

COMMON D86 MAINTAINER TRAINER AT H.M.S. 'SULTAN'

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ABSTRACT

The Common D86 Maintainer Trainer System represents a small distributed control system consisting of a control and data collection unit reporting to a central unit. Appropriate man-machine interfaces are provided. The instructor can inject a large number of faults to aid the training of specialized control system maintainers on Type 23, Type 2400, SRMH and VANGUARD Class ships and submarines.

Introduction

The Common D86 Maintainer Trainer has recently been installed and accepted into service at H.M.S. *Sultan*. The system has been produced by Vosper Thornycroft Controls Ltd using their proprietary range of D86 digital control modules. This equipment is being used in the machinery control and surveillance systems of the Type 23 (DUKE Class) and Single Role Mine Hunter (SRMH) (SANDOWN Class) ships, and the secondary surveillance systems of the Type 2400 (UPHOLDER Class) and VANGUARD Class submarines. At an early stage it was identified that a common maintainer trainer for all these ships and submarines, sited at H.M.S. *Sultan*, would provide the most cost-effective form of training for artificers involved in the maintenance of these equipments.

The system is designed to train naval personnel, with some knowledge of electronics, in the maintenance of D86 systems. The trainees will not, however, necessarily have a detailed knowledge of digital technology and the trainer system is specifically designed to take this into account. The trainer will be used to acquaint trainees with equipment and facilities which are typical of those he will encounter in service. It will also allow the maintainer to overcome any inherent doubts about the technology and become confident in using the equipment and its particular features.

The control strategy and structure of a D86 digital control system is also demonstrated. The equipment enables the trainee to understand the function and scope of a secondary surveillance system, and experience its use with regard to system fault finding. Both discrete and system related faults are introduced, allowing the trainee to interrogate the system, analyse problems and, most importantly, identify the logical reason/location of failures.

The repair philosophy for D86 systems in the Royal Navy is Upkeep by Exchange (UxE) of Line Replaceable Units (LRUs). A LRU could be such an item as a modular power supply, processor, memory or serial data transceiver unit. Trainees/maintainers will not require the ability to understand the details of operation of individual modules or how to repair them. However, they do need to gain the knowledge and ability quickly to diagnose faults and to rectify them (by replacing the faulty LRU if required).

The system is intended to provide maintenance training for any D86 system, and the operations it performs are not specific to any particular application but are typical of the functions found on the Type 23, SRMH, Type 2400 and VANGUARD systems. Further specific-to-type application training will be provided on the appropriate Machinery Control and Surveillance (MCAS) system simulator.

Overview

The D86 Maintainer Trainer System is designated to represent a small distributed control system, consisting of one Control and Data Collection Unit (CDCU) reporting to a central unit. The hardware, as shown in Figs. 1 and 2, consists of the following main components laid out in a classroom setting at H.M.S. *Sultan*:

- (a) Trainee's Console.
- (b) Man-Machine Interface (MMI) Console.
- (c) Instructor's Console.
- (d) Dummy D86 Rack.

System Description

The Trainee's, MMI and Instructor's Consoles are all interconnected whilst the Dummy D86 Rack is a stand-alone unit. Fault switches, situated on the Instructor's Console, enable either hardware or software faults to be injected into the system. Standard Vosper Thornycroft D86 modules are used throughout and therefore the wide range of faults provided should be typical of those which may be encountered at sea.

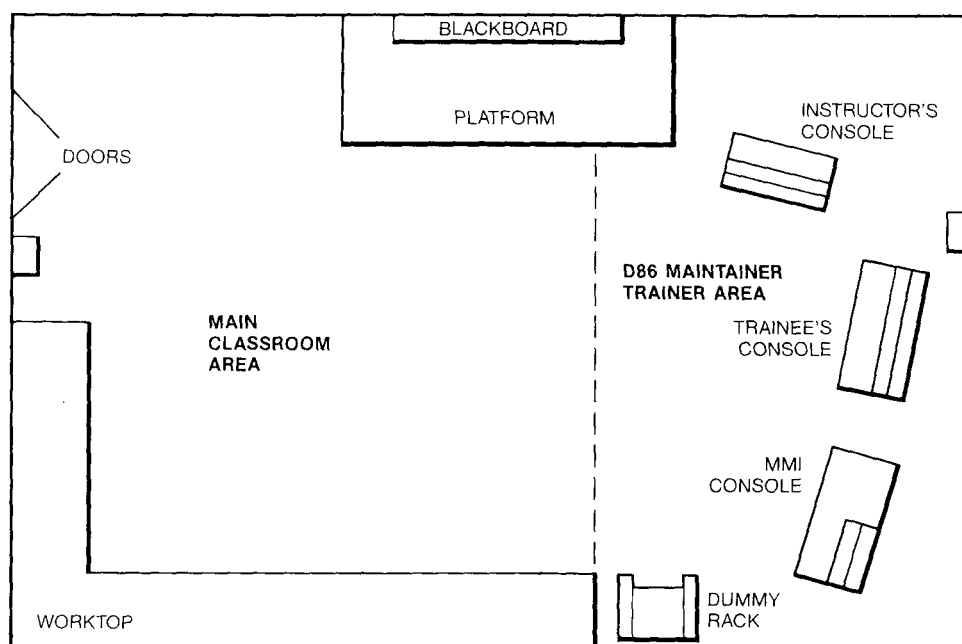


FIG. 1—D86 MAINTAINER TRAINER LAYOUT

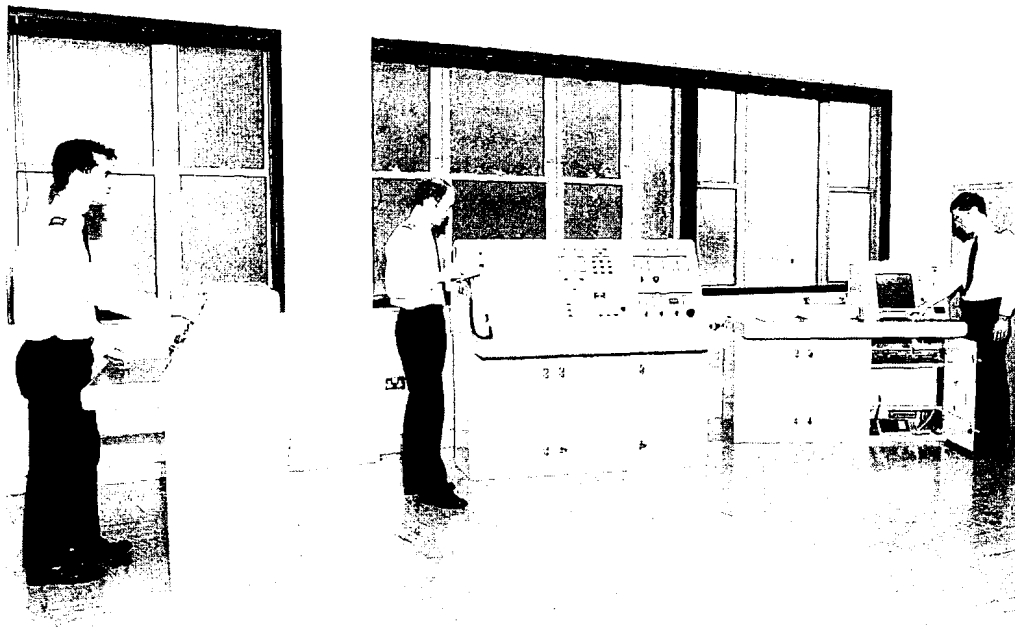


FIG. 2—D86 MAINTAINER TRAINER: (FROM LEFT TO RIGHT) INSTRUCTOR'S CONSOLE, TRAINEE'S CONSOLE, MMI CONSOLE

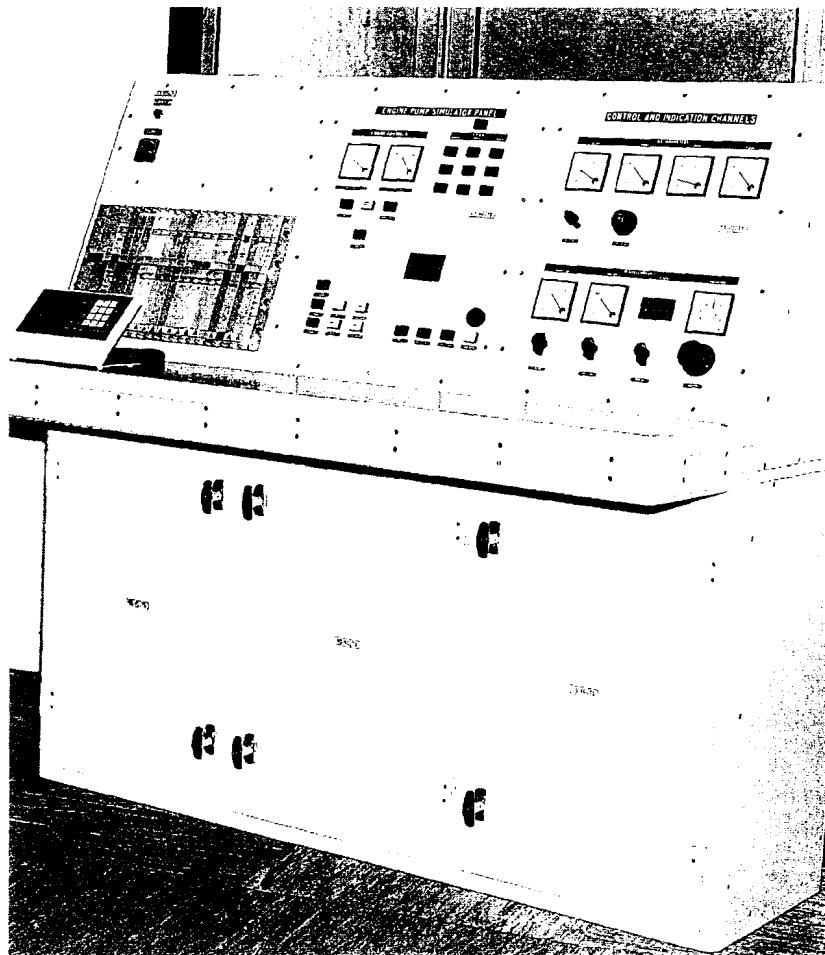


FIG. 3—TRAINEE'S CONSOLE

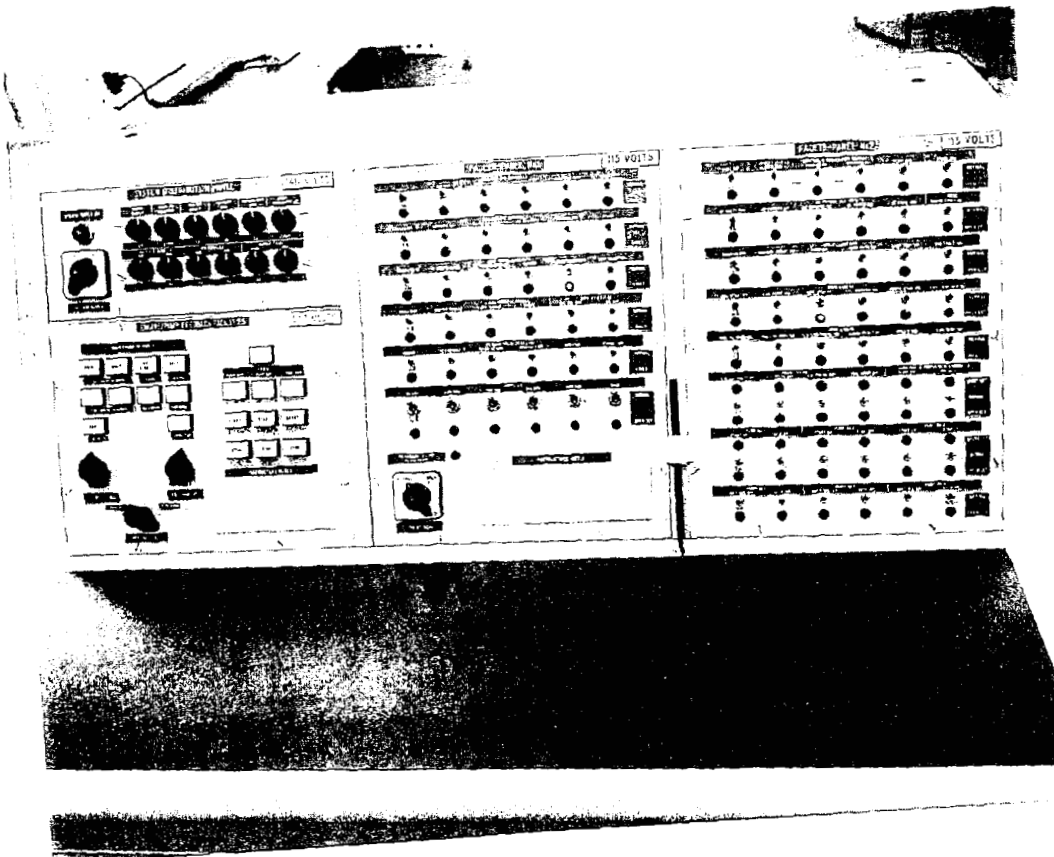


FIG. 4—INSTRUCTOR'S CONSOLE

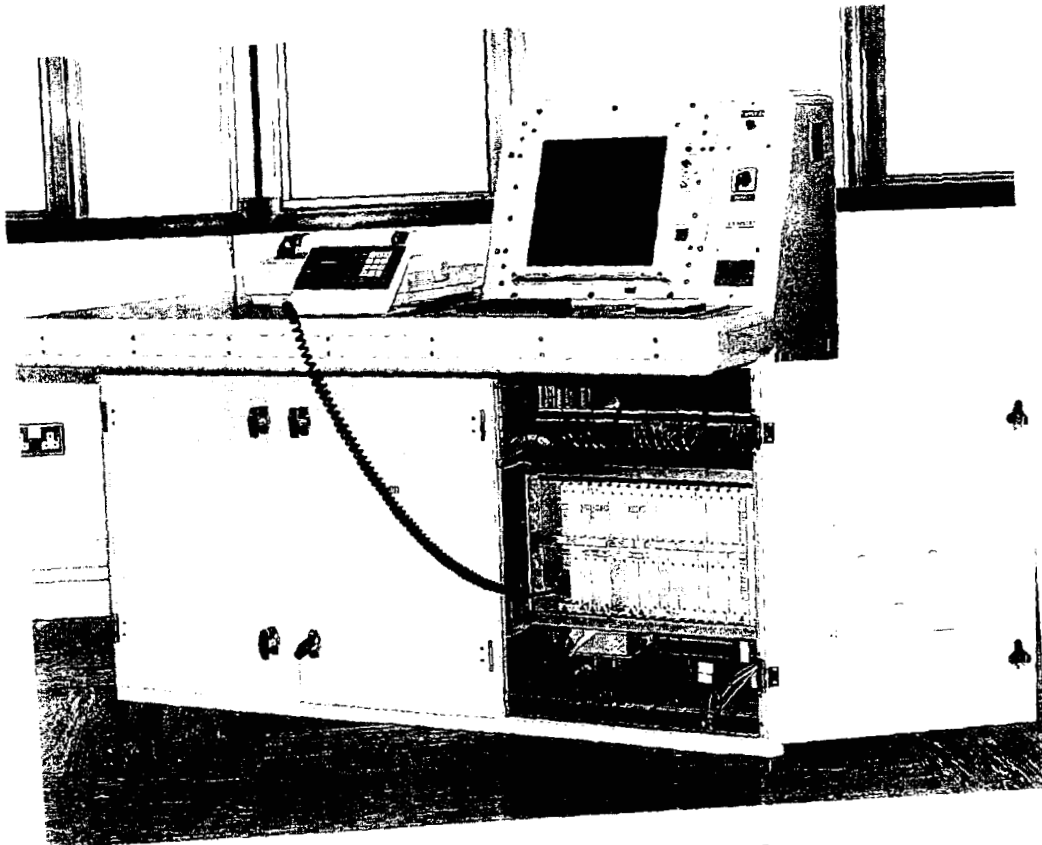


FIG. 5—MAN MACHINE INTERFACE (MMI) CONSOLE

The Trainee's Console (FIG. 3) represents an operator's position, providing control and surveillance facilities. It also houses the trainee's D86 rack, or CDCU. Representing the interface between the control system and its associated machinery, the Instructor's Console (FIG. 4) provides facilities for simulating feedbacks, setting inputs and also for creating fault conditions on the Trainee's and MMI Consoles. The MMI Console (FIG. 5) houses the central D86 unit and provides VDU and printer facilities for interrogation and display of the system status, and for hard-copy event logging.

The training philosophy requires the trainees to identify faults from the symptoms presented at the Trainee's and MMI Consoles. For this purpose the D86 handset is used and it may also be necessary to remove a PCB from the D86 rack to measure signals at the PCB connector using an extender card. The trainees will not be required to dismantle the system further.

The Dummy D86 Rack (FIG. 6) represents a typical CDCU and is completely separate from the rest of the system. It provides the trainees with the opportunity to replace PCBs, ribbon cables, motherboard, etc., and to investigate the whole assembly.

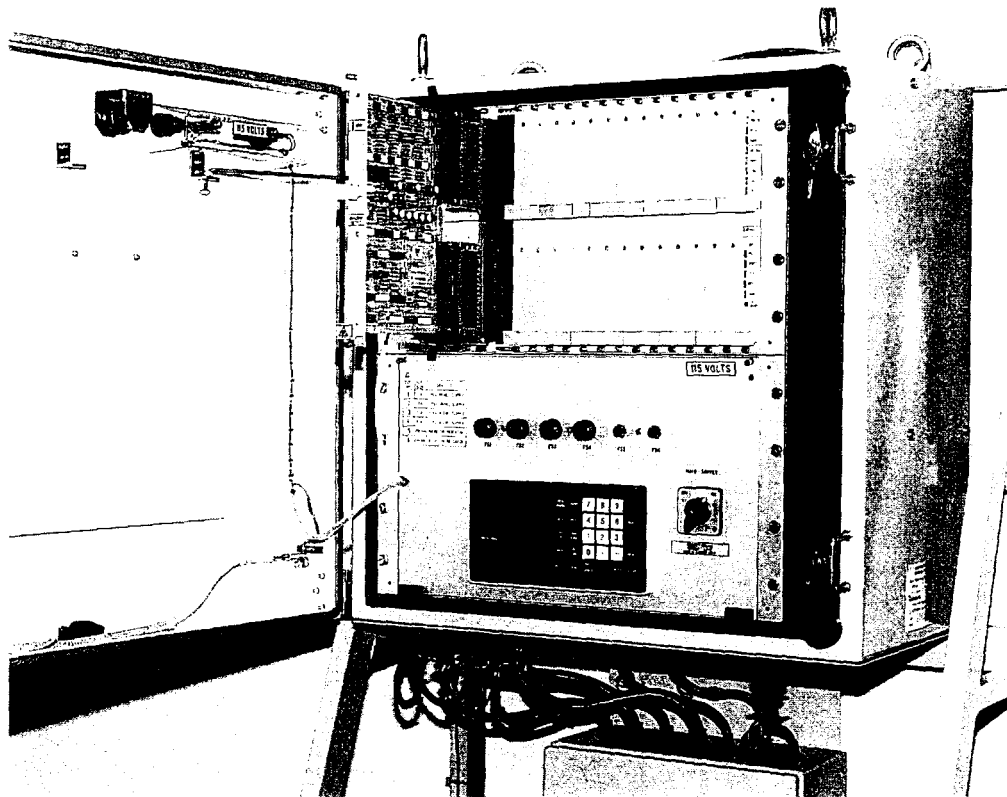


FIG. 6—DUMMY RACK

Facilities Available

The D86 Maintainer Trainer is situated in a classroom in Parsons Block, H.M.S. *Sultan*. A large portion of the classroom is retained for normal instructional use. The Instructor's Console is positioned such that its controls are not visible to the trainee/classroom, yet the instructor has clear vision of the controls on the Trainee's and MMI Consoles, to view the trainee's responses and address the class. The Trainee's Console, MMI Console and Dummy Rack have their control panels facing the classroom, thus allowing the rest of the class a good view.

Before use the Instructor sets the equipment to either Type 23 or Type 2400 mode, using a select switch at his console.

Faults

A total of 83 different faults can be injected from the switch positions on the Instructor's Console. There is no limit to the number of faults that may be in use at any one time. Spare fault channels are available for possible future updates. A list of typical faults is given in TABLE I.

TABLE I—Typical System Faults.

Internal D86 faults	Input/Output timeout failure Memory timeout software fault Serial Data PCB failure Handset failure
MMI faults	Keypad fault Printer fault VDU fault
Power Supply faults	5V PSU failure 24V PSU failure Digital Input OV fault
Input/Output faults	Engine Start input fault LO Pressure input fault Warning Accept input fault Exhaust Temperature output fault
Indication Faults	Synchro Position fault A.C. Voltage Indication fault Pressure Indication fault

Trainee Console

From his Console, the trainee is able to initiate a number of different functions and examine the system status, as described below:

- (a) *Engine Stop/Start Sequence.* Provided that the interlocks are satisfied, the trainee is able to request an engine start sequence based upon that of a Type 23 gas turbine. Provided that the instructor gives the correct responses within a given time then the engine will start correctly. Faults may be overlaid on top of this process either to prevent a start occurring or to give incorrect indications. Once running, the engine will shut down automatically if either the low lub oil pressure or high exhaust temperature alarm inputs are set. Manual shutdowns can be requested by the trainee.
- (b) *Pump Control Sequence.* This represents a simplified version of the Type 23 High Pressure Sea Water (HPSW) Pump start sequence. The trainee can either request individual starts or set the pumps to an automatic sequential start for activation when the flow switch is made at the Instructor's Console.
- (c) *Alarms and Warnings.* In Type 23 mode, separate alarm channels are employed and the warning channels are split into groups with an associated group warning accept button. In Type 2400 mode there are no alarm channels, only warning channels. Furthermore, these are not gathered into groups but are treated individually. When several channels are in warning the oldest is accepted by pressing the accept button on the Type 2400 keypad at the MMI Console. A total of two digital alarms and four analogue warnings are provided. Channel warning levels and filter periods can be altered and channels inhibited using the facilities provided by the D86 handset.
- (d) *Input Indication.* A total of eight inputs, covering frequency, synchro position, A.C. parameters, temperature and pressure, can be set at the trainee's console. These are read and scaled by the CDCU to a range suitable to drive the analogue output indications on the trainee's console.

- (e) *Diagnostic Checking*. Standard D86 diagnostic checks are performed:
- (i) Analogue input checks.
 - (ii) Complementary digital input pairs valid.
 - (iii) EPROM checksum check.
 - (iv) RAM checks.
 - (v) I/O bus check.

If any of these checks reveals a fault then the standard D86 handset messages will be displayed.

MMI Console

The D86 housed in the MMI Console acts as a central unit. It performs the following functions:

- (a) Serial data link handling, receiving data from the CDCU providing information on diagnostic messages, channel states, and alarms and warnings.
- (b) Printer message formatting including event logging, demand logging and screen prints.
- (c) VDU page formatting depending on whether Type 23 or Type 2400 mode has been selected.

The MMI Console is provided with two types of keypad, one for use in Type 23 mode and the other for use in Type 2400 mode.

Dummy Rack

The Dummy D86 Rack is a stand-alone system which the trainees are allowed to dismantle. However, in order to indicate correct re-assembly, the system will perform some simple self-diagnostic checking. Output channels on the digital, analogue and mixed I/O PCBs are connected to input channels on the mixed I/O PCB. If a discrepancy between output and input states or values occurs then the channels will be marked as failed on the handset and the failset relay on the diagnostics PCB will be de-energized. Two 'faulty' cards are also provided with the Dummy Rack in order to further confuse the trainee.

Conclusion

The D86 Maintainer Trainer has now been in use at H.M.S. *Sultan* for a number of months. It has proved to be a reliable and flexible item of training equipment which enables the trainee to start at a low level with simple faults gradually building up to complex multiple fault scenarios. It allows the trainee to develop his fault-finding and diagnostic skills to a high level using the equipment and techniques that he will encounter when he joins a D86 equipped ship or submarine at sea.
