

INTERNAL COMBUSTION PISTON ENGINE TRAINING

BY

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Introduction

The adoption in 1968 of the internal combustion engine as the propulsion and generation prime mover for the future Fleet has highlighted the need for the Marine Engineering Branch to include the operation and maintenance of internal combustion piston engines (ICPE) and gas turbines (GT) in career training. The training package to meet the needs of the future Fleet is very complex, with decreasing emphasis on traditional craft training and more on diagnosis and defect rectification using spare gear. Career training, particularly in the ICPE field, must reflect this trend.

The aim of this article is to bring to the notice of marine engineer officers the changes that have taken place in ICPE training at *H.M.S. Sultan* over the past three years, to explain the reasons for these changes, and to present some ideas for the future pattern of ICPE training.

The Past

Specialist Training

For many years the specialist qualification (ICE) has been guarded jealously by those in possession, and to some extent envied by those without. There has never been any shortage of volunteers for the ICE courses; this may have been because ICE men have tended to remain in small ships where their particular expertise has provided them with more responsibility. They, therefore, have had better motivation and more job satisfaction.

Internal combustion piston engine training, at all levels from MEM1 to MEA(P), has always included the operation and maintenance of machinery as well as details of construction. The syllabuses for the old six-weeks Junior Basic Diesel course, the eight-weeks Senior Basic Diesel course and the nine-weeks Adqual 2 (ICE) course seem to be very similar in content though the technical

ability of the student is very different. It has been said that it took three weeks longer to train an Adqual student to the same ICE standard as an MEM1 on the junior basic diesel course (JBD)! This, of course, was not so: each Adqual subject was taught at a greater pace allowing more technical detail to be given to the student, and the instructor passed on much of the 'nice-to-now' information gained from his past ICE experience.

The duplication of instruction was necessary because, as they were not career courses, a rating could join one of the more advanced ones with no previous ICPE training. This is demonstrated in FIG. 1 where Man A completed the Adqual with 26 weeks of ICPE training, whereas Man B had only eleven weeks. During his instruction Man A would have completed five practical top overhauls on one of the Foden or Perkins engines.

Marine engineering artificers complete an ICE course of approximately two weeks during their apprenticeships and after Adqual 2 as a MEA1 will have had a total of eleven weeks of training—very similar to that of mechanic B in FIG. 1.

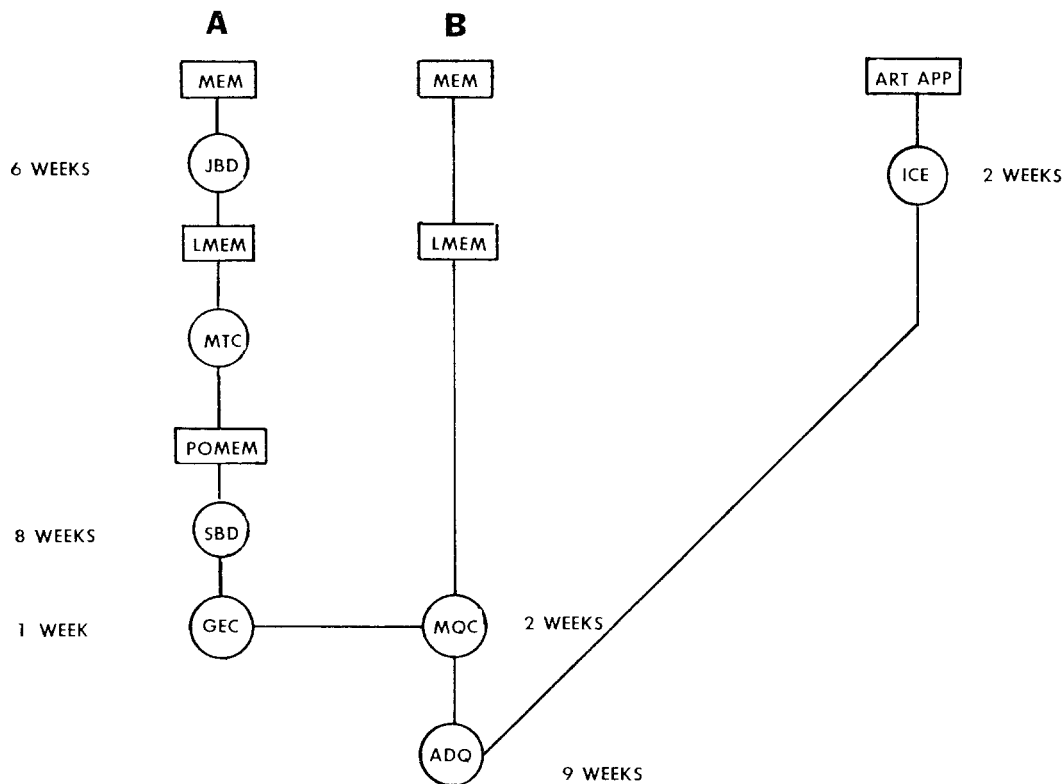


FIG. 1—ICPE TRAINING 1973

Pre-Joining Training (PJT)

ICPE instruction was given in no less than fifteen different pre-joining courses. This ranged from a one-day acquaintance with Paxman Venturas and Johnson outboards for the *Leander* senior ratings' course to a three-week Napier Deltic engine type course for the MEA or MN about to take charge of the engines of a coastal minesweeper for the first time. The engine courses required specialist instructors with previous sea experience of the machinery and, in order to give the student some practical training, functional engines were also required. Functional engines, although costly to install, have proved to be the most valuable of the training aids available, and over the years many types have been fitted in H.M.S. *Sultan* to provide the best possible instruction.

Many of the career and PJT courses were well established and, despite some overtraining and repetition in career courses, the standard was considered to be satisfactory.

DELTIC COURSE: This was a three-weeks course, the first two weeks of which were attended by MEAs, MNs, and POMEMs drafted to coastal minesweepers or to base-support teams. It was very factual and covered the engine in great detail. The starting and running routines were taught on the Deltic engine but there was no practical maintenance. Only the MEAs and MNs attended the third week which was devoted to administration and the standard documentation system. It is significant that these latter subjects were also fully covered by the first-class rates' career course.

LISTER COURSE: This one-week course was for CMEAs, MEAs and MNs drafted to coastal survey ships. The first three days were devoted entirely to the Lister engine used for propulsion and generation, and the remaining two days covered general ship systems, hydraulics, the controllable-pitch propeller, and the Stone Vapor generator. POMEMs drafted to these ships stayed only for the first three days.

JOHNSON OUTBOARD: This was a one-day course for ME senior ratings to acquaint them with the operation and routine maintenance of the standard outboard engine. Practical work on the engine was not attempted.

VENTURA COURSE: This was a four-day course for ME senior ratings dealing specifically with the Paxman Ventura engine. There was no practical instruction in the course.

41/61 ASR1 COURSE: This was a three-week course for ME senior ratings and dealt with construction, operation, and maintenance of the ASR1 engine. Details of the ship systems and some practical work was included in the course.

The Present

The adoption of objective training in 1970 gave an opportunity to redesign ICPE training as a whole and to consider the following points in the redesign of each course:

- (a) Elimination of overtraining.
- (b) Elimination of repetition in career courses.
- (c) Standardization of courses.
- (d) Provision of a logical sequence in ICPE career training.
- (e) Reduction in course length.
- (f) Making of better use of functional machinery.
- (g) Separation of ICPE and gas turbine instruction.
- (h) Provision of sufficient technical expertise for MEAs and MEMNs.

The retention of technical details of ICPE theory and construction in the senior ratings' career and pre-joining training courses was necessary in order to provide the depth of training essential for fault diagnosis.

Career Courses

There is an ICPE content in four career courses, namely the junior basic diesel course, the mechanical training course, the general engineering course, and the mechanics qualifying course:

JUNIOR BASIC DIESEL COURSE (JBD): The redesign of the JBD established that the mechanic had been overtrained. During the first week of the new

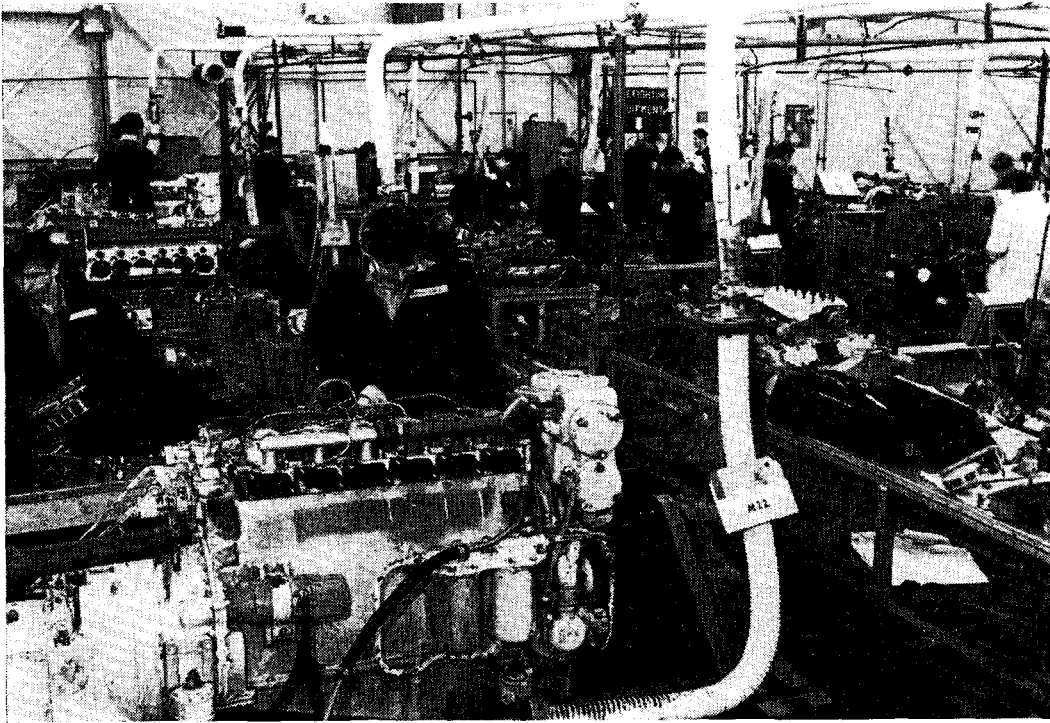


FIG. 2—MEMS ENGAGED ON PRACTICAL TOP OVERHAUL ROUTINE DURING THE SECOND WEEK OF THE JBD COURSE

course, classroom instruction on the elements of engine construction and a basic knowledge of combustion theory is given. In the second week, this is put to practical use when the mechanics carry out a top overhaul of a motor-boat engine (Perkins, Foden or Enfield) with only limited supervision. They also spend an afternoon watchkeeping on one of the major diesel generators. There are no course hand-outs as *B.R. 3003*, Volume 1, is used as the reference for instruction.

The two-weeks course achieves the same standard of practical knowledge as the former six-weeks course. The major difference now is that instead of only a few mechanics being trained in ICPE, all MEMs who joined the R.N. since the summer of 1974 have completed the course as the final element of their new-entry Part II training. This has allowed greater drafting flexibility and provided more highly trained ratings.

Successful completion of the course now removes the necessity for formal training in motor-boats and diesel generators as part of the auxiliary machinery course. On-job training in his ship to the satisfaction of the MEO is still required, however, to adapt the ratings to the ship's systems and orders.

At present, the junior basic diesel course is not confined to Part II trainees. MEMs from sea will continue to be drafted to the two-weeks course until 1977, by which time it is expected that H.M.S. *Centurion's* ICPE quota will be filled by ex-Part II JBD-trained ratings. The marine engineering branch of the Royal Naval Reserve and the Sea Cadet Corps now also use this course for their basic training.

THE MECHANICAL TRAINING COURSE (MTC): The ICPE content of the eight-weeks MTC is only half a day and this time is spent on practical tests of lubricating oil, inhibited cooling water, and a diesel engine injector.

THE GENERAL ENGINEERING COURSE (GEC): The fifteen-weeks GEC—the confirmation course for A/POMEMs—is a second opportunity for suitable candidates to gain selection for the mechanics qualifying course (MQC),

and provides technical up-dating for the mid-career mechanic. The course includes one week of ICPE training, the second half of which is devoted to a practical top overhaul of a small engine. The standard achieved is that of the JBD.

THE MECHANICIAN QUALIFYING COURSE (MQC): The two-years MQC contains only two weeks of ICPE instruction. During the first of these weeks, details of theory and construction are given, and in the second week a motor-boat engine is top overhauled. The MEA apprentices complete a very similar course before leaving H.M.S. *Caledonia*. Both these courses are examined by an external authority—the Naval Air and Marine Examination Board (NAMEB).

A syllabus comparison is shown in FIG. 3; this shows that the level of ICPE training in the present marine engineering career courses (MEA apprentices, GEC, and MQC) is very similar to that reached by JMEMs who have completed their Part II training.

	M	T	W	T	F
1	THEORY + CONSTRUCTION	GOVERNORS + TRANSMISSION	FUEL INJECTION LUBRICATION SYSTEMS	STARTING ROUTINES REVISION	EXAM
2	PRACTICAL		TOP	OVERHAUL	DRAFT ROUTINE

JBD

ICPE THEORY CONSTRUCTION	FUEL INJECTION	SYSTEMS
TRANSMISSION GOVERNORS SUPERCHARGERS FAULT DIAGNOSIS THEORY	PRACTICAL TOP O/H FAULT FINDING	
TOP O/H FAULT FINDING	REVISION EXAM	

MEA/A OVER 7 WEEK PERIOD

CONSTRUCTION + LUBRICATION	SYSTEMS FUEL INJECTION	GOVERNORS TRANSMISSION START AIDS	PRACTICAL TOP	OVERHAUL
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GEC

ICPE THEORY + CONSTRUCTION	SYSTEMS	FUEL INJECTION + COMBUSTION	GOVERNORS SUPERCHARGERS	TRANSMISSION
PRACTICAL		TOP	OVERHAUL	

MQC

FIG. 3—ICPE SYLLABUS IN CAREER COURSES 1975



FIG. 4—LMEMs AND POMEMs ENGAGED ON PRACTICAL OVERHAUL OF LISTER SR2 MOTOR-BOAT ENGINE DURING THE SBD COURSE

Specialist Training

The junior basic diesel course is no longer considered to be a specialist course as it forms an integral part of Part II training which, as already said, is a career course.

SENIOR BASIC DIESEL COURSE (SBD): A job evaluation of POMEMs was completed in August 1973 by the Naval Manpower Utilization Unit (NMUU); this provided a basis for the redesign of the SBD and, as a result, the length of the course has been halved from eight to four weeks and the contents streamlined to suit the needs of the rate. In many ICE ships, the LMEM performs a similar technical task to the POMEM and he should therefore receive the same training. Accordingly LMEMs now do the SBD before joining an ICE ship and the course has been adopted as a module of the MTC.

A survey of old course wash-ups showed that too much time was spent on theory and construction details of ICPEs and, although stripping and testing a fuel injection pump was of interest, it did not form part of the POMEMs' job at sea. The Ventura is the standard generator engine in the Fleet and the course syllabus is now based on this engine thus removing the need to teach it as a separate subject. All ratings apart from MEMs complete a PJT course before joining a gas-turbine ship and so this subject has also been removed from the SBD. The new senior basic diesel course is shown in FIG. 5. This shows that the time spent on :

- (a) theory and construction has been condensed;
- (b) fuel injection has been reduced;
- (c) the Ventura engine, as a separate subject, has been deleted;
- (d) gas turbines have been deleted.

Perhaps the greatest single change in course content is in practical maintenance. The repeated instruction on top overhauls in previous courses had little instructional value, and the reduced complements of modern and future ships highlighted the need for mechanics to be taught new skills. The removal of a line of parts (piston and liner) from a Vee engine now forms part of the SBD. The engines used are Paxman 12 YHA which are very similar to the Venturas in the Fleet, and the standard of workmanship is proved by running the engine on completion. This radical change in the teaching of mechanics has proved very successful, and the practical input has recently been increased to include the complete strip of a Lister SR2 motor-boat engine. The correct use of documentation is stressed throughout the course and the maintenance tasks are carried out under only limited supervision. The SBD also serves as a pre-release vocational training (PRVT) course for personnel of the three Services about to enter civilian employment.

ADQUAL 2: This, the most advanced course on internal combustion piston engines, has proved to be the most difficult to redesign. The present course is a streamlined version of the old course, and was evolved from course wash-ups that revealed areas where redesign was needed. The removal of gas-turbine instruction, intermediate examinations, and some practical work has provided the bulk of the reductions. Specialist instruction in gas-turbines will now be by PJT for those ratings drafted to such ships. The Adqual student is no longer required to complete a top overhaul of a motor-boat engine, but now does the same practical instruction as that done on the new SBD course. The maintenance tasks are carried out on functional engines, thus allowing practical assessment of student performance.

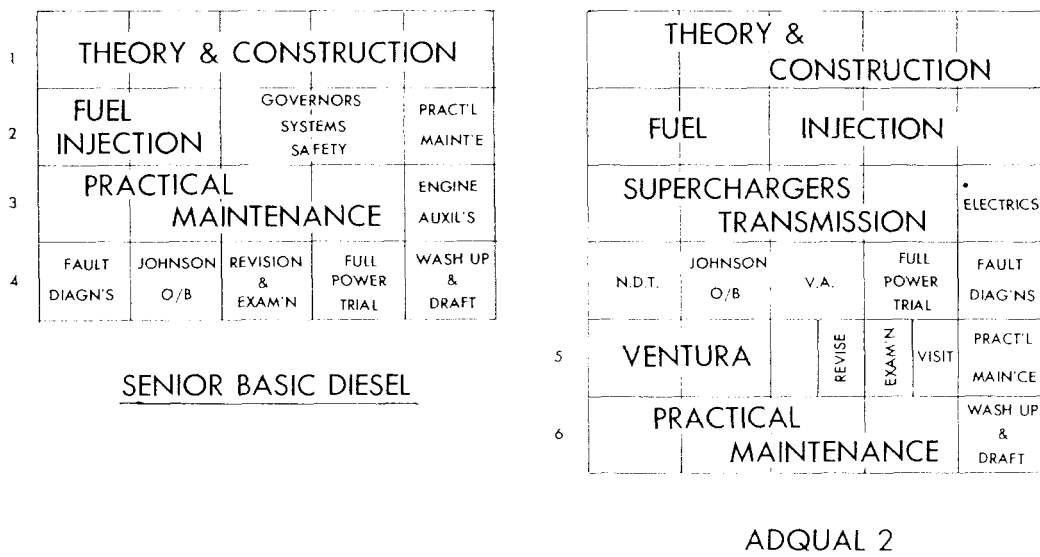


FIG. 5—SPECIALIST COURSES 1975

Pre-Joining Training

The relationship of pre-joining training courses to the senior basic diesel course is shown in FIG. 6.

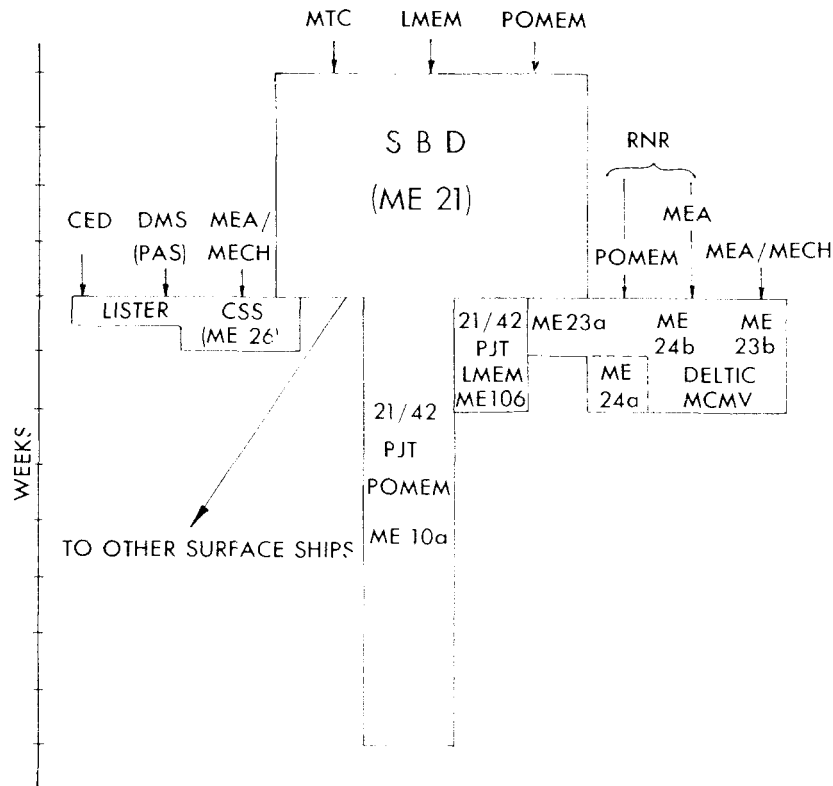


FIG. 6—PRE-JOINING TRAINING COURSES AS RELATED TO THE SENIOR BASIC DIESEL COURSE

JOHNSON OUTBOARD: This one-day course is now included in both the SBD and Adqual courses, but also remains a separate course in its own right. Recent acquisition of four functional engines will enable practical tasks to be undertaken by the students.

DELTIC COURSE: This course has been completely redesigned, and now also accepts LMEMs as students. During the first week all students receive instruction in basic engine construction, practical operation, ship systems and auxiliary machinery. Only MEAs and MNs attend the second week which covers the engine in more detail and includes some practical maintenance of a functional machine. The third week (administration) no longer takes place because this is covered during the First Class Rates course. R.N.R. engineer officers and senior ratings attend the two-weeks course as part of their annual training commitment.

VENTURA COURSE: This course has been deleted as being sufficiently covered by career and specialist courses.

41/61 ASR1 COURSE: The programmed course has been deleted. Functional machinery, however, has been retained in order to provide training on an 'as-arranged' basis.

LISTER COURSE: Very few changes have been made to the existing course, LMEMs drafted to coastal survey ships now complete this course after the senior basic diesel course.

The Future

The need for ICPE-trained mechanics and technicians to man the Fleet of the future is clear, and to achieve the necessary standard the current specialist training (SBD and Adqual) will need to be absorbed into career training. Pre-joining training, and in particular the use of simulators, has proved to be of

great value in training men to perform a specific task, but the basic knowledge on which to build this training must be acquired in career courses.

It seems that the present ICPE career training is not sufficient to enable junior technicians to cope with the diagnostic and maintenance problems they are likely to meet. Mechanics at LMEM level, having completed the senior basic diesel course, are now trained to a standard that will enable them to complete major maintenance tasks under limited supervision. Technicians are not trained to this standard until they have completed the Adqual as a first-class rating. It is essential that technicians are able to understand the task being performed by mechanics in order to supervise their work and be responsible for functional tasks; and to achieve this, technicians must be trained to at least the same level as mechanics of equivalent rate.

Career Training—Mechanic

The junior basic diesel course is now an established part of career training, and the next step is to include the senior basic diesel course in the career training of marine engineering mechanics.

The MTC has a twofold aim, namely:

- (a) to qualify LMEMs professionally for confirmation in the rate;
- (b) to select ratings for the MQC.

This eight-week course is undertaken at H.M.S. *Sultan* by all A/LMEMs. It is followed by various 'modules' to suit the next employment of the student, i.e. steam module, gas-turbine module (PJT) or diesel module (SBD). In future all A/LMEMs returning for the MTC will have completed the JBD during their Part II training, and the training standard will be common although their subsequent experience will be varied. The inclusion of the SBD as an integral part

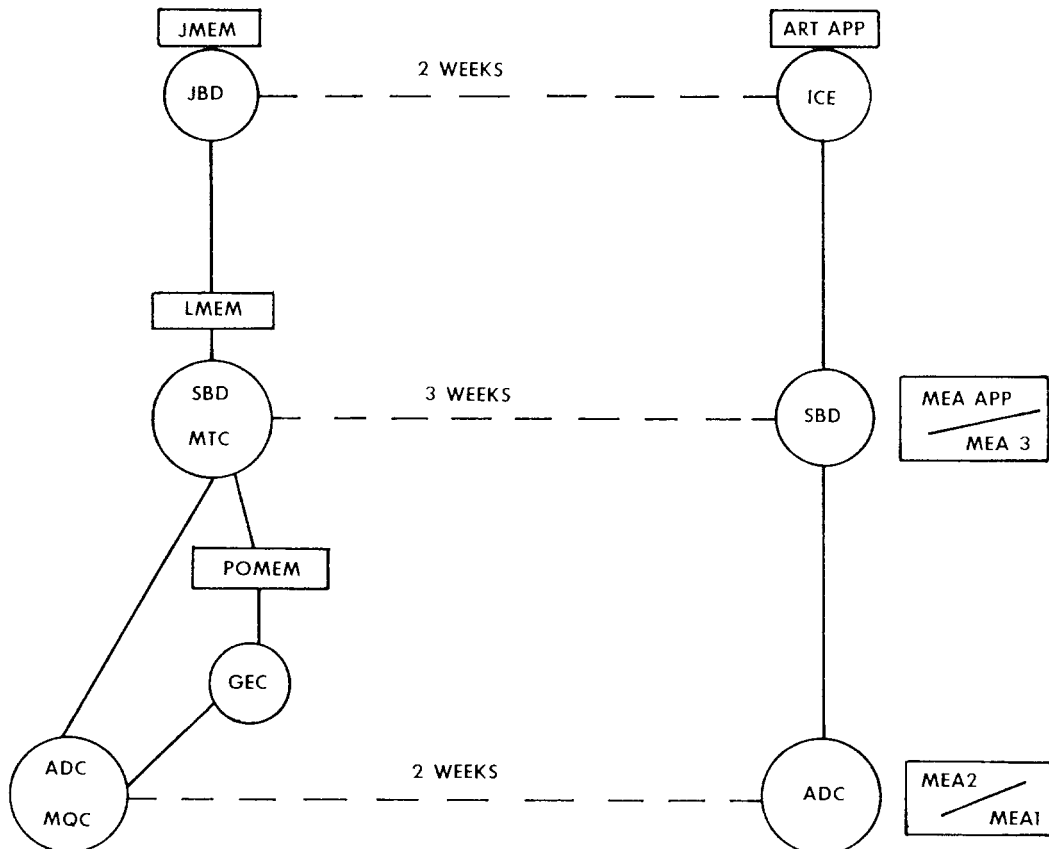


FIG. 7—A PROPOSAL FOR THE FUTURE

of the MTC would ensure common training in ICPE to SBD level for all LMEMs, and its length could be cut from four to three weeks as basic theory and construction of the engines has already been covered by the JBD course.

The ICPE instruction in the general engineering course (GEC) would then be deleted and any further ICPE training would be given by pre-joining training courses.

Career Training—Technician

The current training programmes of MEAs and mechanics leave little scope for change in the immediate future as an increase in course length would not be in line with the present policy of reducing training time. It would be desirable to have MEAs and mechanics achieve the same ICPE standard at the same or similar rate as shown in FIG. 7. The adoption of the junior basic diesel course by MEA apprentices would provide the common basis for the senior basic diesel course which would follow at the end of apprentice training or during the period following sea experience as MEAs 3rd class. This equates with LMEMs in terms of rate and experience.

The additional training to provide technicians with professional expertise to cope with diagnosis, trials, quality assurance and overall job planning in the ICPE field would then be provided by a two-weeks advanced diesel course. This could replace the present ICPE instruction during the mechanics qualifying course and possibly be added to the first-class rates course for MEAs. The course could be monitored by NAMEB if so desired.

Feedback

The training of men to suit the future needs of the Marine Engineering Branch within the modern Fleet has a constantly changing pattern, and feedback from marine engineer officers at sea employing the 'end product' is most important in the evaluation of training courses. The constraints placed on the available manpower are well understood, but the extended use of mechanics in the maintenance role may well provide a very willing and more than able pair of hands.
