

BRIEF FOR
INDIGENOUS DEVELOPMENT OF BOAT ENGINE - MAKE II
CATEGORY

1. **Aim.** The stated aim of the project is to pursue indigenous development of diesel engines for boat propulsion, in the power range of 220 - 330 HP, to cater to future requirements in accordance with tentative boat procurement plan. Prototype of 330 hp is envisaged to be developed factoring the requirement of engines in this rating being the largest.

2. **Background.** The diesel engines used in boats have a high power-to-weight ratio due to space and weight constraints. Although, Indian OEMs manufacture engines in similar power range, they are much heavier and larger in dimensions, making them unsuitable for use in Indian Navy boats. Some of the features used by the foreign boat engine OEMs are aluminium engine blocks, dry liners, electronic fuel injection etc. The power range of diesel engines that are presently being used to propel *IN* boats are in the range of 170 HP to 320 HP. However, with the trend of advanced equipment being installed resulting in boats becoming heavier and larger, future requirement of engines would be in the range of 220-330 HP. It was therefore opined that if a common base engine can be developed to cater for the complete or majority of the power range, it could bring about standardization in the engines/ spares and also considerably reduce the development cost.

3. **Requirement.** There exists a tentative requirement of 240 engines in the power range of 220-330 HP for use on various boats to be inducted by *IN* between 2022-2026. It was also decided that a prototype engine of 330 HP be developed, the requirement of engines in this rating being the largest. Prototype development cost is essentially a factor of the number of iterations that would be required, culminating in successful prototype development. The indigenisation of boat engine will ensure the following:-

(a) Ensure self-reliance, it is essential that the technology for high speed boat engines be developed within the country, to meet our ever growing demand for such engines.

(b) Import substitution/ new induction/ replacement/upgradation/ indigenisation due to obsolescence.

4. Confirmation of Indian Vendors with technical knowhow on the development of the equipment and that indigenous design would be possible.

5. **Technical Specs.** Details of technical specs of the equipment/system is as follows:-

<u>Description</u>		<u>Requirements</u>
(a)	Propulsion Type	Inboard diesel engine integrated with stern drive unit comprising of Propeller & Steering System.
(b)	Quantity	One Engine set per Boat.
(c)	Rated Power RPM of Engine	330 HP @ 4000 ERPM

(d)	Overload Capability	<p>(a) The Boat Diesel engine shall have 10% overload capability, which shall be demonstrated during factory acceptance trials.</p> <p>(b) However, such capability shall not be normally utilized during exploitation of the boat.</p>
(f)	Environment Conditions	All equipment & Machinery should be suitable for continuous operation in ambient temperature conditions from -15°C to 50°C, relative humidity of 100% at 35°C and roll of 25° and pitch of 8°.
(g)	Indicative Dimension [L x B x H (in mm)] of Engine aggregate including Stern Drive and propeller	1900 x 800 x 1500.
(h)	Indicative Weight of Engine aggregate including Stern Drive and propeller	Dry – 650 Kg.
(j)	Expected Life of Engine	30 Years @ 400 hrs of annual exploitation.
(k)	Type of Fuel Used	High Flash High Speed Diesel (HFHSD) as per IS 1460: 2000 (Fuel Specification), min. Cetane No. – 46.
(l)	Basic Design Features	<p>(a) Reciprocating</p> <p>(b) Four Stroke</p> <p>(c) Inline / V-configuration</p> <p>(d) Electric Starter</p> <p>(e) Turbocharging & Charge Air Cooling</p> <p>(f) Common Rail Fuel System</p>
(m)	Emission Norms	The Diesel Engine should comply with IMO Tier III emission norms and must adhere to controlling limits as laid down in Annexure VI of MARPOL 73 / 78 regulations.
(n)	Engine Operation	<p>(a) The engine shall be able to operate in both Ahead and Astern modes without any restriction caused due to limitation of associated systems.</p> <p>(b) Fuel control lever is to be fitted with an adjustable stop to limit the overload capacity.</p> <p>(c) The design of the engine and engine driven sea pump should be such that the engine should be able to run without water up to 05 minutes without any detrimental effects. This to facilitate giving the helmsman immediate control of the boat as soon as it enters the water.</p>

		(d) The engine starting systems and starting aids shall start the engine at an ambient temperature of -15°C within two minutes of commencing a start procedure.
(p)	Associated Engine Auxiliaries	<p>(a) Each Diesel engine shall be provided with following auxiliaries and drives:-</p> <ul style="list-style-type: none"> (i) Engine driven Lub Oil Pump (ii) Engine driven Fuel Pump (iii) Engine driven Fresh water pump (iv) Engine driven Sea water pump (v) Turbocharger (vi) Alternator for charging of batteries <p>(b) Engine system & auxiliary systems are to be designed iaw 'Guidelines for Lifeboats & Rescue boats – Germanischen Lloyd Classification'/ equivalent and NCD 7000 Issue 1.</p> <p>(c) The design of fuel and lubricating system shall prevent the loss of more than 250 ml of fuel / lub oil, should the boat capsize.</p>
(q)	Stern Drive Unit/ Propeller	<p>(a) The steering shall be from the helmsman position actuated by rim type wheel mounted at 45° to the vertical and transmitted by a hydraulic system to the Stern Drive Unit at the transom. Vessel steerage is achieved by movement of the out drive unit.</p> <p>(b) Propellers shall be of a proven design and made of corrosion-free and erosion resistant material. Propeller and power transmission including steering system is to be designed iaw 'Guidelines for lifeboats & Rescue boats – Germanischen Lloyd Classification' / equivalent.</p> <p>(c) The connection of the propeller to the propeller shaft shall be of proven design, such as flanged, key taper connection, hydraulic connection. The cap nut is to be provided and shall be suitably secured.</p> <p>(d) All propellers shall be designed with due regard to the safety of persons in water and to possibility of damage of propulsion system by floating debris.</p>
(r)	Engine Mounting	(a) The engine shall be longitudinally aligned with steel tapping plates moulded into the longitudinal bearers in the hull in way of the engine mounting feet.

		<p>(b) The engine shall be suitably located to meet the stability requirements.</p> <p>(c) The engine together with power transmission & Stern drive unit is to be such that alignment is preserved under all operating conditions. The alignment of the propulsion component is to be preserved by the use of spigots, a proportion of fitted bolts or dowels.</p> <p>(d) The holding down requirement should take into consideration the requirement for rapid removal of engine aggregate, and their replacement with a spare unit.</p> <p>(e) The engine shall be bolted onto anti-vibration mounts, which are to be bolted in to hull. These should be Oil proof elastic mounts.</p> <p>(f) The mountings bolts shall be secured with self locking nuts of nylon insert type.</p> <p>(g) To facilitate routine inspection and removal of mounting, permanent jacking or lifting device to be incorporated such that all mounts can be removed at the same time.</p> <p>(h) In addition, since the correct functioning of mounts is greatly affected by flexibility of other connection to hull, all such connections are to be provided with rubber durites/ flexible connections.</p>
(s)	Engine Casing	<p>(a) The engine, transmission and engine accessories shall be enclosed by a fire retardant casing or other suitable arrangements providing similar protection. Such arrangements shall protect the engine from exposure to weather and sea. The engine casing has to be easily dismantled without using tools. Such arrangements shall also protect persons from coming in accidental contact with hot or moving parts.</p> <p>(b) The engine casing top shall be incorporated with seats for men, a capped hole through which the fire extinguisher nozzle is directed, O2 engine air intake cowls with water trap facilities to prevent sea water ingress, and stowage for the fuel tank dipstick.</p>

		(c) Adequate means shall be provided to reduce the engine noise so that shouted orders can be heard. It is recommended that the acoustic pressure does not exceed 60 dB(A) at 01 meter distance from the engine casing.
(t)	Submergibility/ Flooding	The engine shall be capable of operating when the boat is flooded upto the center line of crank-shaft.
Engine Instrumentation & Controls:-		
(a)	Command Console	<p>(a) Command Console would cater for fitment of engine instruments, electric control box, engine throttle and gear control which would be operated by the helmsman.</p> <p>(b) The propulsion unit (engine & Stern Drive unit) shall be controlled from the helmsman's position through joy-stick controls. The control system shall be designed to give control through the full regime of propulsion.</p> <p>(c) The control lever for the propulsion direction has to be moved in the direction of the movement.</p>
(b)	Engine Instrumentation & Safety Devices	<p>(a) The instrument panel shall be mounted in front of the helmsman position and shall contain engine instrumentation and switching.</p> <p>(b) Cable wiring shall be loomed inside the console and fed through ducting to the engine compartment of the various services.</p> <p>(c) All instruments and switches fitted on command console shall be weather proof and shock resistant. All buttons shall be rubber sealed. All electrical controls and instrumentation are to be compliant to IP 57.</p> <p>(d) Meter illumination and warning lights shall be fitted with dimmers. All the gauges are to be fitted symmetrical to the wheel should be easily visible to the helmsman.</p> <p>(e) The maximum permissible operating parameter is to be indicated on each gauge by a red mark. The instrumentation considered essential but not limited to, to be fitted on control panel shall include following:-</p> <ul style="list-style-type: none"> (i) Engine oil pressure gauge. (ii) Turbo boost pressure gauge. (iii) Lub oil temp gauge.

		<p>(iv) Fresh water temp gauge. (v) Engine exhaust temp gauge. (vi) Steering position indicator. (vii) Ammeter, Voltmeter. (viii) Lamp test switch. (ix) Tachometer – to show engine rpm. (x) Fuel level gauge. (xi) Speedometer (xii) Water in fuel indicator (xiii) Tilt Trim indicator</p> <p>(f) Alarms. A list of alarms essential but not limited to, required to be provided for diesel engine is as mentioned below:- Low Lub Oil Pressure High Coolant temp Low Expansion Tank level(if applicable) Engine Over speed High Exhaust Temp</p> <p>(g) Engine is to be equipped with safety or speed regulator which prevents the rated speed exceeding beyond 15 %.</p>
(c)	Engine Controls	<p>(a) The engine shall be started by a 3 position (off/ power/ ignition) key switch and a start push-button.</p> <p>(b) The starter motor used for engine starting shall be min of IP57.</p> <p>(c) A separate bracket mounted engine stop control cable shall be provided on the forward face of the engine casing.</p> <p>(d) Action of the cable shall pull the control rack on the fuel injection pump to the no fuel position, thereby shutting down the engine.</p> <p>(e) Engines shall stop automatically or be stopped by the Helmsman's emergency release switch should the boat capsize. When the boat has righted, engine shall be capable of being restarted.</p> <p>(f) A single lever control head, sited at helmsman console shall control engine speed and stern drive selection.</p> <p>(g) Movement of the control lever shall be transmitted to the fuel injection pump, and to the stern drive shift, through separate cables. The cables shall be secured to the side of the</p>

		console and routed through the engine casing.
(d)	Engine Starting	<p>(a) Engine is to be fitted with alternator that shall supply electrical power, for all electrical systems.</p> <p>(b) 24 Volt Electric starting equipment along with suitable battery catering to a minimum of 40 consecutive starts of the engine, with provision for alternative mechanical start.</p> <p>(c) The battery back-up shall also provide a secondary power source for short periods of time when:-</p> <p style="padding-left: 40px;">(i) The engine has stopped.</p> <p style="padding-left: 40px;">(ii) A fault condition develops in the alternator system.</p> <p>(d) Should comply with IHQ MoD(N) / DEE specification EED – Q – 071 (R3).</p> <p>(e) Ingress protection should conform to IP 57.</p>
(e)	EMI / EMC	The system in totality should be compliant with MIL-STD-461-F.
(f)	Inspection & Testing	Engineering machinery, propulsion, shafting, systems, piping and associated electrical installation as per Class Regulations. The first of the Engine shall be type tested.
(g)	Maintenance Philosophy	The Boat Diesel engine aggregate (including Stern Drive Unit & Propeller) should be designed to cater for Mean time between major overhauls, not less than 8000 hrs.