MACHINERY CONTROLS TRAINING FACILITIES FOR TYPE 22 FRIGATE AND COMMAND CRUISER

BY

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Background

New training facilities are to be installed in the Naval Marine Engineering School at H.M.S. *Sultan*, Gosport in 1979. Their purpose is to provide training for marine engineering ratings on pre-joining training courses (PJT's) for the Type 22 frigates and the Command cruisers. The project is in the contract phase following detailed studies, preparation of specifications and tendering action. This article describes the development of the project.

H.M.S. *Sultan* has experience of machinery control room simulators dating from 1968 when a training facility for the County Class destroyers was installed. That simulator, known as H.M.S. *Buckinghamshire*, is described in ref. 1; it consisted of a steam plant control console on which the many gauges responded to the push buttons and levers through an analogue computer. There was an instructor's console by means of which faults could be introduced and operators could be guided by the instructor on correct drills and procedures. It was very realistic for the watchkeepers in charge of the boilers and steam turbines but it had limitations for the chief of the watch. The effect of cross-connecting units was not simulated and links with the imaginary machinery spaces and gas turbine control room had to be provided by the instructor from his cubicle. An annex with suitable communications was added to represent compartments from which trainees could respond to broadcast instructions. Control system maintenance training was given on pneumatic controls courses for which an equipment demonstration area was provided.

When the Type 42 and Type 21 Classes were ordered in 1968, the Ministry of Defence approved Training Equipment Proposals for the purchase of another simulator for operator training at *Sultan* and for part of a working console for maintainer training at *Collingwood*. The new propulsion machinery was all gas turbine and the controls were electronic. The contract for the simulator was placed in 1970, with the same manufacturer as before and it was available to

train watchkeepers for the Type 21 first-of-class sea trials in July 1973. Known as H.M.S. *Aylesbury* and described in ref. 2, it was a copy of the Type 42 console with additional sections to represent the Type 21 layout. An instructor's console and a bridge console were provided behind a glass partition. An annex was added to represent machinery spaces as for the County Class facility.

The maintainer training console was purchased from the controls manufacturer and delivered to H.M.S. *Collingwood* in 1971. It has been used for PJT courses for teaching first level fault-finding and for training ordnance electrical artificers in fault diagnosis and rectification to enable them to work within the marine engineering departments in ships.

Equipment for the Type 22 Frigate and the Command Cruiser

Research

When orders were placed for the first Type 22 frigate and for the cruiser, *Sultan* raised Training Equipment Proposals for the necessary facilities. Two simulator manufacturers were approached by D.G. Ships for estimates in 1974. The figures received made it necessary to seek sponsorship of a Naval Staff Target and approval of a Naval Staff Requirement to fund the possible costs. At the same time a consultant firm was invited to carry out studies to advise on the most cost-effective training solution. The research study contract was placed in September 1975 and the recommendations were produced in April 1976. TABLE I shows the history of the project and the completion schedule.

During these studies, the consultant analysed the operator and maintainer tasks, the roles of the trainee and the instructor, and the training standards. The total costs of shore training and onboard training were estimated and compared. A computer model was used to assess penalties in drill performance, such as damage to machinery and loss of ship availability. In association with D.G. Ships representatives, the consultant visited ships and training establishments to determine training objectives. Requirements were discussed with many authorities including the R.N. School of Education and Training Technology, Flag Officer Sea Training, C.-in-C. Fleet, C.-in-C. NavHome, shipbuilders, manufacturers and the Applied Psychology Unit of the Admiralty Research Laboratory.

TABLE I—*Project history and completion schedule*

1973–74	Proposals raised.
Oct. 75–Feb. 76	Research study. NST endorsed.
Feb. 76–Apr. 76	Feasibility study.
Nov. 76	Final study report.
Mar. 77	NSR endorsed.
July 77	Specifications complete and validated by D.G. Ships and training establishments.
Aug. 77	Invitations to tender.
Nov. 77	Tenders received.
Dec. 77–Jan. 78	Contracts placed.
Jan. 79–Apr. 79	Training aids delivery.
Apr. 79	Building works complete. T22 Procedure Trainer delivery.
July 79	T22 Procedure Trainer set to work. Cruiser Procedure Trainer delivery.
Aug. 79–Oct. 79	Maintainer Trainer delivery. Cruiser Procedure Trainer set to work.

The Type 21/42 courses were studied for lessons to be learned. All types of training device were reviewed. A series of training package options were costed, ranging from the short course with simple devices coupled to extensive onboard training to the full shore based course with computer-driven simulator.

Recommendations

The initial recommendation was for a systems-orientated PJT with simple consoles for familiarization and a properly structured onboard training course. In discussions with the authorities concerned, the possibilities for onboard training were shown to be limited by operational considerations and by the likelihood of variation in standards between ships. Therefore it was decided that the consultant should develop the specifications for the most suitable shore-training facilities. The Final Study Report (ref. 3) was produced in November 1976 and the Tender Specifications were completed in July 1977.

The general recommendations for training were as follows:

(*a*) The operators must be trained to appreciate the machinery state from the surveillance systems provided and to take the appropriate actions in the normal and breakdown modes. To instil confidence in operating the plant as a whole, the facility should include a representative machinery space environment for local control and communications.

(*b*) For breakdown drills requiring diagnostic ability, operators must be given an understanding of systems such as transmission, fuel, controls, &c. To achieve this a series of training aids in the earlier stages of the course will be necessary.

(*c*) Simulators which accurately represent the performance of ships' equipment are not necessary to train individual operators their tasks; however, for training watchkeeping teams low-cost, low-fidelity simulators are justified.

(*d*) For control system maintenance training, working equipment must be used suitably arranged to teach fault-finding. The equipment and course must demonstrate system upkeep policy and should include a thorough grounding in the use of test facilities.

(*e*) The indirect costs and the instructor/trainee costs over a thirty year period were shown to be five times the life-cycle costs of the training equipment. Thus to reduce costs significantly, the length of course and the number of instructors should be kept to the minimum.

(*f*) To ensure that the pre-joining training course is kept to a minimum, the balance between the career course and the PJT should be regularly reviewed. The career course should include general system operation and maintenance principles but the PJT course should aim to give a thorough understanding of relevant systems to the level at which upkeep is carried out.

Training Equipment Specifications

As a result of the design studies the following items of equipment were specified in Naval Staff Requirement 7005:

Introductory Training Aids: In addition to system wall-diagrams and full-scale panel photographs to be produced by the Training Establishment, it was recommended that animated diagrams illustrating the interacting features of systems should be purchased. These would be operated by the instructor in the classroom. A part of the Type 22 propulsion system training aid is shown in FIG. 1: it indicates the detail of the control sub-system.

Sub-system Training Aids: These are similar to the introductory aids and they will use micro-processor or solid-state logic, illuminated flow lines, lamps and switches to show the relationships between flow diagrams and operating panel indications. They will be used by the instructor in the classroom and should illustrate normal and fault conditions.

Procedure Trainers: These are to be full-scale mock-ups of ship control centres (SCC), consoles and local control positions. Gauges, controls, alarms and

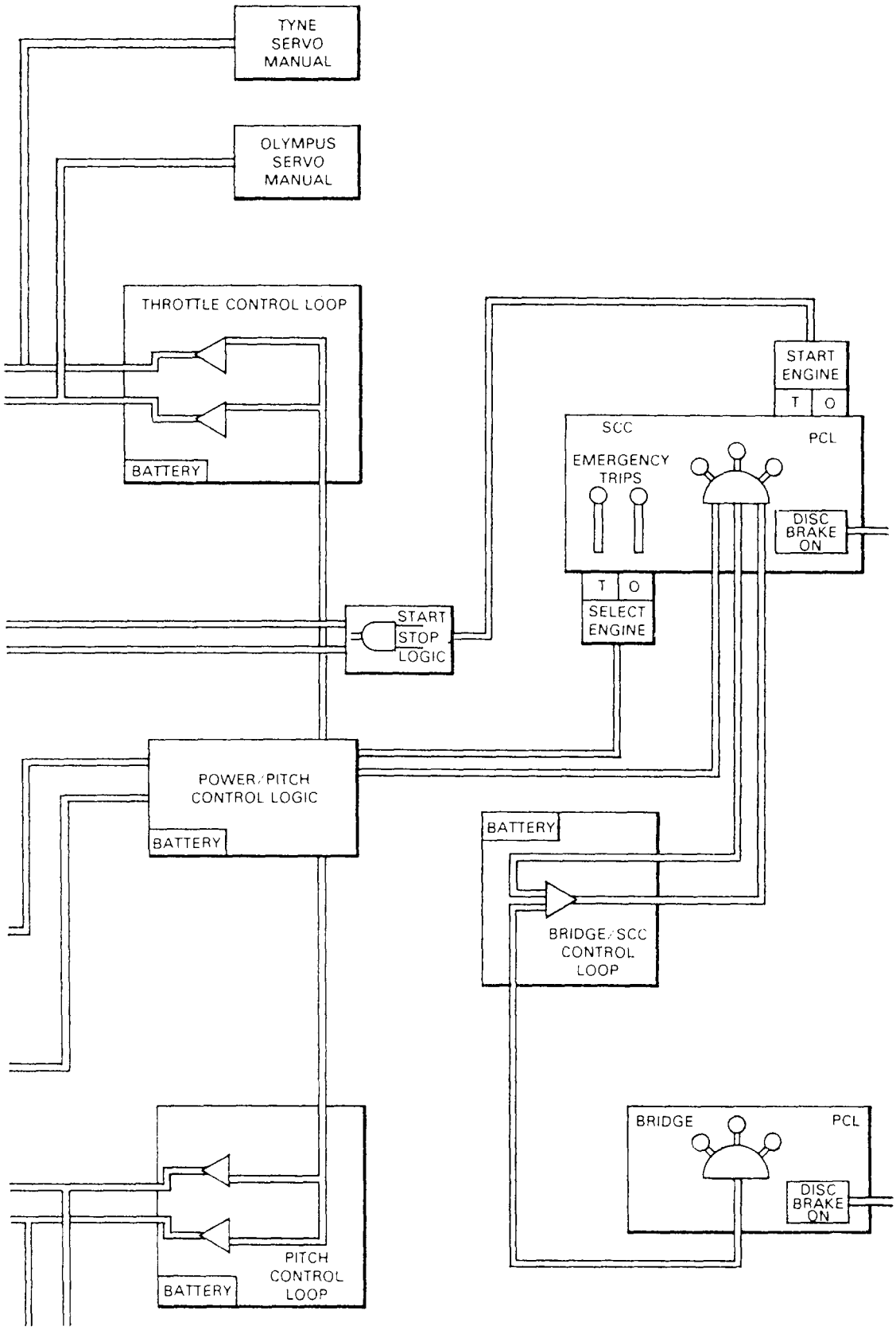

FIG. 1—PART OF PROPULSION SYSTEM INTRODUCTORY TRAINING AID

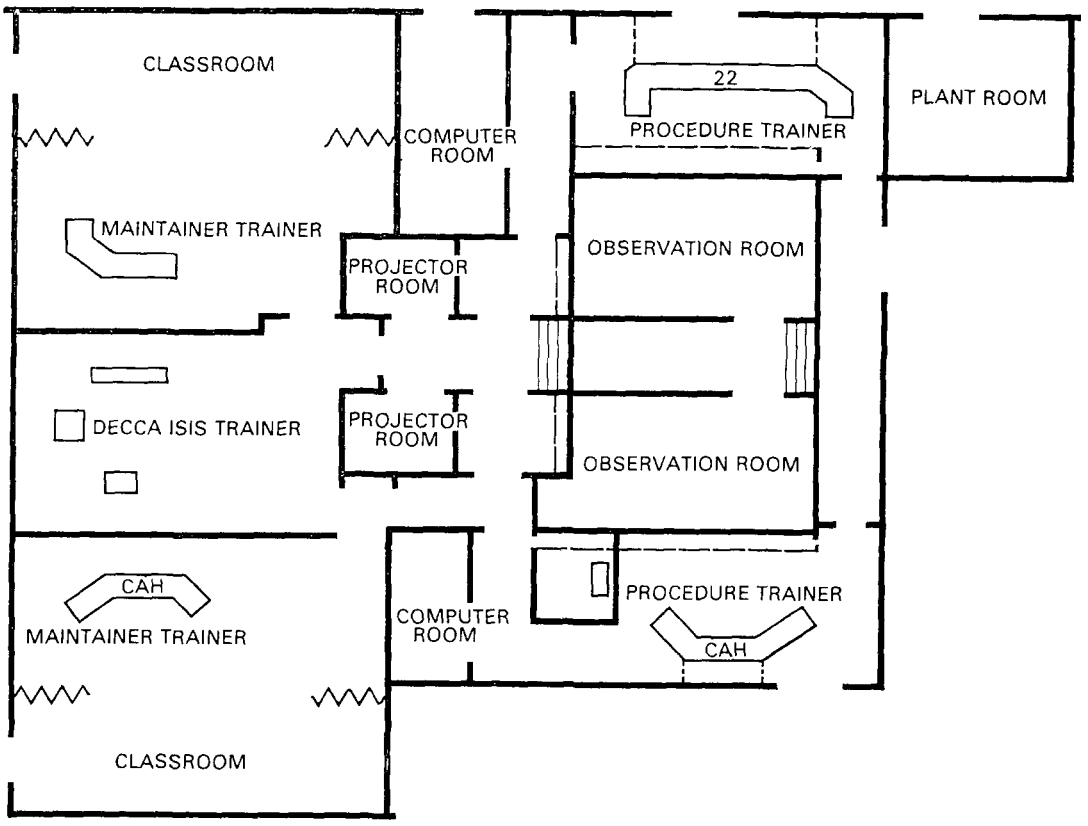

FIG. 2—TYPE 22 FRIGATE PROCEDURE TRAINER—SHIP CONTROL CENTRE

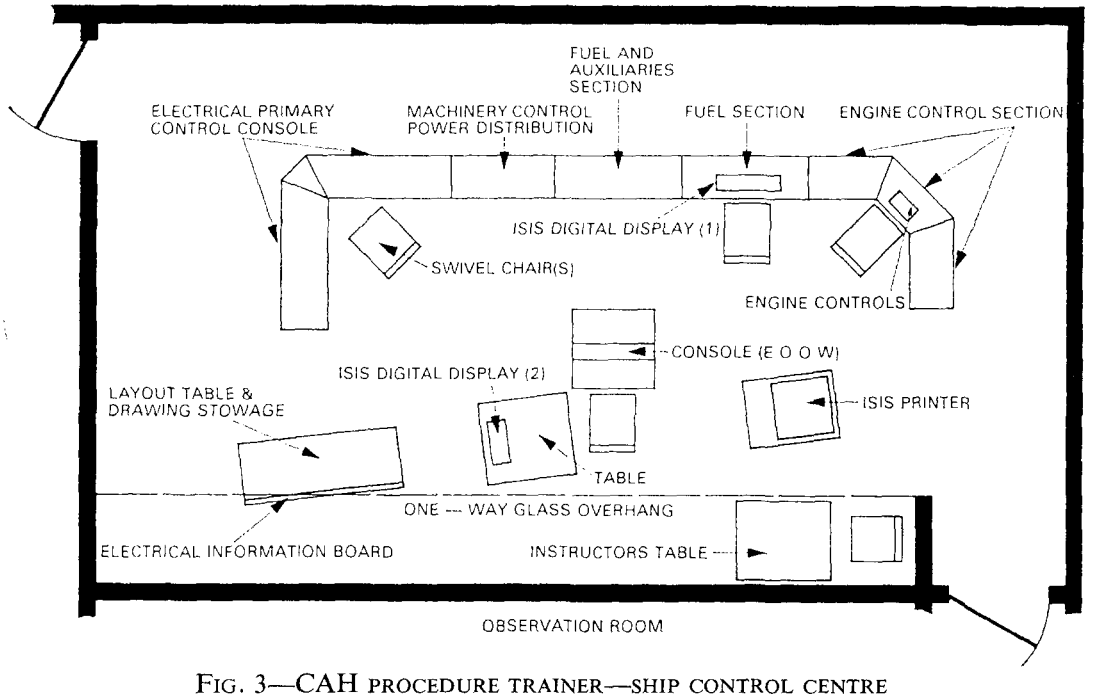

FIG. 3—CAH PROCEDURE TRAINER—SHIP CONTROL CENTRE

warnings, driven by digital computer, are to work as in the ships although exact analogue response is not essential. Operations will be tied to the practice of normal and emergency procedures. Operations external to the SCC will be accomplished in a realistic machinery compartment where the trainee will key a visual display unit to select the appropriate action. Compartment realism will be heightened by the use of back-projection screens showing selected views of machinery spaces. Communications will be as provided in the ship. The Type 22 SCC layout is shown in FIG. 2 and that of the Cruiser in FIG. 3.

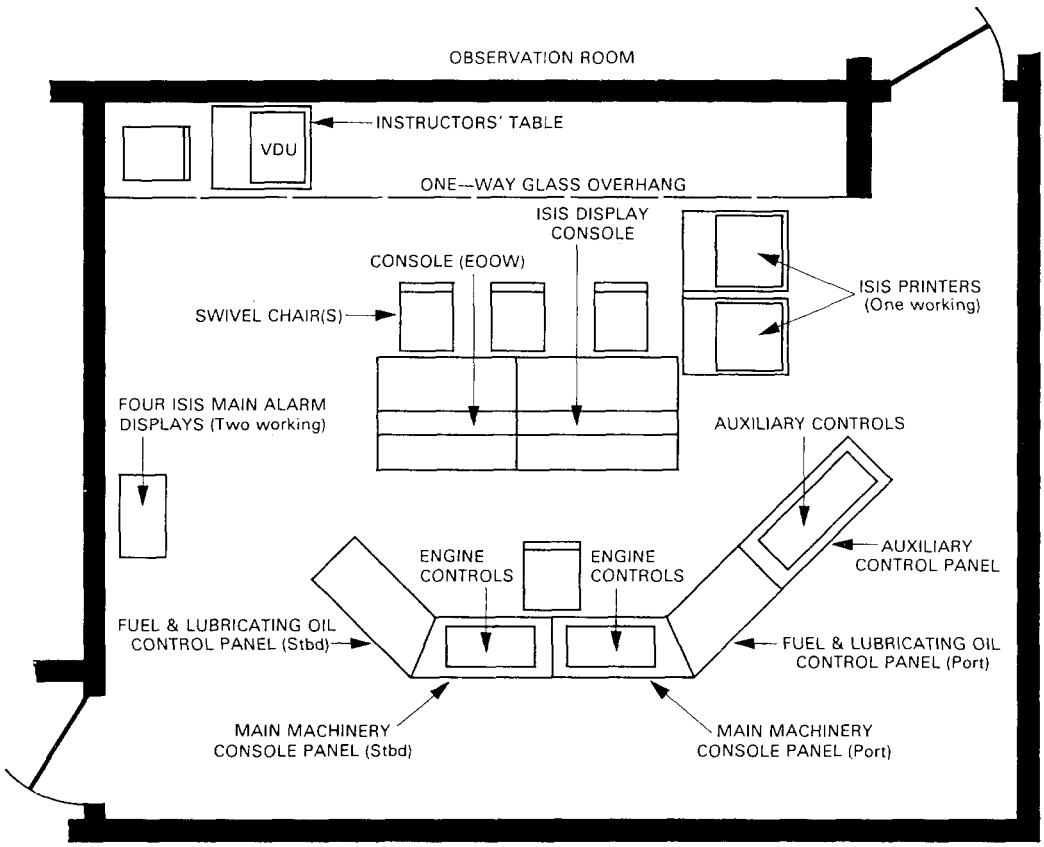

FIG. 4—TYPE 22 FRIGATE AND CAH SHIP CONTROL CENTRE TRAINING FACILITIES AT H.M.S. 'SULTAN'

There will be two instructors' consoles with visual display units, one in the SCC and one in the observation room. The latter will incorporate bridge control simulation. The observation room will enable extra members of a class or visitors to the facility to watch procedures without intruding upon the realism. The complete plan of the training facilities showing the various compartments is shown in FIG. 4.

Details of how the procedure trainer may be used could form the basis of another article but a brief idea is given of the possibilities, which will depend on the programming of the computer. In a typical exercise the SCC instructor will set a machinery condition by keying the VDU and selecting the simulation programme. The trainees will carry out watchkeeping duties in response to orders from the 'Bridge', the instructor in the observation room. The EOOW may require an item of machinery to be checked, so a watchkeeper will be sent to the machinery compartment. He will see on the VDU screen there a plan of the machinery with a code against each item and he will select the location of the machine by keying the code number. The VDU will name the machine selected and a view of it will appear on the back projection screen. It may be the wrong one. The observation room instructor will be able to monitor this. The watchkeeper may check a machine by interrogating the VDU for data such as lubricating oil level, discharge pressure, &c. A fault may have been programmed in; he will report back to the SCC. The exercise may continue thus or the instructors may inject problems by selecting an exercise which sets off warnings and alarms. The SCC team then carry out a breakdown drill to render the machinery safe and maintain manoeuvrability. The programming of the exercises will be done in the preparation of the course, initially by the manufacturer and later by *Sultan* staff after appropriate training.

Maintainer Trainers: These will be sited, as shown, adjacent to classrooms so that instruction on the equipment can be followed in handbooks by members of

the class seated at desks. The equipment will comprise one working shaft set of panels, chassis, modules, and wiring. An instructor's console will enable faults to be introduced for diagnosis. Solid-state logic and slave actuators will simulate the functions of the controls. Built-in test equipment (BITE) and digital voltmeter (DVM) with switchbox will be available for testing. A set of Decca Isis 300 surveillance equipment will be provided to demonstrate its functioning.

The maintainer trainer will teach fault-diagnosis of the control system by observation of the operation of the console and by use of the test equipment. The procedure trainer will not show faults in the control system but will be used to teach how to deal with faults in the plant by reverting to alternative modes. Thus the two sets of training equipment have different but complementary roles. One general purpose set of equipment could not have met the requirements for course scheduling for operator and maintainer training and would have been more expensive.

Installation

The training equipment described above is to be installed in Parsons Block, H.M.S. *Sultan* after conversion of part of the building by the Property Services Agency of the Department of the Environment.

Summary

It is intended that the training facilities when complete and working will meet all the requirements for effective training which have been brought out in the research studies. In this project the lengthy approval procedures and supporting work have delayed the placing of contracts but tendering companies have appreciated the completeness of specifications, and firm price contracts have been agreed. The facilities will make use of up-to-date technology. The course content and structure will need to be fully prepared for procedure programming. The maintenance training element of the PJT may be conditioned by changes in the Engineering Branch Structure but the equipment will be available to train personnel with electrical or mechanical backgrounds to levels compatible with the upkeep policy.

Acknowledgements

In presenting this project review, the author has drawn upon work by past and present members of the Ship Department Machinery Control Section. The diagrams are reproduced from specifications prepared by Messrs. Easams Ltd. (Consultants).

References:

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