DRA HASLAR NEWSLETTER

AUXILIARY MACHINERY TESTING AND EVALUATION

BY

COMMANDER R. T. STANTON, BSc, CEng, MIMarE, RN
(Defence Research Agency Maritime Division, Haslar)

ABSTRACT

The Mechanical Engineering area of the Engineering Systems Department, formerly the Naval Auxiliary Machinery Division (NAMD), is involved in the test and evaluation of all types of auxiliary machinery for ships and submarines and includes the investigation of in-service problems. Nuclear Steam Raising Plant components are also evaluated and other areas of work include fuel treatment, corrosion, flow measurement and noise and vibration monitoring.

Introduction

The four year period since the last Newsletter was published in December 1987[1] has been one of rationalization and reorganization at Haslar. In the summer of 1990, the Auxiliary Machinery Division, Haslar, merged with the Electrical Engineering Division, West Drayton, and this was followed by a handover of the facilities at Portland to the adjacent ARE site. In April 1991 the Defence Research Agency (DRA) was launched. Within the Maritime Division of the DRA, NAMD and West Drayton now form the Engineering Systems Department of the Marine Technology Directorate. These changes have provided an opportunity to streamline the organization and the next major step, as the DRA rationalizes its asset base, is the intended move of the West Drayton facilities to Haslar. However, the arrangements and timescale for this move are still under discussion and will be dependent upon a final decision relating to the retention of the Department either within the DRA or in the proposed Test and Evaluation Defence Support Agency.

The Facilities

The Engineering Systems Department, Haslar, has eight test facilities, of which the largest is the Auxiliary Machinery Test House. This has a floor area of 1500 square metres and contains separate cells for work on pumps, steam valves, compressors, chilled water plants and seal testing.

Next in order of size is the Steam Test Facility (STF) which comprises two Thompson-Lamont boilers and associated auxiliaries. The STF can supply steam at up to 82 bar, 510 deg C, 12 kg/s.

The remaining test facilities mainly deal with fuel, hydraulics, flow, and heat transfer, but one of the most interesting is the Safety Valve Testing Facility which is unique to the UK (and possibly Europe) in that it is the only place at which all nuclear submarine safety valves can be tested.[2]

In direct support of the test facilities, there are extensive mechanical, electrical and instrumentation workshops. There is also a noise and vibration section and a well equipped materials laboratory.

Current Work

There are normally about 60 mechanical engineering projects in hand, ranging from short duration tests of individual nuclear plant valves, to complex system and equipment investigations which may take up to four years to

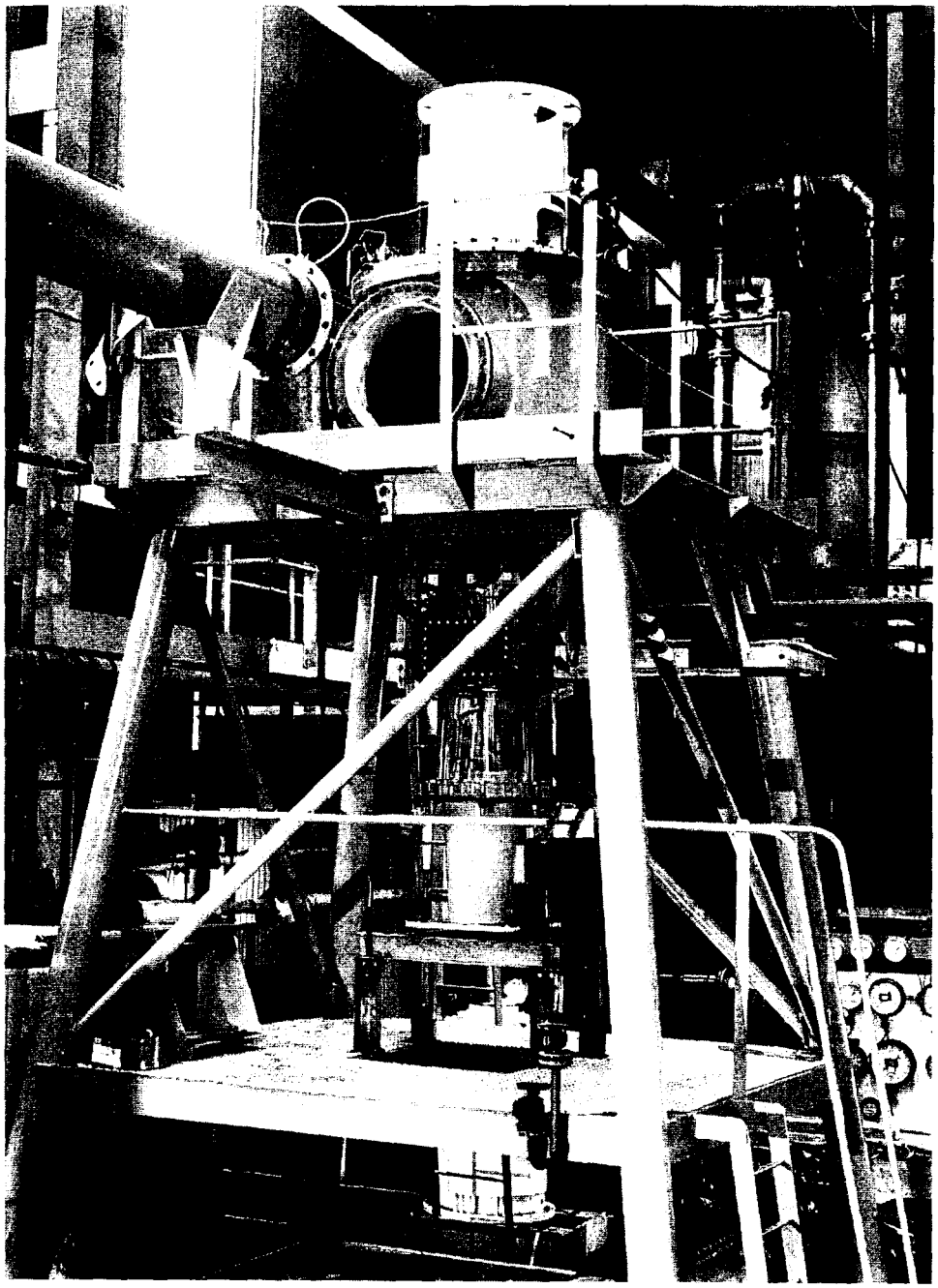

FIG. 1—SUBMARINE MAIN CIRCULATING WATER PUMP TEST RIG

complete. The following paragraphs highlight some of the recent major areas of work.

Steam Systems

Following modifications to reduce background noise and vibration levels, the Manoeuvring Valve Test Facility has seen extensive use to evaluate various designs of prototype main engine throttle valve for the VANGUARD Class submarine. Apart from noise and vibration measurements, the general inter-dependent characteristics of flow, pressure, valve opening, pressure drop and valve operating forces have also been investigated.

Sea Water Systems

As a result of the closure of the outstation in Portland, the Materials Life Evaluation rig has now been transferred to the Haslar site. This rig will continue to support valuable work in the investigation of corrosion mechanisms and protective coatings for condenser sea water systems.

Another area of sea water system testing is the investigation of cavitation damage occurring in some submarine main circulating water pumps. A full scale test rig is being constructed of which an important feature is the clear plastic draft tube through which it should be possible to view the conditions at the impeller (FIG. 1). The programme of work includes the evaluation of different impeller materials and coatings.

Compressed Air Systems

Compressed air plant continues to provide a steady workload (FIG. 2). On the HP air side for example, a considerable amount of time has been spent running the Type 23 compressor to sort out initial problems with seals and air cooler size. During the course of these trials, it was firmly established that there was a correlation between cooling water temperature and valve carbon formation. Current trials are evaluating designs of compressor to replace the units fitted in Type 21 and 22 frigates. Because of the valve carbon problem, these compressors are being run on synthetic oil which should give improved valve life.

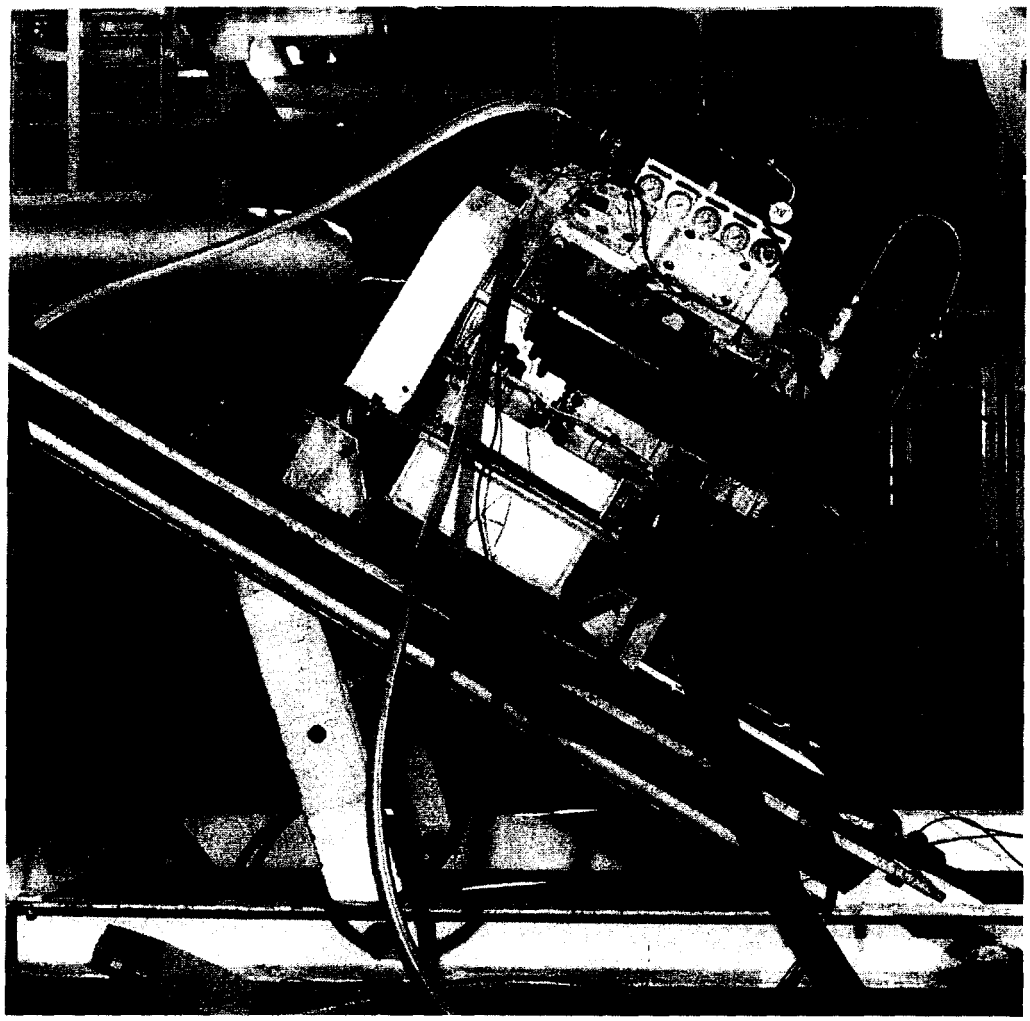

FIG. 2—HP AIR COMPRESSOR ON TILT TEST RIG

Trials are also in hand with coalescing filters and air driers to improve the quality of air passed into ship systems. Particular attention is being given to air filtration systems for submarine applications to ensure that any potentially harmful contaminants from synthetic oil do not reach the enclosed atmosphere.

Mention was made in the last Newsletter[1] of the LP Blower for VANGUARD Class and the Masker Blower for the Type 23 frigates. Both these units proved very reliable and have now completed their trials. However, in both cases serious and difficult to correct problems occurred with associated ancillary systems, thus highlighting the advantage of comprehensive shore testing.

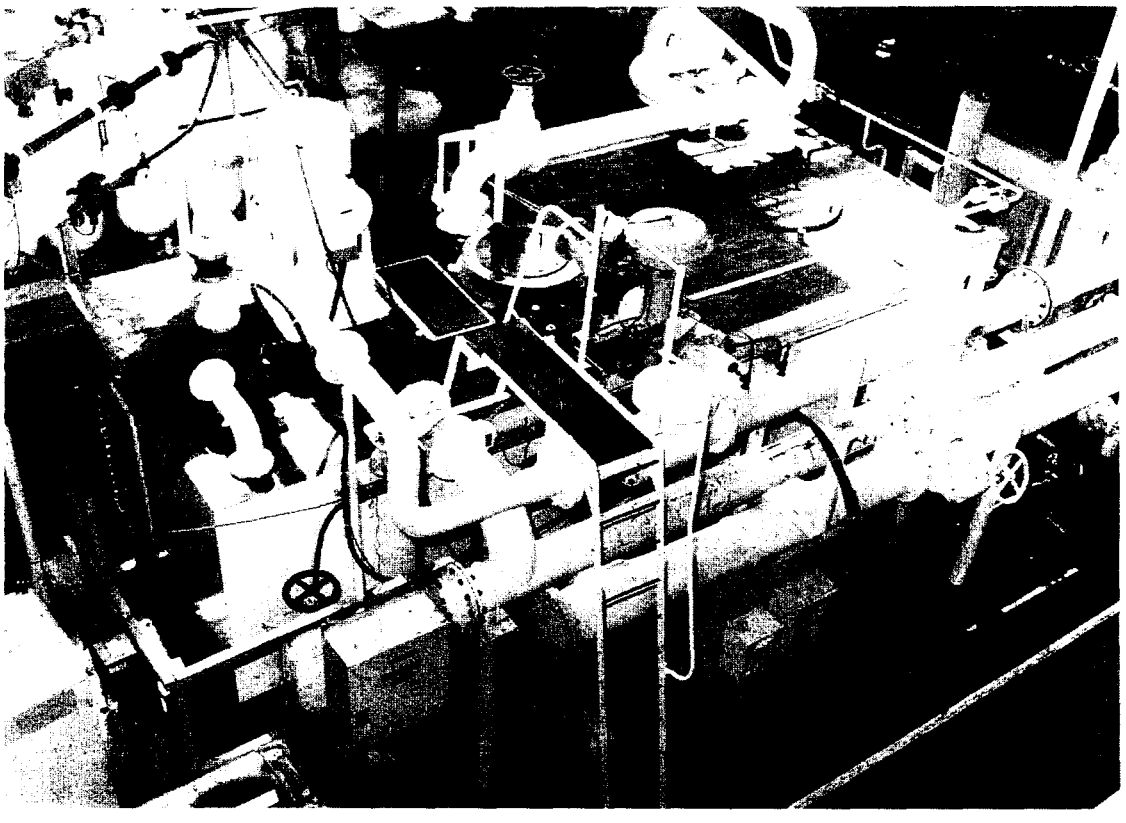

FIG. 3—LUBRICATING OIL PUMP TEST RIG

Fuel Systems

Gas turbine fuel system cleanliness has been a major area of work at Haslar. Extensive testing of filter and coalescer elements has been undertaken and an investigation into the effects of heating fuel prior to centrifuging has been carried out to see if this enhances the removal of organic dirt from naturally degraded dirty fuel. No significant difference in centrifuge performance was noted over a temperature range of 16° to 43°C. However, it was found that dirt removal was significantly increased by the addition of water. A 5% injection of water approximately doubled the amount of dirt removed when compared with the same fuel centrifuged 'dry'.

Wax formation in diesel fuels has also been studied, as cost savings could be achieved by using higher cloud point fuels. A long running trial investigating the pumpability of cold diesel has now been completed. This employed a mock-up of a ship's wing tank in which the fuel was cooled until a wax layer formed.

The results indicated that fuel with a cloud point of -1°C should be pumpable with a sea water temperature of -2°C.

Type 23 Lub Oil System

During HMS *Argyll's* Sea Trials a dip in the lub oil pump discharge pressure set off alarms and brought on line the standby and emergency pumps. Opaqueness of the oil indicated excessive aeration and, as part of an overall assessment of the problem by Yarrows, an urgent investigation was set at Haslar using the lub oil test rig. This was reconfigured as shown in FIG. 3 to simulate the Type 23 drain tank with one pump operational and it was found possible to replicate the aeration and pressure dip displayed by the actual system. The flow paths of the oil through the tank were filmed and the distribution of the aeration mapped. To improve de-aeration, a series of changes to the position of limber holes and de-aeration screens was assessed and proposed modifications to improve pump performance were also investigated. Steps have now been taken to alleviate this problem in the ships affected, but some work continues as the residence time of oil in the tank is a significant factor and needs investigation.

Bilge and Waste Disposal

In this environmentally concious age there is a clear commitment to control oily water discharges overboard. Recent tests on an oily water separator for the Type 23 frigate showed that satisfactory operation was possible once initial teething problems were corrected. However, the low interfacial tension of some oily water mixtures (and when bilge cleaners had been used) tended to reduce the effectivenes of the seperation process. Some 'quick break' type detergents have been developed to overcome this problem and tests therefore continue.

Tighter regulations governing the disposal of garbage at sea have led to a series of tests on gash compactors. So far two-have been found suitable for use in minor warships, and three which appear suitable for larger vessels will be tested in the near future.

Chilled Water Systems

The VANGUARD Class 400 kW chilled water plant recently completed 7800 hours endurance testing, including running at elevated ambient temperatures. Mechanically the machine proved very reliable, but some potential in-service problems, such as the relatively long period required to restart the unit following a shutdown, were highlighted. The plant is currently being used to run a new test facility to establish the performance of self-contained air conditioning units.

Condenser Heat Transfer

Full-scale condenser heat transfer performance tests have long ceased. However, some interesting work has been carried out on the condensing performance of single tubes and most recently this has involved the investigation of the effects of marine biofouling. This has been carried out in conjunction with the Marine Biology Department of Portsmouth Polytechnic and this symbiotic relationship between biologist and engineer produced some interesting results. In general, the sort of corrosion and biofouling that can occur in 70:30 Cu:Ni tubes exposed to harbour waters can decrease heat transfer by up to 20% and can double waterside pressure loss. In the case of titanium tubes, where only biofouling is a factor, heat transfer loss is about the same, but the pressure drop can be as much as four times that of a clean tube. The Haslar expertise in this area has resulted in a number of commercial repayment contracts.

Feed Water Systems

The VANGUARD Class feed and extraction pumps have been evaluated at Haslar. The feed pump (FIG. 4) has satisfactorily demonstrated its endurance under both steady flow operation and the simulated cyclic conditions of an SSBN patrol. The extraction pump has performed reliably for 15 000 hours, but post-shock performance checks and a test of the effectiveness of the back-up shaft seal have still to be completed.

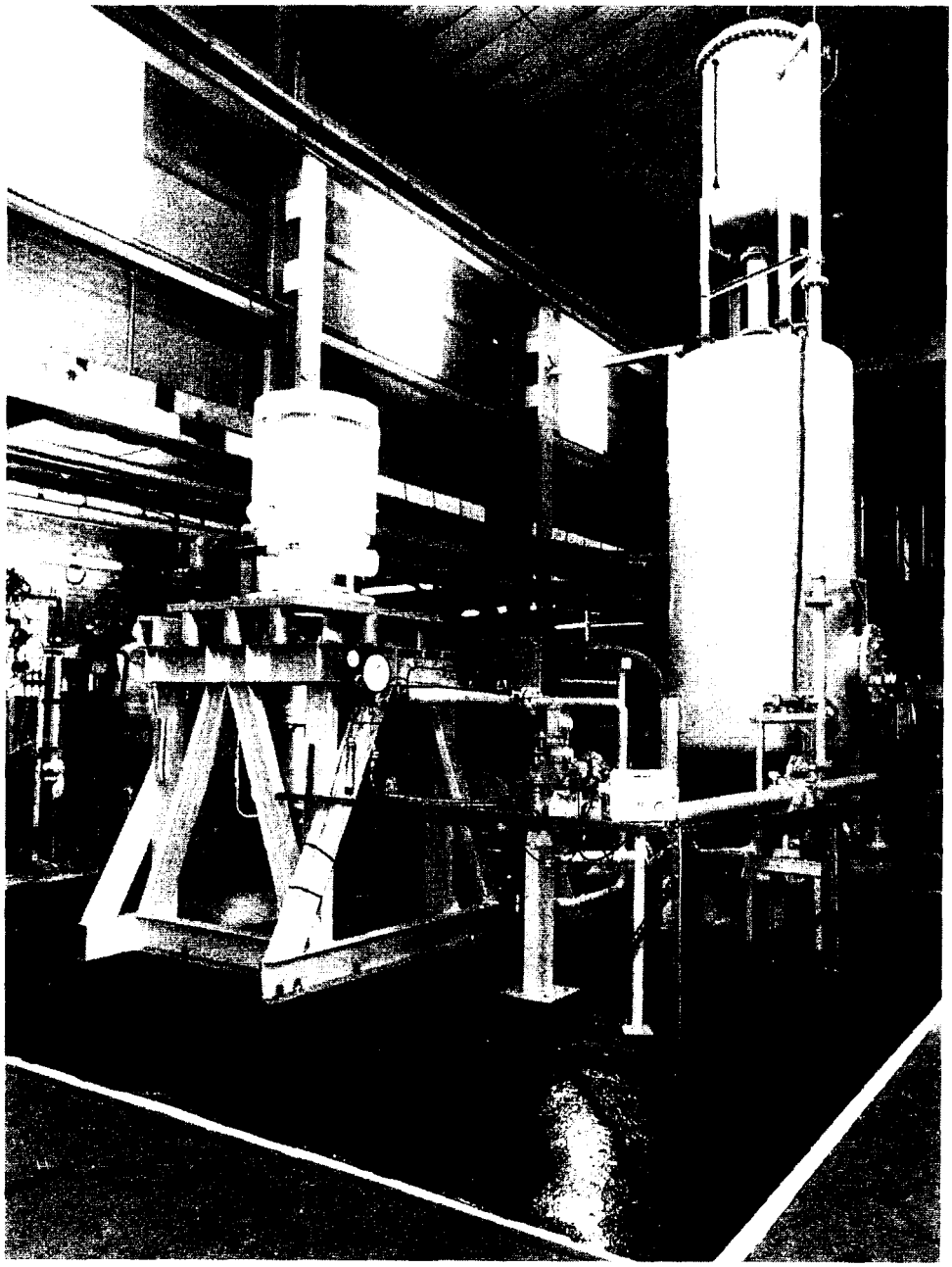

FIG. 4—'VANGUARD' CLASS FEED PUMP ON TEST

Hydraulic Test Facility

OX-40 is an aqueous polyglycol fire-resistant hydraulic fluid. It contains about 40% water and has been used in HMS *Roebuck* since 1987. It is intended to use it in future surface ship designs and the compatibility of the fluid with submarine systems is to be tested in the Hydraulics Test Facility at Haslar.

Pumps, motors, valves, accumulators, silencers and other equipments will be subjected to a typical duty cycle over a prolonged period. On leakage from a system, OX-40 tends to coagulate, leaving a thick glutinous substance which could easily block small clearances. It will therefore be very important to test carefully items such as solenoid valves which could remain pressurized but unused for extended periods.

Flow Measurement Work

Flow measurement is a fundamental part of most projects and therefore a flowmeter secondary calibration facility is maintained which itself has been calibrated to National Standards. Work in this area has included tests on flow control valves for chilled water, flow fuses for hydraulic systems and flow visualization for condenser header corrosion studies. Trials are in progress to evaluate the accuracy and repeatability of three commercial, portable, non-invasive ultrasonic flowmeters for possible equipment condition monitoring use.

The Future

In common with all other areas of the defence industry, the 'Options for Change' announcement will have an effect on the Department's business. However, new important areas of work are emerging, for example the testing of new CFCs designed to meet the latest environmental standards and the evaluation of thermodynamic methods for checking pump performance and condition. With its unique facilities, versatility and speed of response, the Engineering Systems Department at Haslar is also well placed to take on more commercial projects to help fill any shortfall in workload. Being part of the DRA should facilitate this but, as the main customer, the MOD will always have priority for the available resources.

Acknowledgement

Permission by Director Marine Technology DRA Maritime Division to publish this article is gratefully acknowledged. The views contained are those of the author and not necessarily those of the DRA.

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2. Crawford, J. V.: Safety valve testing at ARE Haslar; *Journal of Naval Engineering*, vol. 31, no. 3, June 1989, pp. 632–640.