| viii) Propeller Shaft Fore Bossing Bearing.                              | 88-89     | 2    |

|   |       |    |
|---|-------|----|
| ix) Propulsion Shaft.                   | 86-93 | 2  |
| x) Propeller Shaft Aft Bossing Bearing. | 88-89 | 2  |
| xi) Propeller.                          | 92-93 | 2  |
| xii) Half coupling.                     | 93    | 2  |
| xiii) Fit Bolts.                        | -     | 28 |
| xiv) Shims.                             | -     | 28 |
| xv) Loose bolts.                        | -     | 24 |
| xvi) Shock absorbers (Bumper).          | -     | 20 |
| xvii) Compensating washer.              | -     | 20 |

**6. General Description:** - The submarine has three shaft lines: the main propulsion shaft line and two wing (Port and Starboard) backup shaft lines. In vertical plane the main propulsion shaft line is located parallel to BL and at a distance of 3950 mm. In Horizontal plane the main shaft line is located along CL. The main propulsion shafting is of the left-hand rotation (the sense of rotation ahead running is counter-clockwise looking forward from astern). The total length of the main propulsion shafting from flange of the shaft of the ПГ-141 Propulsion motor as far as end of the propeller fairwater is 21,830 mm. The propeller shaft and the line shafts are the intermediate sections between the propeller and the propulsion motors which are used to transmit the torque from the motor to the propeller, as well as to transmit the thrust from the propeller to the main thrust bearing. The shafts are interconnected with the aid of taper fit bolts driven in the flanges of the shafts and half-couplings. The shafts are supported throughout their length with the bearings. The propeller shaft is supported in the aft, intermediate and fore bearings with Thordon bushes. The thrust shaft is supported with the sliding forced lubrication steady bearings of the main thrust bearing. The line shaft is supported with a steady friction sliding self-lubricated bearing.

The backup shafting consists of the port shaft line and starboard shaft line. In the vertical plane, the backup shaft lines are arranged at a slope of 23.53 mm/m sternward in the horizontal plane, the shafts converge to the CL, convergence to the CL is 29.41 mm/m. The port and starboard shaft lines are identical in construction and are symmetrically arranged with respect to the submarine CL. Since the port shaft line is left-turning and the starboard shaft line is right turning, the propeller, the main thrust bearing and standby propulsion motor ПГ-168 are made in two modifications (the left hand model and the right-hand model). Other items of the equipment of the port and starboard backup shaft lines are identical in construction. The total length of the backup shafting, from the flange of the shaft of propulsion motor ПГ-168 as per as the end of the propeller fairwater is 5470 mm. The purpose of the backup shafting equipment is similar to that of the main shafting equipment. The shafts are supported with the bearings. The propeller shaft is supported with the aft and fore with Thordon bushes. The thrust shaft is supported with the friction sliding lubrication steady bearing of the main thrust bearing.

**7. Description of work:** - On completion of medium repair, all shafts & shafts lines bearings/ components, Main Motor, Eco-motor, Reserve motor and pneumatic couplings will be handed over to the contractor for installation. Main Motor routines have been carried out in situ. Lowering of the Eco-motor & Reserve motor in side submarine will be carried out by the HSL, Remaining all equipment/ components are to be lowered inside submarine/ dock floor by the contractor. All equipment/components are to be inspected for its completeness and condition by the contractor before alignment and installation. All bolts and nuts are to be phosphotize before installation the equipment/components. During installation all clearances/ fits limits are to be maintained as per related documents/ drawings. Foundation bolts with nuts are to be drilled in-situ for fitment split pins. De-preservation and preservation of equipment are to be carried out by contractor till its alignment, installation and trials onboard. The required & assembled components are to be installed on board and connected up as per the led down technical specifications, documents and general Engineering Standards. The Submarines general structural work will be completed by HSL and made ready for installation of all the components. However, some minor works like welding of brackets, clamps, base plates etc., are to be carried out by this contractor. Bedding and blue contact test of shaft journal with shell are to be carried out in all bearings during installation. Bearings cooling coils are to be installed. (Cooling coils have already been repaired). The alignment & connecting up of Main Motor with Shaft Lines and Reserve Motor with Shaft Lines are to be done by the contractor of this Work Package. The associated system viz, Shaft cooling / Lubrication/ CAKT etc. are being installed/ connected up and Pressure tested by other respective Contractors. Electrical trials of Main Motor, Eco-motor & Reserve motor not covered in this scope of work. All the contractors should coordinate with each other while carrying out the alignment, all associated system pressure testing & during trials of motors. Total work can be sub divided into following activities.

**a) Alignment:** - On completion of complete structural work, the contractor should carry out the preliminary alignment of the bosses (Shaft brackets) and indicate the requirement for resiting (Repositioning) of Bossing. After resiting, the contractor should satisfy himself by rechecking and give the required data for machining the Thordon bossing bushes. Stbd. Shaft Line alignment is to be carried out in loading condition. All the Shaft Lines are to be installed on board in correct sequence and aligning them properly with each other as per documents. **If required machining to be done by contractor.**

**b) Installation:-** Main motor, Eco-motor, Reserve Motors, Bearings Ship foundation beds, Cylindrical shock mountings bed faces, shock mountings both (top & bottom) faces, shims both faces and Main motor, Reserve Motor & Eco-motor bottom faces bedding are to be carried out by eliminate nicks, notches, scores by means of scrapping, then check with a testing plate by Persian blue. Foundations holes with shims and bearings bed holes are to be ream together in situ after final alignment of the shaft lines. Fit bolts-50 nos., Loose Bolts-374 nos., compensating washer-20 nos. and shims-128 nos. are to be manufacture as required for fitment the Motors/ equipment during alignment. After final fitment of fit bolts 0.05mm feeler gauge no go are to be checked between the shock mountings both faces, shims and foundation beds of Main motor, Eco-motor, Reserve Motor & bearings. Final length of bolts, pins and thickness of shims are clarified during installation. Thickness of shims can be from  $20 \pm 10\text{mm}$  &  $25 \pm 15\text{mm}$ . All bolts, nuts and washer are to be used for installation should be cadmium plated/ phosphate coat and oiled before installation the equipment/ components in contractor scope.

c) **Shims & Foundation bolts (Loose & Fit):-** All Bearings, Main motor, Eco-Speed motor & Reserve Motor Foundation Shims, Compensating washer, Loose/Fit Bolts & Tapper fit bolts are to be manufactured by the contractor as required. Final length of Bolts and the thickness of adjusting gasket/shims/ Compensating washer will be finalized during mounting. All connecting shaft to shaft tapper fit bolt and foundation fit & loose bolts after fitment drilling are to be carried out in situ with Nuts for fitment of split pins.

d) **Main Propulsion Motor II Г-141:-** Main Propulsion Motor II Г-141 installation is to be carried out as per drawing 877-ЭKM-411-9006СБЭ (17/1508). Connection of the II Г-141 propulsion motor with Shaft line is effected through a Pneumatic coupling (11 WMC) as per drawing 877ЭKM-411-9009СБЭ(17/1510).

e) **Eco-Speed motor: -** Cruising speed electrical motor (PG-140) installation to be carried out as per drawing 877EKM-411-9010 СБЭ (17/1511). Endurance propulsion motor ПГ-140 is designed for moving the submarine at slow endurance speed. This is also a stand by propelling device used in case of derangement of main propulsion motor ПГ-141. The endurance propulsion motor is installed in the aft compartment. The endurance propulsion motor maximum power is 139 KW (189hp) & Rotational speed -150 R/Min. The electric motor is installed on eight backing-up resilient mountings and two cylindrical thrust mountings. Connection of the ПГ-140 propulsion motor with line shaft No.1 is effected through a flexible coupling.

f) **Reserve Motor II Г-168:-** Reserve Motor II Г-168 installations are to be carried out as per drawing 877-ЭKM-411-9013СБЭ (17/1568). The ПГ-168 propulsion motor is connected with the thrust shaft thorough a flexible half-coupling. The flexible half-coupling is secured to the flange of the shaft of propulsion motor ПГ-168 and to the fore flange of the thrust shaft.

g) **Propeller: -** Propeller of the Main Shaft Line to be installed onto the Shaft by method of hydraulic press fitting. In the initial position fit the propeller without oil supply onto mating conic surfaces using force: 58 KN (5800 kgf). Axial movement of the propeller along the shaft cone from the initial position is  $1.7 + 0.1$  mm. Oil pressure supplied onto the matic conic surfaces  $P=33$  MPa (330 kgf/cm<sup>2</sup>). The force of final press fitting of the propeller  $Q=820$  KN(82000 kgf). Propeller Installation procedure are to be follow as per Document 877ЭP2-411-029(Stage-1/747). Propeller baffle plates (rope guard) are to be manufactured as per template in situ after installation of propeller.

The Propeller of the Reserve Shaft Lines are to be installed onto the shaft by method of hydraulic press fitting. Install the propeller to the initial position (without applying oil to the mating conical surfaces) with force  $Q_0=6600$  N (660 kgf). Axial displacement of the propeller along the shaft cone is relative to the initial position  $6.6+0.05$  mm. Pressure of oil, applied to the mating conical surfaces,  $P=33$  MPa(330kgf/cm<sup>2</sup>). The force of final propeller pressing  $Q=85$  KN (8500 kgf)-Wing Shaft Propeller Installation Procedure to be follow as per document 877 Э P2-411=025 Cb (Stage-1/750) & RTDL-17/1570.

h) **Thrust Bearing: -** The main thrust bearing is designed to take the axial thrust from the propeller and to transmit it to the submarine hull. The main thrust bearing is mounted on the horizontal pedestal in the aft compartment. The thrust shaft is supported with the friction sliding lubrication steady bearing of the main thrust bearing receiving oil from the diesel-generator and shafting oil system. Main shaft Thrust Bearing foundation bed with shim together to be reamed 12 Nos. Holes  $\varnothing 38$  H7 after final alignment and fit bolts are to be manufacture with interference fit. When assembling the bearing check clearance between race and gasket in

tightened up condition. The clearance should not admit 0.02mm by feeler gauge. The lower and upper liners for proper fit to the body and cap Blue contact test before final alignment. Collar of thrust shaft with thrust pads blue contact also be carried out. Oil Clearance (Diameter) and axial clearance between Shaft collar and thrust pads are to be carried out also before final alignment. Thrust Bearing cooling coils are to be installed. Bearing installation and testing are to be carried out as per Documents 17/1630 & 17/1509.

Wing Shaft self aligning thrust bearings installation and testing of bearing to be carried out as per document 482-67.3473CO (17/5400). Bearing Foundation Beds are to be bedded and Blue Contact test are to be checked. The 0.05 mm thick feeler gauge shall not be capable of penetrating between the shims and the bed plate and also between the shims and the base surface of the bearing feet. The heads of the bolts and the nuts shall be snug against the bed plate or against the feet of the bearing housing. The 0.05 mm thick feeler gauge shall not be capable of penetrating to under the nuts & bolts head within the length equal to the thirds of their perimeter. Thrust Bearing foundation bed with shim together to be reamed 12. Holes Ø 17H9 after final alignment and fit bolts are to be manufacture with interference fit as per RTD 17/1646.

**i) Stern gland (Propeller Shaft Bearing-YTB-260) :-** The propeller shaft seal is designed to prevent of sea water into the ship through the annular space between the propeller shaft and the boss where the shaft extends from the pressure hull of the submarine. The propeller shaft seal is secured on the fore boss of the shafting through an equalizing ring. Installation and Trials of stern gland to be carried out as per Drg:8677 ЭKM-411-9014 cbЭ (17/1513) and 482-65.883 cb (17/5088) and 482-03.363 ПМ (17/5299). YTB-260 propeller shaft seal consists of the main carbon graphite packing and emergency hemp packing. Under normal operating conditions, the propeller shaft is sealed with the main carbon graphite packing, the emergency packing shall be kept loose. The functioning of the main packing is checked by the rate of dripping which shall not exceed 40 l/h. The leakage water shall be drained to the bilge through the drain pipe. The emergency packing provides for reliable sealing of the shafting at a sealed medium pressure of up to 0.3 MPa (3 kgf/cm<sup>2</sup>). for a short period of time (up to 100 hours) within the entire range of the shaft rotational speeds at a rate of dripping not below the rated value and for an extended period of time when the shafting is not revolving.

Stern gland (Propeller Shaft Bearing-YTB-140) of Reserve Shafting – Construction & operation of the YTB-140 propeller shaft seal of the back up shafting is similar to that of the YTB-260 propeller shaft seal of the main shafting. Assembly/Installation & Hydraulic Test & Trials with shaft seal are to be carried out as per Technical Specifications 877 EKM-411-003 UR(17/1503), 482-65.879 cb(17/1589), 482-03.363 ПМ(17/5299), and 877 EKM-411-9008 cbЭ (17/1569).

**j) Air Distributor Bearing & Pneumatic Clutch:-** The pneumatic coupling, type 11 ИИМC, is designed for connecting the shaft of main propulsion motor ПП-141 with and disconnecting it from line shaft No.1 which receives the power. Engagement and disengagement of the pneumatic coupling will be effected with air delivered from the diesel-generator starting air and pneumatic coupling control air system. 11 WMC coupling, Air Distributor Bearing and Shaft Rotating mechanism are to be installed as per Drawing 877- ЭKM 411-9009cbЭ (17/1510). Pneumatic Clutch mechanism to be assembled and also Tacho generator ring with their accessories to be assembled. After installation pneumatic clutch with system should be pressure tested at 12 kg/cm<sup>2</sup> for 24 hours.

**k) Elastic coupling/ Flexible coupling for Main Shafting: -** The flexible (solid) coupling is designed to transmit the torque from the ПГ-140 propulsion motor to the shafting. One rim of the flexible coupling is secured on the half-coupling of line shaft No.1, the other rim is secured on the aft flange of propulsion motor ПГ-140. The flexible coupling consists of inner rim and outer rim, disk and twenty rubber strips. The inner rim is held to the half-coupling of line shaft No.1 with the aid of taper fitted bolts. Disk is connected with outer rim with the aid of fitted bolts and is held to the aft flange of the shaft of the ПГ-140 propulsion motor. Inner rim and outer rim each have ten blades. The blades of one rim are arranged in between the blades of the other rim. Rubber strips are laid between the blades of the inner and outer rims. Plates bolted to the outer rim are used to hold the strips longitudinally between the blades. During Assembly the flexible coupling, select diametrically opposite shells and securing plate with weight difference of not more than 5 g. or as per marking given during static balancing to be follow strictly. Radial clearance between the shells and coupling bands should not exceed 0.1 mm. Coupling assembly to be carried out as per drawing 877-4110---044 cbЭ (17/1546).

**l) Flexible half-coupling for Reserve Shafting: -** The ПГ-168 propulsion motor is connected with the thrust shaft thorough a flexible half-coupling. The flexible half-coupling is secured to the flange of the shaft of propulsion motor ПГ-168 and to the fore flange of the thrust shaft. The flexible half-coupling consists of half-coupling, buffer gaskets, pins, and spacer bushes. The flexible (solid) coupling is designed to transmitted the torque from propulsion motor ПГ-168 to the shafting to compensate for angular and parallel misalignment of the connected shafts, as well as for cocking caused by vibration of the propulsion motor installed on the resilient mountings, its shifts due to list and fore-and-aft inclinations of the submarine, and commission of the submarine hull when submerged. Ensure axial alignment while mating the flexible half coupling with the shaft of electric motor. Set final length of Bush while assembling the half coupling after ensuring a preliminary tightness of Buffer gasket set- 05-1.0mm contact of nuts with end surfaces of flanges should be more than 0.05mm. Buffer gasket set should be selected so that the outer diameters of gaskets differ by not more than 0.5 mm and the inner diameters ensure tightness at pin up to 0.5 mm. Assembly of Thrust half coupling to be carried out as per Document 877 ЭKM -411-9013 cbЭ (17/1568) and 877-4110---120 cbЭ (17/1598).

**m) Half Coupling: -** The half-coupling is forced onto the shaft taper by a hydraulic pressure and is held on it with a key and a nut in the same way as the half-coupling of the propeller shaft. The half-coupling of line shaft No.1 has a bead for fitting and securing the inner rim of the flexible coupling. During Assembly and Stripping the connection of half coupling with shaft, value of pressure of oil on Mating Conical Surfaces and force of final press fitting should not exceed the maximum permissible value as mentioned the correspondence shaft with coupling fitment Drawing /Documents. All other components for fitment the coupling also to be assemble as per Drawing. Intermediate shaft No.1 with half coupling assembly to be carried out as per Drawing 877-4110-042 CbЭ (17/1544). During assembly do not supply oil to mated tapered surfaces. Propeller Shaft with half coupling assembly be carried out as per Drawing 877 ЭKM-4110-0 03 cbЭ (17/1522).

**n) Steady bearing:-** The steady bearing is designed to take the radical load of the weight of the line shafts and pneumatic couplings. This is mounted on the horizontal pedestal in compartment 5. Steady bearing consists of a housing, cap, an upper and a lower shell, two cases, two oiler rings, and other parts. The steady bearing is a self-aligning individually lubricated bearing.

**o) Bulkhead stuffing box:** - The bulkhead stuffing box is of a float-type. This is designed to effect packing around the propeller shaft both locked and revolving where it passes through a watertight bulkhead. The bulkhead stuffing box is fitted in the bulkhead in compartment 5. Consists of Split housing, hemp packing, gland, securing flange, and a buffer gasket. The stuffing box gland is a manual compressing device with a two-side operating gear. The stuffing box may be compressed against the bulkhead from either adjacent compartment. The stuffing box is secured to the bulkhead with the aid of twenty studs. Bulkhead stuffing box installation is to be carried out as per Drg. 877 ЭKM-411- 9003 CбЭ (17/1507).

**p) Brake (100-500):-** The brake is designed to hold the inoperative shafting from revolving caused by the motion of the submarine during operation of other shaft lines and when towing the submarine. The brake is installed on the horizontal foundation on the flanged connection of line shaft No.2 and the shaft of the main thrust bearing. The brake consists of base, two hoops, coupling screw, axles, axle/nuts. The function of the brake disk is performed by the flanged joint of line shaft No.2 and the thrust shaft. When tightening the Brake clearance between the strap and pulley on the entire working section of brake should not exceed 0.1 mm. Brake installation to be carried out as per Drawing 484-03.055 cbЭ(17/1558) & 877 ЭKM-411-9012 cbЭ(17/1512).

**q) Tachometer generator:** - The distant-reading Tachometer is designed to measure the rotational speed of the shaft and to indicate the sense of its rotation, as well as to perform summing-up with the aid of the revolutions counter. The stator of the tachometer generator Main shaft is mounted on the bracket secured to the foundation of the shaft line brake, its rotor being secured on line shaft No.2. Rotor consists of two halves fitted on line shaft No.2 and coupled together with the aid of bolts. Rubber gasket is laid between the shaft and rotor. Stator of the tachometer generator is secured on bracket with the aid of bolts through gaskets.

The stator of the tachometer generator Reserve shafts is fitted on bracket secured to the pedestal of the thrust bearing, its rotation being held on the line shaft. Rotor of the tachometer generator consists of three halves fitted on the line shaft and bolted together. Rubber gasket is laid between the shaft and the rotor. Stator is held to bracket by means of bolts and shims. Bracket is secured on the pedestal of the thrust bearing with bolts.

During Installation, the tachometer- Generator Rotor and stator axis should be "00", Axis misalignment should not exceed 1 mm. The final length of Bolts and thickness of Gaskets/Shims is exacted during installation. After alignment drill to suit the mating components. The Tachometer-Generator must be earthed with the help of Jumper.

**r) Bossing Bushes:** - The aft and intermediate bearings of the propeller shaft are fitted in the aft and intermediate bosses welded in the outer hull of the submarine, while the fore bearing of the propeller shaft is fitted in the fore boss welded in the pressure hull of the submarine. The bearing is press-fitted in brass sleeve and is held to the end of the sleeve with the aid of bolts. The chambers between bearing bush and sleeve are packed with grease. All three Shaft lines all Bushes will be handed over by HSL after fitting Thordon bushes in the carrier duly machined. These Bushes are to be installed in the bossing. Bossing Housing all threads are to be re-tapped.

s) **Guard of Shaft Lines:** - All the revolving parts of the main/ reserve shafting are enclosed in guards. Guard of Shaft Lines in Compartments 5&6 finalize the location and structures of posts for securing the casing on site after the installation of the shaft line taking into account the general arrangement of spaces, convenience of causing dismounting and requirements to shaft line maintenance. Additional fasteners are to be fitted on site to exclude the casing vibration, if required. The gap between casing and rotating parts of the Shaft line should not be less than 30 mm. Pneumatic clutch guard covers are to be manufactured and installed. Guard of Shaft line is to be manufactured as per guidance Document 877 EP2-411-017MY (Stage-1/745).

t) Installation & Integration checks.

u) Final installation of the system.

v) HATs and SATs as per Methodica.

8. (i) **HATs:** HATS are to be carried out as per Hats Methodica which is enclosed at an Appendix-2 to this Work Package. During HATs all parameters should be satisfied as per HATs Methodica. No additional payment will be made for defect rectification during trials due to misalignment. During HATs all consumable are at HSL scope.

(ii) **SATs:** SATs will be carried out by Ship Staff. Any defects observed during SATs and remarks given by SS are to be rectified by the contractor. No additional payment will be made.

9. **Safety:-** The contractor should ensure that his men working on board follow all safety precautions strictly and they are covered by ESI. HSL is not responsible and will not pay any compensation towards damage due to accidents.

10. **Preservation & Assembly:** - All assembled components are to be preserved with grease. Lubricants and Paint as applicable and protected from entry of foreign particles whenever required, the lubrication oil is to be changed by the contractor.

11. **Guarantee:** - The assembly/installation must be guaranteed for trouble free and efficient operation for six months from the date of completion of Harbor Acceptance Trials/ Trials of Motors & Basin trials of the customer/ Indian Navy. Any defect arising are to be attended to promptly and rectified at contractor cost. Required spares will be supplied by HSL. All inspection observation/defects observed during installation inspections, Harbor & Sea Trials and during guarantee period are to be rectified by the contractor. During trials, if any bearings shells get scored/ wiped out due to improper alignment/ installation, relining of bearings shells, machining and bedding of the shells will have to be carried out by this contractor at his cost.

12. **Miscellaneous:-**

a) **Repeated works:** No additional amount will be paid for repeated jobs till completion of guarantee period.

b) **Work Standards:** General Engineering practices and special instructions laid down the reference documents are to be strictly adhered by the contractor during the execution of the contract. Clearance standards as laid down in the reference documents are to be achieved during manufacturing, assembly/installation and trials.

- c) **Ventilation:** Ventilation blowers and hoses will be supplied by HSL. May be rigged up and used by the contractor while working in confined spaces.
- d) **Drawing/Documents:** All reference documents/drawings will be available for reference in document section or with the engineer-in-charge which is enclosed at an Appendix-1 to this Work Package. However, the contractor may take Xerox copies at his cost for reference, on completion of work the Xerox copies are to be returned to HSL.
- e) Contractor should employ professionally qualified site Engineer with similar job work experience has been carried out in past for supervising the work.
- f) Contractor should employ highly skilled technicians who have previous experience, should be able to read the drawings and well acquainted with measuring instruments.
- g) Inside and outside the submarine there will be so many contractors working parallel for different systems. You should co-operate with each other and maintain healthy atmosphere.
- h) It is a challenging project linked with so many agencies including foreign countries. Contractor has no right to ask any explanation or claim against time delay.
- i) Crane services will be provided by HSL for loading and unloading the equipment/ components within HSL.
- j) Manufacturing the jigs and fixture for installation/ pressure testing are in the contractor scope.
- k) Erecting Stages / Scaffolding required for carrying out various works and alignment checks are a contractor scope. Material will be provided by HSL.
- l) On completion of installation inspections, trails are to be carried out in all specified regimes. The trials include Sea Trials & Full Power Trials also. The Contractor's Specialists may have to sail on board the Submarine to conduct trails.

**Appendix-1**  
**List of Drawings for Main Shaft Lines & Wing Shaft Lines.**

| <b><u>S.No.</u></b> | <b><u>Description</u></b>  | <b><u>Drawing No.</u></b>          |
|---------------------|--|------------------------------------|
| 1                   | Shaft Lines Expansion.   | 877᠑P2-411-021, Stage - II – 748   |
| 2                   | Propeller of Main Shaft Line Installation.   | 877᠑P2-411-021, Stage - II – 747   |
| 3                   | Shaft Lines, General arrangement.  | 877᠑P2-411-018, Stage - II – 746   |
| 4                   | Propeller Assembly Drawing.  | 877᠑P2-411-025CБ, Stage-II - 750   |
| 5                   | Propeller.   | 877᠑P2-411-025, Stage-II – 749     |
| 6                   | Guard of Shaft Lines in Comp. 5&6 installation - drawing.                              | 877᠑P2-411-017MЧ, Stage - II - 745 |
| 7                   | Guard of Shaft Lines in Comp. 5&6 installation - specification.                        | 877᠑P2-411-017, Stage - II – 744   |
| 8                   | Technical Specifications for Medium Repair of Shafting.                                | 877᠑᠑KM-411-033Y᠑᠑, 17/1503        |
| 9                   | Bulkhead Stuffing Box.   | 877᠑᠑KM-411-9003CБ᠑, 17/1507       |
| 10                  | Bulkhead Stuffing Box specification.   | 877᠑KM-411-9003᠑, 17/1507(a)       |
| 11                  | Thrust Bearing, Thrust & Intermediate Shaft No.2.                                      | 877᠑KM-411-9007᠑, 17/1509          |
| 12                  | Thrust Bearing, Thrust & Intermediate Shaft No.2 Specification.                        | 877᠑KM-411-9007᠑, 17/1509(a)       |
| 13                  | Clutch (11 WMC).   | 877᠑KM-411-9009CБ᠑, 17/1510        |
| 14                  | Clutch (11 WMC) specification.   | 877᠑KM-411-9009C᠑Б, 17/1510 (a)    |
| 15                  | Crushing Speed electric motor Plummer bearing & Intermediate Shaft No.1                | 877᠑KM-411-9010CБ᠑, 17/1511        |
| 16                  | Crushing Speed electric motor Plummer bearing & Intermediate Shaft No.1 Specification. | 877᠑KM-411-9010᠑, 17/1511 (a)      |
| 17                  | Break and Sensor of Tachometer.  | 877᠑KM-411-9012CБ᠑, 17/1512        |
| 18                  | Break and Sensor of Tachometer Specification.  | 877᠑KM-411-9012᠑, 17/1512 (a)      |
| 19                  | Propeller Shaft Bearing Y᠑B - 260  | 877᠑KM-411-9014CБ᠑, 17/1513        |
| 20                  | Propeller Shaft Bearing Y᠑B - 260 Specifications.                                      | 877᠑KM-411-9014᠑, 17/1513 (a)      |
| 21                  | Screw Propeller.   | 877᠑KM-411-9020CБ᠑, 17/1515        |
| 22                  | Screw Propeller Specification.   | 877᠑KM-411-9020᠑, 17/1515 (a)      |
| 23                  | Propeller Shaft with half coupling.  | 877᠑KM-4110-003CБ᠑, 17/1522        |
| 24                  | Propeller Shaft with half coupling Specification.                                      | 877᠑KM-4110-003, 17/1522 (a)       |
| 25                  | Half Coupling.   | 481-21-025᠑, 17/1523               |
| 26                  | Propeller Shaft Stern Bearing.   | 877-4110-024CБ᠑, 17/1527           |
| 27                  | Propeller Shaft Stern Bearing Specification.   | 877-4110-024᠑, 17/1527 (a)         |
| 28                  | Bearing Bush.  | 877-4110-025᠑, 17/1528             |
| 29                  | Propeller Shaft and Intermediate Bearing.  | 877-4110-030CБ᠑, 17/1533           |

|    |  |                                  |
|----|--|----------------------------------|
| 30 | Bearing Bush.  | 877-4110-031᠑ ,17/1534           |
| 31 | Intermediate Shaft No.2.   | 877-4110-164᠘᠖᠑ ,17/1539         |
| 32 | Intermediate Shaft No.2. Specification.  | 877-4110-164᠑ ,17/1539 (A)       |
| 33 | Intermediate Shaft No.2  | 877-4110-036᠑ ,17/1540           |
| 34 | Main Thrust Shaft  | 877-4110-040᠑ , 17/1542          |
| 35 | Intermediate Shaft No.1.   | 877-4110-041᠑ , 17/1543          |
| 36 | Intermediate Shaft No.1, with half coupling.                                       | 877-4110-042᠘᠖᠑ , 17/1544        |
| 37 | Intermediate Shaft No.1, with half coupling Specification.                         | 877-4110-042᠑ , 17/1544 (a)      |
| 38 | Compensating Ring.   | 877-4110-107᠑ , 17/1554          |
| 39 | Half Coupling Boss.  | 877-4110-043᠑ , 17/1545          |
| 40 | Elastic Coupling.  | 877-4110-044᠘᠖᠑ , 17/1546        |
| 41 | Elastic Coupling Specification.  | 877-4110-044᠑ , 17/1546 (a)      |
| 42 | Brake - 100 - 500.   | 484-03.055᠘᠖᠑ , 17/1558          |
| 43 | Brake - 100 - 500 Specification.   | 484-03.055᠑ , 17/1558 (a)        |
| 44 | Thrust Bearing, Thrust & Intermediate Shafts. (Stand by Shafting).                 | 877-᠑᠕᠕᠕-411-9005᠘᠖᠑ , 17/1566   |
| 45 | Thrust Bearing Thrust & Intermediate Shafts. (Stand by Shafting).Specification.    | 877-᠑᠕᠕᠕-411-9005᠑ , 17/1566 (A) |
| 46 | Stand by Shafting Tachometer - Generator.  | 877-᠑᠕᠕᠕-411-9011᠘᠖᠑ , 17/1567   |
| 47 | Stand by Shafting Tachometer - Generator. Specification.                           | 877-᠑᠕᠕᠕-411-9011᠑ , 17/1567 (A) |
| 48 | Propeller Electric Motor & Thrust half coupling of Reserve Shafting.               | 877-᠑᠕᠕᠕-411-9013᠘᠖᠑ , 17/1568.  |
| 49 | Propeller Electric Motor & Thrust half coupling of Reserve Shafting Specification. | 877-᠑᠕᠕᠕-411-9013᠑ , 17/1568.(a) |
| 50 | Propeller Shaft Bearing ᠑᠒᠖ -140 Reserve Shafting.                                 | 877-᠑᠕᠕᠕-411-9008᠘᠖᠑ , 17/1569   |
| 51 | Propeller Shaft Bearing ᠑᠒᠖-140 Reserve Shafting Specification.                    | 877-᠑᠕᠕᠕-411-9008᠑ , 17/1569 (a) |
| 52 | Stand By Shafting Propeller Screw.   | 877-᠑᠕᠕᠕-411-9019᠘᠖᠑ , 17/1570   |
| 53 | Stand By Shafting Propeller Screw Specification.                                   | 877-᠑᠕᠕᠕-411-9019᠑ , 17/1570 (a) |
| 54 | Propeller Shaft with half coupling.  | 877-᠑᠕᠕᠕-4110-009᠘᠖᠑ , 17/1578   |
| 55 | Propeller Shaft with half coupling Specification.                                  | 877-᠑᠕᠕᠕-4110-009 , 17/1578 (a)  |
| 56 | Intermediate Shaft.  | 877-4110-165᠘᠖᠑ , 17/1581        |
| 57 | Intermediate Shaft Specification.  | 877-4110-165᠑ , 17/1581 (a)      |
| 58 | Intermediate Shaft.  | 877-4110-064᠑ , 17/1580          |
| 59 | Half Coupling.   | 481-21.026᠑ , 17/1579            |
| 60 | Propeller Shaft Bearing Stern.   | 877-᠑᠕᠕᠕-4110-005᠘᠖᠑ , 17/1584   |
| 61 | Propeller Shaft Bearing Stern Specification.                                       | 877-᠑᠕᠕᠕-4110-005᠑ , 17/1584 (a) |
| 62 | Bush Stern.  | 877-᠑᠕᠕᠕-4110-004᠑ , 17/1585     |
| 63 | Propeller Shaft Bearing, Fore.   | 877-4110-077᠘᠖᠑ , 17/1590        |
| 64 | Propeller Shaft Bearing, Fore Specification.                                       | 877-4110-077᠑ , 17/1590 (a)      |
| 65 | Fore Bush.   | 877-4110-078᠑ , 17/1591.         |
| 66 | Thrust Shaft.  | 877-4110-084᠑ , 17/1596          |
| 67 | Compensating Ring.   | 877-4110-101᠑ , 17/1597          |
| 68 | Flexible Half- Coupling.   | 877-4110-120᠘᠖᠑ , 17/1598        |

|    |   |                                |
|----|---|--------------------------------|
| 69 | Flexible Half- Coupling Specification,                                  | 877-4110-120Э , 17/1598 (a)    |
| 70 | Half Coupling.  | 877-4110-121Э , 17/1599        |
| 71 | Thrust Bearing M.R. Manual 6K3-250                                      | 482-67.4826 CO, 17/1630.       |
| 72 | Thrust Bearing Repair Document List.                                    | 482-03.4826BP, 17/1630 (a)     |
| 73 | Thrust Bearing 6K3.250 (Left hand<br>, Assembly Drawing).               | 482-03.107-1,СБ, 17/1631       |
| 74 | Thrust Bearing 6K3.250 (Left hand<br>, Assembly Drawing) Specification. | 482-03.107-1, 17/1631(a)       |
| 75 | Filter Assembly Drawing.  | 482-67.1153СБ , 17/1633        |
| 76 | Filter Assembly Drawing Specification.                                  | 482-67.1153Э , 17/1634         |
| 77 | Bushing Assembly Drawing.   | 482-67.1285-1 cb, 17/1635      |
| 78 | Bushing Specification.  | 482-67.1285-1 , 17/1636        |
| 79 | Lower Coil Assembly Drawing.  | 482-67.1289СБ , 17/1639        |
| 80 | Upper Coil Assembly Drawing.  | 482-67.1288СБ , 17/1637        |
| 81 | Upper Coil Specification.   | 482-67.1288 , 17/1638          |
| 82 | Self - aligning Thrust Bearing M.R. Manual.                             | 482-67-4891PC, 17/1643         |
| 83 | Thrust Bearing Repair Document List.                                    | 482-67-4891 BP, 17/1643 (a)    |
| 84 | Thrust Bearing Assembly Drawing.  | 482-67-3032СБ, 17/1646         |
| 85 | Thrust Bearing Specification.   | 482-67-3032 , 17/1647          |
| 86 | Plummer Block 2.3 ГN - 250 M.R. Manual.                                 | 482-67-4902PC, 17/1658         |
| 87 | Plummer Block 2.3 ГN - 250 Assemblies<br>Drawing.                       | 482-03.480СБ, 17/1661          |
| 88 | Plummer Block 2.3 ГN - 250 Specifications.                              | 482-03.480 , 17/1662           |
| 89 | Propeller.  | Бф 877-00-013. 17/1668         |
| 90 | Propeller Shaft PackingsУГБ-140, УГБ-260<br>M.R. Specification.         | 482-65.879УСЭ, 17/4124         |
| 91 | Main Shaft stern gland assembly Drg. УГБ-<br>260                        | 482-65.883СБ, 17/5088          |
| 92 | Reserve Shafting stern gland assembly Drg.<br>УГБ-140                   | 482-65.879СБ, 17/5089          |
| 93 | Installation of Main Propulsion motor PG-<br>141                        | 877-ЭKM-411-9006СБЭ , 17/1508  |
| 94 | Installation of Main Propulsion motor<br>specification                  | 877-ЭKM-411-9006Э , 17/1508(a) |

**HARBOUR ACCEPTANCE TRIALS****13. SHAFTING**1301. **Instruments Required.**

- (a) Megger

1302. **Systems Required.**

- (a) Ships hydraulic system
- (b) Shaft cooling system.
- (c) Shaft Lubricating oil system.
- (d) All propulsion motors.

Checks

1303. **Installation.** Check the installation of the shafting in accordance with instructions **877 KM-902-3058 T0.**

1304. **Insulation.** Measure the insulation resistance of NSV 40/15 Pump and system CAKT 02-1 and record it in Table A. Measure the insulation after the trials also.

1305. Ensure that there are no extraneous matters in contact with the shafting.

1306. **Fill in lubricating oil in the following shaft bearings, up to the working level, between the high and low mark, on the oil gauge glass and check that the drain plug is not leaky.**

- (a) Plumber bearing.
- (b) Eco Motor forward bearing.
- (c) Eco Motor aft bearing.
- (d) Main thrust bearing.

1307. **Check the following bearings for forced lubrication by running pump No 3 & 4 separately. Check that the pressures are within limits as specified in table B.**

- (a) Main Motor Forward bearing.
- (b) Main Motor Aft bearing.
- (c) Air Distributor bearing.
- (d) Main Thrust bearing.
- (e) Reserve Motor forward bearing (Port & Stbd).

(f) Reserve Motor Aft bearing (Port & Stbd).

(g) Reserve Motor thrust bearing ( Port & Stbd).

1308. Ensure that the inserts of lignum vitae wood are kept in moist condition after fitting the bearings of propeller.

1309. After final fitment of the propellers and mounting of the shafting, check the clearances between the inserts of lignum vitae wood and the linings of propeller shafts. Clearances should be within the limits indicated in the table C. Record the actual clearances.

**1310. Check the CAKT-02-1 distance reading resistance thermometer for proper functioning at different temperature and alarm at limiting values Trials**

1311. At the time of harbor trials the operation of shafting on the propeller is checked for two hours at each mode.

(a) **Main shafting.** When operated by the electric motor PG141 (with the pneumatic clutch engaged) at a rotational speed of 175 RPM and when operated by the electric motor PG140 (with the pneumatic clutch disengaged) at a rotational speed of 150 RPM.

(b) **Reserve shafting.** Combined operation of the reserve shafting at both sides with a rotational speed of 650 rpm.

1312. If during the harbour trials, malfunctioning of the shafting or the units is detected, then the trials should be stopped and the causes of unsatisfactory functioning found out. The trials are to be repeated again.

1313. Check and compare readings of the CAKT 02-1 and local thermometer continuously. Record the temperatures in table D.

**Plummer Block.**

1314. Ensure supply of cooling water to the plummer bearing, which can be judged by the sense of touch.

1315. In the case the temperature of the bearing rises to 75 ° C, inspect the bearing. For this purpose, disassemble the bearing to check the condition of the working surfaces of the bush shells, shaft journal and oil rings, in accordance with para 8.12 of RTDL 17/1658.

1316. After the defects are eliminated, assemble the bearing and repeat the trials.

**Thrust Bearing**

1317. Check the oil pressure in the bearing, which shall be within 0.2 to 0.5 kg/cm<sup>2</sup>. Make sure that there are no oil leaks through the flange joints and packing.

1318. If oil temperature is less than 5 ° C, the speed of the shaft rotation should not be more than 30% of the maximum speed. Shaft rpm may be increased to maximum value if oil temp reaches to 25 ° C.

1319. If the bearing temperature rises to 70 ° C, open up the bearing to find the cause of the trouble. Check the condition of the working surfaces of the lower shells, thrust pads, collars and journals of the thrust shaft.

1320. Measure the axial displacement of the thrust shaft in the bearing. Record the results in table E.

### **Stern Gland**

1321. **Check installation of the propeller shaft seals as per the technical description and operating instructions 482 -65.879 TO and 482-65.883TO.**

1322. Check the non-uniformity in the circumference clearance between the shaft and the bore of cover under the hemp packing for diametrically located measuring points. It should not exceed + 0.4 mm.

1323. **Carry out hydraulic testing of aft hydraulic lock and the main face type seal of stern gland in accordance with subsection 2.3 and 2.5 of Instructions manual and check the following:**

(a) Rate of water leak through propeller shaft seal of propeller shaft seal cover should not be more than 40 lit/hr (20 lit/hr for reserve shaft seals).

(b) The duration of each test is 10 min.

1324. The temperature of main shaft seal should not exceed 50 ° C during trials.

### **Main Shaft Coupling**

1325. **Carry out installation checks in accordance with instructions 11ShMS.11RE**

1326. **Check the pneumatic coupling for proper engaging and disengaging. The engaging/disengaging time should not exceed 15 seconds.**

1327. **Check the operation of light signalling when coupling is engaged and disengaged. The following readings should be obtained during this check:**

(a) Air pressure in supply main should be 15 - 20 kg/cm<sup>2</sup>.

(b) Check the tightness of the pneumatic coupling and associated systems. For this install appliance 4ShMS.6.9SPU-A on the coupling and engage the coupling. Pressure test the clutch at a pressure of 12 kg/cm<sup>2</sup> for 24 hrs. The fall of pressure should not be more than that from 12 kg/cm<sup>2</sup> to 11 kg/cm<sup>2</sup> during the test period.

(c) Check the conformity of the light signalling, with pressure in the tyre, with local pressure gauge fitted on the coupling as per the table.

| <u>Clutch Condition</u> | <u>Signal</u>   | <u>Pressure In Tyre Kg/Cm<sup>2</sup></u>                                 |               |
|-------------------------|-----------------|---|---------------|
|                         |                 | <u>Permissible</u>  | <u>Actual</u> |
| Discharged              | White           | 1.0 <sup>+/-0.6</sup> and lower   |               |
| Inflation Process       | -               | 1.0 <sup>+/-0.6</sup> to 10 <sup>+/-0.5 to 1</sup>                        |               |
| Charged                 | Green           | 10 <sup>+/-0.5 to 1</sup> kg/cm <sup>2</sup> to 12 <sup>+/-0.5 to 1</sup> |               |
| Over Charged            | Green and White | 12 <sup>+/-0.5 to 1</sup> and above                                       |               |

1328. Check the axial play of the shaft, clearances K (between the rotor and the transformer core) on both the sides should be 0.5 - 1.7mm and dimension P 15 - 18mm. Dimension P may be set by adjusting the thickness of the gasket under the stator's bracket.

1329. Check the freeness of friction blocks suspended on pins for radial play. Cotter-pin the pins of the blocks in pairs with galvanized wire 3.0.C-II, GOST 3282-74, using tool 4ShMS.6.17. Bend the pin wire of the blocks towards the clutch center and do it in such a way that it (wire) winds around the friction block pin with a clearance of 2.5 to 3.0 mm.

1330. The close fit of the flanges of the inner and outer drums against their mating shafts should be up to at least 70%.

1331. Measure the clearance between the inner drum and friction pad. It should be between 3-8 mm.

#### Air Distributor Bearing

1332. Check the lubricating oil level in gravity tank, if required top it up.

1333. Check air distributor bearing for leaks physically.

1334. Check and record the following clearances in table F :

- (a) Total end clearance between shaft shoulder and bearing face.
- (b) Diametrical clearance.
- (c) Clearance between pressure strap and air distributor housing lug.
- (d) Diametrical clearance between air distributor cover and textolite half ring.
- (e) Axial clearance between Textolite half ring and shaft shoulder (with regards to shaft axial displacement).
- (f) Axial clearance of shaft which mounts air distributor.

1335. Check temperature of the bearing by sense of touch.

1336. Check the automatic connection of stand by lub oil pump when lub oil pressure in the system drops below 1.6 Kg/cm<sup>2</sup>. Lowering of pressure in the system is done by opening of by pass valve of the system. Check auto control panel for :

- (a) 'Oil Pressure Normal' should go off.  
 (b)  'Pressure Of Oil' Coming on with a bell ring.

**TABLE – A**

**CHECK RESULT OF INSULATION RESISTANCE**

|    | <u>Description</u>     |                                      | <u>Normal Value</u><br><u>Meg. Ohm</u> | <u>Actual Value</u><br><u>Meg.Ohm</u><br><u>Before Test</u> | <u>Actual Value</u><br><u>Meg.Ohm</u><br><u>After Test</u> |
|----|------------------------|--------------------------------------|--|---|--|
| 1. | <b><u>NSV40/15</u></b> | <b><u>No.</u></b><br><b><u>1</u></b> | <b><u>0.5</u></b>                      |   |  |
|    |                        | <b><u>No.</u></b><br><b><u>2</u></b> | 0.5                                    |   |  |
|    |                        | <b><u>No.</u></b><br><b><u>3</u></b> | 0.5                                    |   |  |
| 2. | System CKT 02-1        |                                      | 0.5                                    |   |  |

**TABLE – B**

**OIL PRESSURE/FLOW RATE IN DIFFERENT BEARING**

| <b><u>S.No.</u></b> | <b><u>Description</u></b>            | <b><u>Flow Rate</u></b><br><b><u>L/min</u></b> | <b><u>Pressure</u></b><br><b><u>Kg/cm<sup>2</sup></u></b> | <b><u>Actual</u></b> |
|---------------------|--------------------------------------|--|---|----------------------|
| 1                   | Main Motor propulsion motor bearing. | 21   | --  |                      |
| 2.                  | Air distribution bearing.            | --   | 0.5 – 2.0   |                      |
| 3.                  | Main thrust Bearing.                 | --   | 0.2 – 0.5   |                      |
| 4.                  | Port Reserve motor bearing.          | --   | --  |                      |
| 5.                  | Stbd Reserve motor bearing.          | --   | --  |                      |
| 6.                  | Port Reserve Thrust bearing.         | --   | 0.2 – 0.5   |                      |
| 7.                  | Stbd Reserve Thrust bearing.         | --   | 0.2 – 0.5   |                      |

**TABLE - C****PERMISSIBLE CLEARANCE IN THE BEARING OF THE SHAFT OF THE PROPELLER SHAFT**

| <b><u>S.No</u></b> | <b><u>Description</u></b> |                      | <b><u>Clearance Between The Boring Of Lignum Vitae And The Jacket Of The Propeller Shaft In Mm.</u></b> |   |  |                      |
|--------------------|---------------------------|----------------------|---|---|--|----------------------|
|                    |                           |                      | <b><u>As per Drawing</u></b>  | <b><u>Permissible During Repair</u></b> | <b><u>Permissible During Operation</u></b> | <b><u>Actual</u></b> |
| 1.                 | Main shafting             | Aft bearing          | 1.9+0.5   | 4.5                                     | 6.6  |                      |
|                    |                           | Intermediate Bearing | 1.9+0.5   | 3.4                                     | 4.5  |                      |
|                    |                           | Fore bearing         | 1.9+0.21  | 3.4                                     | 4.5  |                      |
| 2.                 | Reserve shafting          | Aft bearing          | 1.1+0.21  | 2.7                                     | 4.0  |                      |
|                    |                           | Fore bearing         | 1.2+0.24  | 2.1                                     | 2.8  |                      |



**TABLE - E**  
**SHAFT LINE LOG**

| <b><u>Axial Displacement Of Shaft According To Certificate Mm</u></b> | <b><u>Max. Permissible Axial Displacement. Mm</u></b> |                         |  |
|---|---|-------------------------|--|
|   | <b><u>During Operation</u></b>                        | <b><u>After M/R</u></b> | <b><u>After Replacement Of Thrust Pads</u></b> |
| 0.5 to 1.0  | 1.8   | 1.4                     | As specified in certificate                    |

**TABLE – F**  
**CLEARANCES OF AIR DISTRIBUTOR BEARING**

| <b><u>S.No.</u></b> | <b><u>Description</u></b>  | <b><u>Mounting Clearances, mm</u></b> |                    | <b><u>Extreme Clearance In service mm.</u></b> |
|---------------------|--|---------------------------------------|--------------------|--|
|                     |  | <b><u>Min.</u></b>                    | <b><u>Max.</u></b> |  |
| 1.                  | Total end clearance between shaft shoulder and bearing face.   | 0.13                                  | 0.19               | 0.25   |
| 2.                  | Diametrical clearance.   | 0.18                                  | 0.25               | 0.5  |
| 3.                  | Clearance between pressure strap and air distributor housing lug.  | 0.3                                   | -                  | -  |
| 4.                  | Diametrical clearance between air distributor cover and textolite half ring                                | 0.3                                   | 0.7                | -  |
| 5.                  | Axial clearance between Textolite half ring and shaft shoulder (with regards to shaft axial displacement). | 0.3                                   | 0.7                | -  |
| 6.                  | Axial clearance of shaft which mounts air distributor  | 0.25 max.                             |                    | -  |

Representative of HSL production Department

Representative of Quality control Department - HSL

Representative of WOT

Representative of Ship's Staff

## **B - COMMERCIAL TERMS & CONDITIONS**

1. **TIME SCHEDULE:** The completion time schedule is **90 days** from 15.09.2010.

2. **PAYMENT TERMS:**

2.1 **Stage –I :-** 30% Payment shall be made after completion of **alignment** against the submission of the satisfactory work done certificate duly certified by the concerned production department.

2.2 **Stage –II :-** 50% Payment shall be made after completion of **machining work and installation onboard** against the submission of the satisfactory work done certificate duly certified by the concerned production department.

2.3 **Stage –III :-** 10% Payment shall be made after completion of **HATs & SATs (Test & Trials)** against the submission of the satisfactory work done certificate duly certified by the concerned production department.

2.5 **Stage- IV :-** Balance 10% payment shall be made after completion of guarantee Period.

3. **GUARANTEE PERIOD** : The guarantee period is 12 Months from the date of HATs & SATs of the Shaft Lines onboard. Any defects arising are to be attended to promptly and rectified at free of cost.

4. **PERFORMANCE BANK GUARANTEE** : 10% Performance Bank Guarantee to be submitted upto the period of satisfactory completion of the work within 15 days of issuing LOI / Confirmatory Work Order.

5. **DELAY IN COMPLETION OF WORK** : 0.5% per week subject to a maximum of 10% of the Work Order Value.

6. **GENERAL TERMS & CONDITIONS** : As per Enclosure – 2

7. **EMD** : Rs.60,000/- Demand Draft / Bankers Cheque on the Name of M/s Hindustan Shipyard Ltd., Visakhapatnam-530 005 towards Earnest Money Deposit to be submitted along with Technical Bid. (Returnable)

**Note:- Vendors who were registered in HSL also should be submitted the EMD.**

8. **TENDER FEE** : Rs.500/- Vide State Bank of India Challan /Bankers Cheque on the Name of Hindustan Shipyard Ltd., Visakhapatnam - 530 005 (Branch No.9082), Cr. HSL Current A/c No. 10299596073 towards tender fee to be submitted along with Technical Bid.(Non returnable)

9. **VALIDITY:-** 90 days from the date of opening of Price Bid.

**Chief Manager (SBO)**