THE SINGLE ROLE MINE HUNTER PROPULSION DIESEL

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This article describes the selection, development and evaluation of the diesel main propulsion engine for the Single Role Mine Hunter (SRMH). It aims to provide the reader with an insight into the studies and development testing required of a diesel engine to give assurance that it will meet its specified power and special ship installation conditions.

Background

In 1980 the Admiralty Board endorsed a new mine countermeasures (MCM) policy. This recognized the need to meet the same main MCM threat as the HUNT Class, but cost savings were to be sought through less sophistication and versatility and possibly acceptance of somewhat higher risk from the mines to be hunted. The resulting vessel was designated the Single Role Mine Hunter[1].

To achieve the desired manoeuvrability, it was decided that Voith Schneider propellers would be fitted and that electric propulsion, particularly at mine-hunting speeds, would be the most effective method of reducing noise while the SRMH was on its primary task. Diesel propulsion was selected as the best means of achieving high speeds and for periods on passage. The propulsion system layout is shown in FIG. 1.

An important aspect of the propulsion engine design was ensuring that the magnetic signature[2] met the limits specified for the SRMH. These limits were less stringent than those for the HUNT Class, and consequently a commercial design of engine could be considered, possibly incorporating demagnetizing coils to reduce vertical induced and permanent magnetic signatures. The shock standard for the engine was also relaxed in comparison with earlier warship engines. To minimize the transmission of noise through the ship's hull the main propulsion package is on a flexibly mounted raft.

Engine Selection

The engine power requirement for each shaft line specified by Vosper Thornycroft Ltd., the prime contractor for the SRMH, was 500 kW. In 1982 the following engines, all of which might meet the power requirements in various combinations of engines, were considered as possible options for the Single Role Mine Hunter:

(*a*) Rolls Royce Motors FD12.
(*b*) Perkins CV12.
(*c*) Paxman 12YHA Ventura.
(*d*) Paxman 6RPA 200M Valenta.

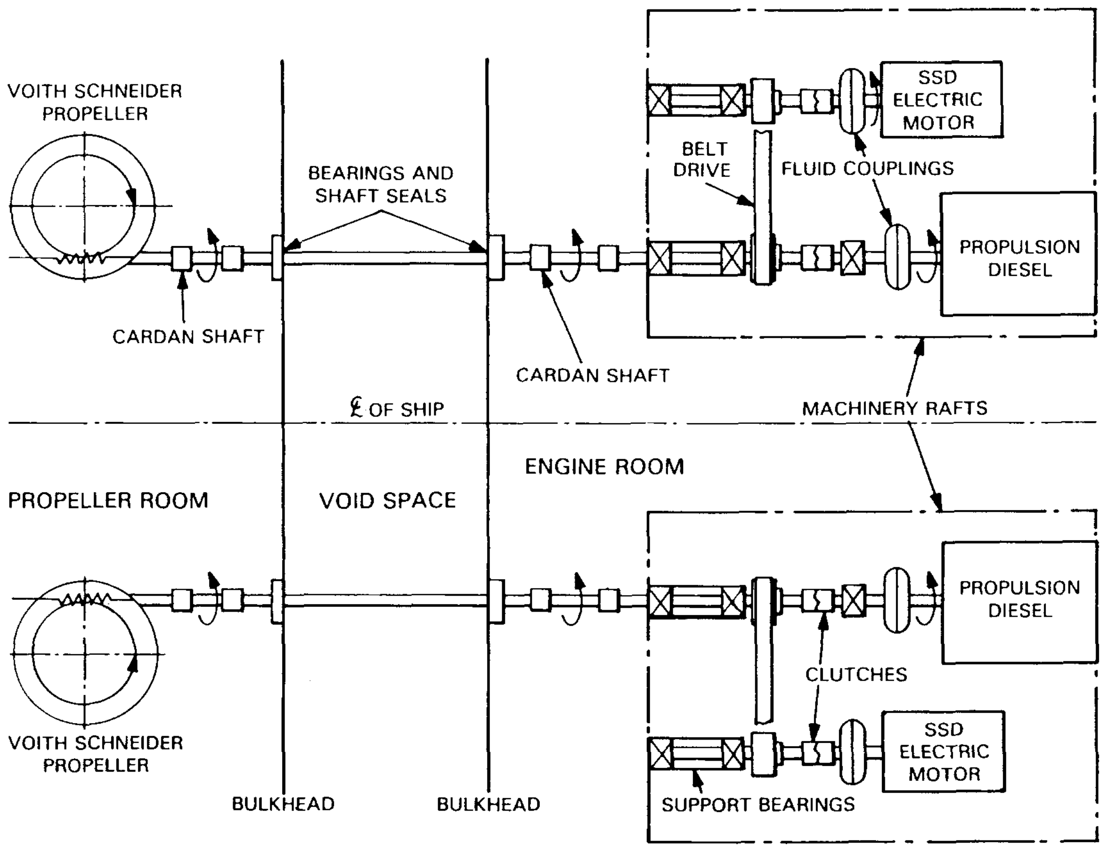

FIG. 1—SRMH PROPULSION SYSTEM

Each of these engines was comprehensively assessed for the purpose, and the Paxman 6RPA 200M Valenta[3] in its derated form, together with a fluid coupling on the same bedplate, was selected as the best option. This engine is illustrated in FIG. 2.

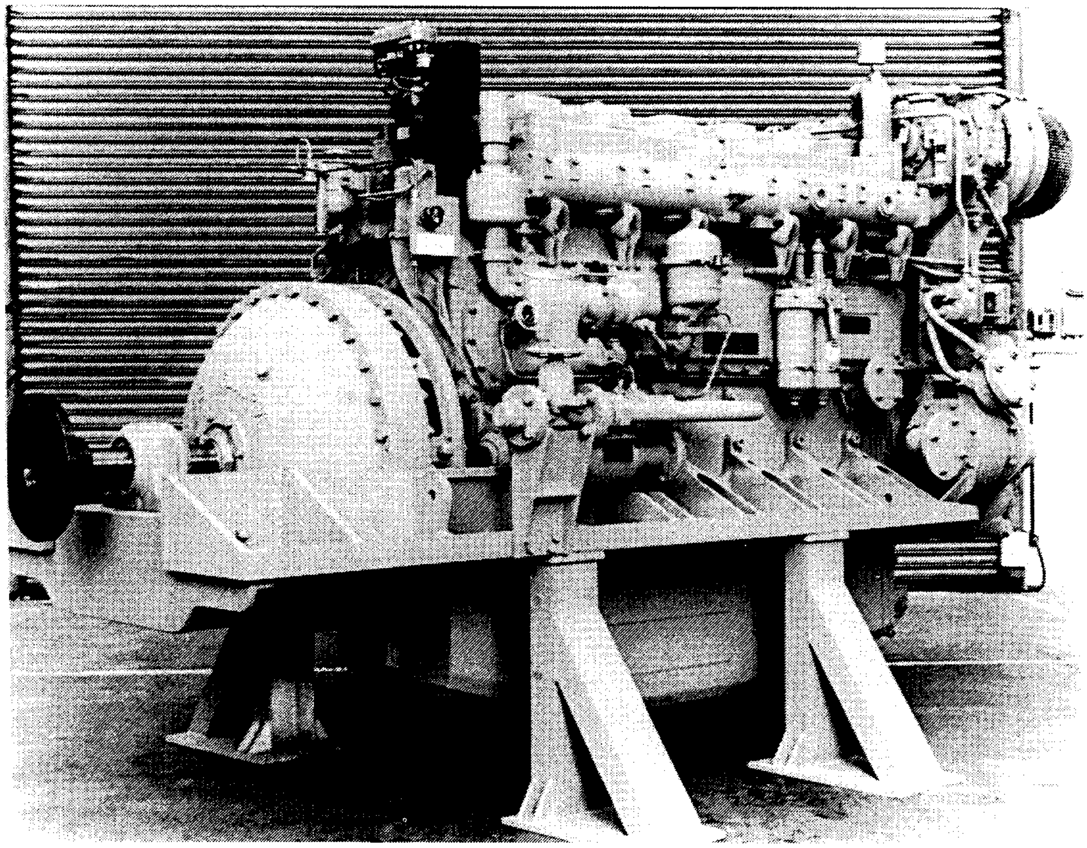

FIG. 2—PAXMAN 6RPA 200M VALENTA FOR SRMH, WITH FLUID COUPLING

Development

A development contract was placed with Paxman Diesels Ltd., to assess in more detail the engine performance, ruggedness, and magnetic signature, against the SRMH requirements. Speed was established as 1280 r.p.m. maximum, with a 600 r.p.m. minimum speed for one hour, and 700 r.p.m. continuously. There would also be occasions when the engine speed could fall as low as 400 r.p.m. for short periods.

The development contract was wide ranging and comprised four phases:

Phase 1:

(*a*) Magnetic ranging of engine crank case and assessment of results.

(*b*) Listing of low magnetic materials and components.

(*c*) Shock calculations and assessment of shock capability.

(*d*) Finite element shock analysis of crank case.

Phase 2:

(*a*) Performance assessment and design study to define engine build standard.

(*b*) Design work associated with a change of turbo-charger.

Phase 3:

(*a*) Design work and cost estimates for production engines.

(*b*) Procurement of performance-related components (turbo-charger, low overlap camshaft, etc.).

Phase 4:

(*a*) Build of a prototype engine.

(*b*) Prototype testing of the engine.

A test procedure was produced by Paxman Diesels Ltd., incorporating the requirements of the shipbuilder and the Ministry of Defence. These tests were successful.

As a result of this study and development testing on the prototype engine, the SRMH engine differs from the standard production engine by:

(*a*) Crank case of SG iron (specification SF400).

(*b*) Low overlap camshaft.

(*c*) Special turbo-blower.

(*d*) Modified engine bearers to support the fluid coupling.

(*e*) Adaptor plate for fluid coupling.

(*f*) Air start motor instead of electric starting.

(*g*) Intercooling by fresh water.

(*h*) Different siting of the Glacier by-pass centrifugal lub. oil filter.

(*i*) By-pass delivery valves in the fuel pumps.

(*j*) Air inlet flap valve.

(*k*) Degaussing coils around the engine.

After prototype testing at Paxman Diesels, the engine was magnetically ranged on the land range at RAE Ditton Park[4] to provide a magnetic datum before the shock testing. It was next sent to ARE Dunfermline for shock evaluation under operating conditions. The engine showed no signs of distress and continued running after each shock test. It was then returned to RAE Ditton Park for further magnetic ranging. The results before and after the shock test were very similar. A post-shock strip and examination at Paxman Diesels works revealed no damage to components and only slight slackness of some bolts. The engine was then rebuilt and successfully retested in the test cell at Paxmans.

Once more the engine was sent to RAE Ditton Park, but on this occasion degaussing coils were fitted temporarily to it in the vertical and horizontal planes, and magnetic ranging was carried out to determine the number of ampere-turns to be installed on the engine. This information was supplied to Paxman Diesels to enable the production engine coils to be designed.

Testing at RAE Pyestock

Though the Paxman 6RPA 200M has already received type test approval, endurance testing and certain special performance tests were necessary due to the changes incorporated in the SRMH engine. It has been delivered to RAE Pyestock and connected to a Schenck dynamometer in a test cell there (FIG. 3).

The following trials are being done:

(*a*) Endurance testing: this comprises running 400 hours at low power, 400 hours at medium power, and 200 hours at high power, with inspection of selected components at each of the shut-down intervals.

(*b*) Inlet depression/back pressure: to confirm that the engine will run satisfactorily for 1 hour at 500 kW and 1280 r.p.m. with inlet depression of 155 mm (water gauge) and back pressure of 255 mm.

(*c*) Crank case breather: to ascertain oil loss from the breather.

(*d*) Slow speed running/clutch shuttle: to measure engine hunt at no load with depressed idling speed.

(*e*) Fluid coupling slip: to establish the slip of the coupling at each duty point.

(*f*) Exhaust shade/combustibles: to established Bosch smoke readings at each duty point and to define the worst condition of unburnt fuel in the exhaust system.

(*g*) Sump oil measurement: to establish lub. oil consumption.

(*h*) Transient response of governor: to provide details of governor behaviour to enable ship control system design to be verified.

(*i*) Five cylinder running: to highlight any undesirable effects of running the engine on five cylinders.

(*j*) Minimum air pressure to start engine: to be carried out with engine cold using starting/heating aids, and with the engine warm without aids.

(*k*) Performance loops: to establish datum performance and fuel consumption throughout the full normal operating range.

(*l*) Testing of torsional vibration damper: to record torsional readings obtained at various powers.

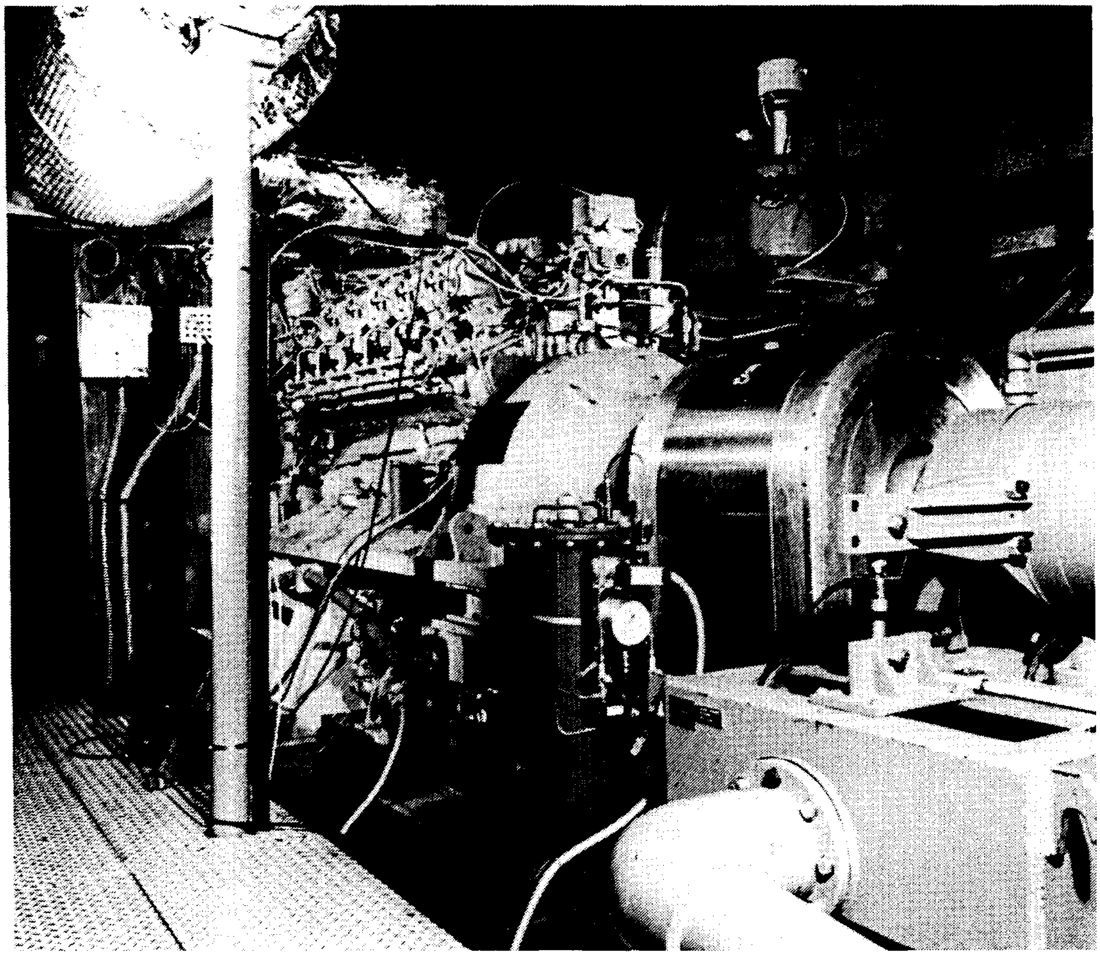

FIG. 3—SRMH VALENTA ON THE TEST BED AT RAE PYESTOCK

For the most part the trials have been satisfactory but, as is the purpose of any trials programme, they have highlighted some areas requiring further attention. For example the smoke levels recorded were above the specified levels despite the fitting of retard helix fuel pumps with by-pass delivery valves. This aspect is being investigated by the manufacturer.

In addition to the formal trials, the opportunity was taken during the shut-down periods to carry out an upkeep evaluation (UPEVAL). Certain selected components were dismantled and replaced by Paxman staff with RAE Pyestock assistance, and each operation was checked by DES(N) staff. The results of this exercise formed the subject of a report to ensure that any shortcomings or design problems affecting the in-service maintenance of these engines are properly addressed and the necessary changes incorporated into the design of the production engines. Vosper Thornycroft Ltd. also make use of this report during the preparation of maintenance schedules.

The final destination of this particular trials engine will be H.M.S. *Sultan* at Gosport, where it will be installed and used as a training aid.

Acknowledgements

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