THE ROYAL NAVAL ENGINEER OFFICERS' CONFERENCE

STANDARDS OF ENGINEERING—THEIR FITNESS FOR WAR AT SEA

The Engineer Officers' Conference was held at the Royal Naval Engineering College, Manadon, on 27th April 1979. The theme of the Conference was 'Standards of Engineering'.

After a welcome to the College by CAPTAIN P. G. HAMMERSLEY, O.B.E., the Chief Naval Engineer Officer, REAR-ADMIRAL L. S. BRYSON, gave an opening address. This was followed by a presentation on standards of engineering in the Fleet introduced by REAR-ADMIRAL D. O'HARA, CSO(E) to Commander-in-Chief Fleet, and supported by CAPTAIN J. JACOBSEN, CSO(E) to FOSM, CAPTAIN A. W. WHEELER, CSO(AE) to FOF3, CAPTAIN J. M. L. HUGHES, FWEO, and CAPTAIN E. MACLEAN, FMEO. Flag Officer Sea Training, REAR-ADMIRAL A. J. WHETSTONE, supported by his CSO(E), CAPTAIN J. P. EDWARDS, M.V.O., then spoke of standards achieved during sea training, and the presentation was concluded by REAR-ADMIRAL O'HARA.

Subsequently, six separate seminar groups were convened each under the chairmanship of a captain at which the following subjects were discussed:

Seminar A—CAPTAIN E. MACLEAN—Do we procure the right equipment for the Fleet?

Seminar B—CAPTAIN A. SHORT—Are our upkeep philosophies about right?

Seminar C—CAPTAIN J. M. L. HUGHES—How can we ensure high weapon effectiveness?

Seminar D—CAPTAIN M. F. SIMPSON—What challenges lie behind the changing face of the Fleet Air Arm?

Seminar E—CAPTAIN P. G. HAMMERSLEY—Is our officer manpower well founded for the future?

Seminar F—CAPTAIN J. S. GROVE—Is our rating manpower well founded for the future?

During the afternoon session, the Conference was re-convened for each chairman to report on the deliberations of his seminar and for open discussion on each subject.

The conference was concluded with remarks by the Chief Naval Engineer Officer.

The addresses, presentation, and seminar reports and discussions are reproduced below.

OPENING REMARKS BY THE CHIEF NAVAL ENGINEER OFFICER

REAR-ADMIRAL L. S. BRYSON

I imagine there are few people here this morning who will doubt the relevance of the theme for our Conference today. The Royal Navy's business is to wage war at sea and to be prepared and ready at all times to fulfil this mission: its ability to do so is directly dependent on its standards of engineering, and their fitness for the task is fundamental. We have also of course to use our equipment as effectively as possible—it is no good having equipment designed and maintained to a high standard if it is not used with knowledge and intelligence. High standards of engineering and skilled operation must complement and support each other. For the marine engineer operation is an integral part of his task—not so for the WE or the AE, and we must bear this in mind.

What, you may ask, do we mean by Standards of Engineering? The Institution of Electrical Engineers' Merriman Report published last year talks of professionalism as 'an almost indefinable but readily recognizable set of personal attributes which characterize an engineer's ability to master the changing environment of his work'. Something rather similar might be said of standards of engineering. They are not all fully and readily definable, though many are; yet generally we cannot fail to recognize them and their importance as a whole to the achievement of that fitness to do our task. They are a very extensive framework embracing material, personnel, organizational and other considerations; design, production, some operation, maintenance, training, practice, competence, discipline, and so on: there are innumerable and complex interrelations, and they are affected by a wide range of factors, many of which are continually changing. In the whole they amount to much more than the individual parts, and are an embodiment of our total engineering activity—of what it should be and what it is—and it is in this sense that we want to examine them today. And I hope 'Standards of Engineering' may be a theme which will not be forgotten at the end of the day: we should be conscious of it and looking at it in this sense all the time.

By giving ourselves such a theme we invite criticism and self-examination and this may be something of a novel approach to one of these conferences. Another novelty is the introduction of seminar groups. Apart from avoiding the rather tedious business of sitting in this hall all day, we hope this will give a much greater opportunity for people to make a real contribution to the conference, and to find out your experiences and views, which is one of the important aims.

After an opening scene-setting session which is rightly being presented by the Fleet, we will divide up into six seminar groups. Each of the subjects directly affects or is affected by standards of engineering: they have been carefully chosen to cover a wide range of important topics—there are of course many others we could have taken, but I hope we have made a good selection.

In the afternoon, we have twenty minutes on each seminar subject: five to seven minutes for the Chairman to report on what emerged from his seminar, and the balance for comment by the other five-sixths of the audience.

Are we being a bit over ambitious? Better that way than the other, and time will show. I hope it will give us a more lively, interesting, productive, and useful conference: and we will certainly welcome views on whether it is a successful experiment that we should repeat.

Time will be short, so please be brief, concise, and explicit: If all that emerges at the end of the day is a catalogue of gloom and doom then we shall have failed. Try to take a positive approach and suggest ways in which we can overcome difficulties within the inevitable constraints we face. Let your criticism be well-founded and your comment objective and above all constructive.

FLEET PRESENTATION

Introduction by Rear-Admiral D. O'Hara, CSO(E) to C.-in-C. Fleet

Before we can discuss engineering standards sensibly, we have to know what we are dealing with.

It is our purpose in the next forty-five minutes to tell you: firstly, what the Fleet is now and what it will be in the near future; secondly, what are its strengths and its weaknesses. I will cover briefly the first aspect and then turn to others of the Fleet Staff for the second.

Let me start by saying that the Fleet has a purpose, which can be phrased in a simple manner as follows:

to meet the threat by providing effective fire power at sea.

A simple statement—the engineering of it is the difficult part!

The principal threat we speak of is that of Soviet sea and air power. It consists chiefly of high-quality missile-carrying surface ships and well over 300 submarines—nearly half of them nuclear powered.

We meet this threat with a mixed bag of ships and weapon types. This is hardly surprising when one remembers the overlap of old and new and the length of ships' lives. However, you should also take account of three events:

(*a*) The Defence Review of 1966—when the decision was taken to phase out the carrier force around which previously we had formed seagoing task groups.

(*b*) The Defence Review of 1974—when the decision was taken to concentrate our attention on the East Atlantic and the Channel where we could make our most effective contribution to NATO.

(*c*) NATO Strategy—at about the same time this was changed from the 'trip wire' concept of massive nuclear retaliation to one of flexible response. Flexible response requires the capability of meeting the Soviet threat at every level.

The implications of these events are far more extensive than might at first be thought. Consider how they affect our ship needs.

In time of tension the task which would exercise us most is likely to be that of ensuring the reinforcement of Europe across the Atlantic. The prime role of the R.N. is therefore an antisubmarine one.

Remember, however, that in addition to the AS fit our ships need to be provided with adequate weapon systems for their own defence and that most attacks will culminate in some form of air-flighted missile whatever and wherever the launching platform may be.

Thus we have a requirement for a ship/weapon fit covering both low and high levels of activity and intensity.

At the high quality end of the range we have nuclear powered submarines and the ASW cruisers. At the low cost end we have Off-shore Patrol Craft and the like.

Our middle range of capability—the DD/FF force—presents a major problem in the balance of quality versus quantity but in spite of ever-rising costs we have so far been able to maintain a force of about sixty-five ships all with the potential to contribute significantly to the higher level of ASW operations.

I would not be forgiven if I omitted to mention the CVS and amphibious lift forces (albeit a secondary NATO role) represented by *Hermes*, *Bulwark*, and the LPDs.

These, like many of the ships in the Fleet today were in being before our role was redefined following the 66/74 Defence Reviews and as illustration of this I make the following three observations:

Firstly —It takes thirteen plus years to design and produce even a frigate.

Secondly—The last four DLGs—designed specifically to provide AA defence for carriers—were accepted into service after the decision to phase out the carrier force. And let us not forget H.M.S. *Bristol.*

Thirdly —*Bulwark's* recall to service is a typical gap-filling exercise—one which becomes necessary when the building rate doesn't match the scrap rate.

But what of the future—what is coming to the Fleet?

The nuclear submarines will continue to roll off to a pedestrian building programme—but with steadily improving designs. The patrol submarine of conventional ilk is a bigger gleam in Daddy's eye than for many years.

The T21s are already with us as good medium quality frigates.

The T22s are the next step up the quality ladder equipped with Seawolf, two Lynxes, and better sonar. *Broadsword*—the first of class—is now with us.

The T42s now joining the Fleet and armed with Sea Dart as an area defence weapon are looked on as the replacement for the DLGs. A stretched design is to follow.

The T43 should be mentioned as the successor to the T42.

I have already referred to the ASW cruisers with their Sea Kings, Sea Harriers, and SAM systems.

I cannot over-emphasize the importance of the MCMV task and we look to the promise of *Brecon* and her Class as they slowly replace our old TON Class in this role.

The off-shore tapestry has given rise to the ISLAND Class as a very successful stop gap and we expect to see very soon a better and more purpose-built edition on its way. In the same scenario we need a replacement for the TON Class.

That Gentlemen, is our Fleet and the future Fleet. A mixed bag, as I said earlier, and with every newcomer more variety and greater complexity. It provides a challenge to all of us to make it function to its maximum capability. Manpower problems exacerbate any material shortcomings and make the challenge that much greater.

If the Fleet is to do its job under these circumstances we need to be able to procure and maintain ships which not only meet the required fighting characteristics, but which also withstand the closest scrutiny in the following:

Functional performance including ease of operation.

Reliability.

Maintainability, which covers all aspects of support including man and his training.

Surviveability, in action.

Adaptability, meaning ease of updating—of growing importance in the face of the rapidly changing threat.

This is where we apply our engineering. Good engineering gives you these qualities at a high level. Bad engineering gives you a headache.

The Submarine Command—Captain J. Jacobsen, CSO(E) to FOSM

The primary weapon system deployed in the Submarine Command is the Strategic Deterrent Polaris. The outstanding overall performance of this system has been achieved by massive expenditure and effort in comparison to that available for tactical weapon systems but there are many valuable lessons that can be drawn from our Polaris experience to improve the fitness for service of submarines and their tactical weapon systems (at modest expense). I would like to draw attention to some of these lessons, including those derived from nuclear propulsion disciplines.

Reliability

It is not necessary in this forum to emphasize the need for quality of material; nevertheless I will do so. Many of our weapon and ship systems are of fundamentally good concept but the quality of component design and manufacture is inadequate for service conditions in some cases. Examples in the submarine service are various—torpedo dispensers, S Class torpedo tubes, wireless and radar masts, joints in steam and fluid systems, balance of rotating machines, insulation of primary electrical generators, corrosion resistance of sea-water systems, etc. In the Polaris weapon system it is noteworthy that great care is taken to obtain quality assurance at the appropriate level for the duty of the component equipment or system. This does not mean first level quality assurance procedures for the Captain's toaster but it does entail a realistic appraisal of the duty of each equipment and the application of appropriate quality procedures at all stages of life from design to disposal.

Our reliability data is limited but a look at the operational days lost in the Flotilla during the past year gives a clear picture. The majority of time lost is due to major defects from material design deficiencies and inadequate standards of refitting and manufacture. The recent failures of conventional submarine main engines demonstrate that our ability to refit and maintain these units, demanding as it does somewhat old-fashioned skills and experience, has fallen off, and we are paying a heavy penalty.

Operability

Standards of operation required are clearly defined for the Polaris weapon system, submarine nuclear propulsion systems, and submarine command and control. The area where we need to make improvements in our standard of operation is the handling, preparation and firing of the tactical weapons. The WE branch has only relatively recently taken full responsibility for tactical weapons and we still suffer from the lack of experience during the transition phase amongst the WE officers and ratings involved. With the advent of computerized tactical data handling and sophisticated torpedoes and missiles, we are introducing more formalized tactical weapon instructions and operating procedures based on Polaris practice. The definition and imposition of weapon system readiness states with appropriate regular performance checks and operational readiness inspections are significant advances which we hope will reduce the current incidence of personnel failures responsible for unsuccessful firings of torpedoes.

In the training field it is my belief that we have reached the limit in the proportion of most men's careers that we can spend in training of the individual ashore. I believe we must maintain the operation training emphasis at sea, and extend it in the tactical weapons area. But the drive will and should be on team training, doing the basic training ashore in simulators such as the NUSCOT, SCTT, Submarine School, FASMAT, and the Polaris School and the continuation training both in these facilities and at sea. In this respect there is a need to provide built-in training simulation in many of our weapon sensor, tactical data, and fire control systems.

Maintainability

The maintainability of submarines is a nightmare—cramped conditions of work, the aggressive environment and inevitable work in wake often make submarine maintenance a trying chore. The designers do all in their power to ease access and minimize maintenance but the dice are loaded against them. All in all, the maintainability of the modern nuclear submarine strikes a reasonable balance between the constraints of payload, equipment design, and available space. Certainly great attention to this aspect is paid at design stage by use of mock ups, maintenance demonstrations, and the specification of major maintenance procedures. There is a continuing and constant need for feedback from the Flotilla to the Ministry.

Ease of modernization is not a characteristic which is easy to build into a submarine. Nevertheless, we continue to modernize submarines successfully albeit at great expense of resources and time in refit. It is in the field of ease of refitting that significant advances can be made in future design. The inside of a submarine is not a suitable place to carry out high precision work and in future designs great rewards in operational time, cost of refit, and quality of workmanship (and hence reliability) will be gained by designing more readily removable openings in the hull for upkeep by exchange and repair ashore under propitious conditions.

The logistic support for the Polaris Force is not equalled by that for the SSN's which currently suffer from shortages of spares of all kinds, particularly the large expensive items of ships service and weapon equipments where the usage outstrips the rate at which these items can be processed through the repair chain and re-supplied to the Fleet. But, of course, if these components were of higher quality the incidence of defects would be less and the current provisioning would be adequate. Again one comes back to quality and the prime value of expending resources on matching the quality of material to its duty, or in other words, 'getting it right first time'.

Performance

The culminating attribute in assessing fitness for service is performance. The role of the Submarine Flotilla is defined in the concept of operations. In peacetime the submariner is fortunate that he can practise all but his shooting ability in contact with potential adversaries. The training patrols which are currently undertaken indicate that U.K. submarines are indeed fit for service and their performance matches that of other nations. A U.K. submarine recently completed an unalerted dived patrol of sixty-five days during which it travelled 10 000 miles. Amongst other contributory factors to this success was the high standard of engineering in the design, construction, support, and operation of that submarine.

The Fleet Air Arm—Captain A. W. Wheeler, CSO(AE) to FOF3

In 1961, when the first frigate fitted to operate the Wasp went to sea, we had eight air-capable ships. Today we have 103. At the same time the number of trained men in the Fleet Air Arm has fallen from about 11 000 officers and men to approximately 5800. By contrast the number of aircraft has increased from 259 to the current front and second line strength of 281. Most of those aircraft are deployed in small units varying from single aircraft flights to four aircraft detachments. Gone, for the most part, are the days of large embarked squadron units, of long continuous deployments, of extensive support facilities and air engineering teams capable of sustained independent operation.

Now, we have to be able to mount short-period detachments to a variety of host ships, deal with the extra support and logistic difficulties this entails, and compensate as far as possible for the wide dispersal of support manpower. Such are the principal problems confronting the Fleet Air Arm today in maintaining its engineering standards.

The success of the Air Arm must be measured ultimately in terms of weapon system performance and reliability, but the mission must first of all be flown and this depends, among other things, on how efficiently we service, maintain, and repair the aeroplane, and on its own inherent reliability and maintainability.

First, then, a brief look at the aircraft themselves from this point of view:

(*a*) *The Wasp:* Thirty-six flights are formed but will reduce with the introduction of Lynx. Its projected service life is impressive. Introduced in 1961, ten aircraft are still planned to be in service in 1990, twenty-nine years later. A tribute to their design perhaps, but most certainly a challenge to the maintainers. It is generally well suited to its environment with a good corrosion record. It has proved reliable and easy to maintain but one must bear in mind that it is a relatively simple aircraft with a limited capability.

(*b*) *The Wessex 3:* This is the aircraft deployed in the DLGs and there are five flights formed. It is single-engined and therefore vulnerable to action damage, ice, and salt accretion. It has a magnesium alloy skin and so is not well suited to the marine environment. Its avionics tend to be unreliable and expensive to maintain.

(*c*) *The Wessex 5:* Two squadrons of twelve aircraft are in being for troop lifting in the commando role and there are three single aircraft to provide the RFA helicopter delivery service. It has the advantage of twin engines, although their in-takes are close to the ground making them less than ideal in the snow and ice they encounter in northern flank operations. It is a simple aircraft with good maintainability. Its principal operational drawback is its inadequate pay-load and some are soon to be replaced by an adapted version of a Sea King with over twice the lift.

(*d*) Moving on to the Sea King, this is the standard ASW MK II version of which there are thirty front line aircraft in five conventional squadrons. There are few corrosion problems but zinc based aluminium alloys are used extensively and while they have good strength/weight ratio they have poor fatigue strength, are easily damaged, and are prone to stress corrosion. Its complex mechanical and avionic systems, and its sensitivity to wear and tear from vibration make this an expensive aircraft to maintain, but it is a good work-horse and well suited to its task.

(*e*) Turning to the new aircraft, firstly the Lynx. It first entered service last year. Twelve flights are now formed and eighteen are planned by the end of this year. The build-up of Lynx will continue well into the mid 80's when some fifty flights will be deployed. There are inevitably teething problems with this new aircraft but the point to be emphasized here is the fact that maintainability and reliability have formed a major feature of the design. The Lynx promises to be substantially better than most and, despite its greater complexity and greatly superior performance, it is comparable in terms of its support bill with its predecessor, the Wasp—and that includes the flight complement.

Notice in passing, the comparative cost of the Wessex. Almost half of this is attributable to corrosion. The problem of the Sea Harrier is plain to see. This will be especially acute in the CAHs where there is insufficient space in which to accommodate the number of maintainers this figure suggests that we need. Thirty-four of these aircraft are on order and there may be more yet. It is planned initially to deploy ten in *Hermes* and five each in the CAHs. The R.N. IFTU forms in June of this year. Some marinization has been undertaken—in particular the elimination of magnesium alloy from the engine—but the airframe is little altered from the earlier generation R.A.F. version, so maintenance costs in this area at least are expected to be high. By contrast the avionics are of modern, integrated design and the prospects for reliability are good.

So much for the hardware. It is a significant fact that since the early 60's we have increased our output in terms of flying hours and reduced the accident rate —this with 45 per cent. fewer men. Not all of this can be attributed to improved reliability, though to be fair we are dealing for the most part with simpler aircraft than the large fixed-wing types which predominated formerly. There can be no doubt that better manpower utilization accounts for some of the gain.

The maintenance teams of the small ship flights have in general performed exceptionally well. Considerable delegation of engineering responsibility has been necessary and this has clearly paid dividends. Despite the lack of the engineering hierarchy and material support enjoyed in the large ships, there is clear evidence that small is beautiful. There is a strong team sense and closer identity with the task which is reflected in the care and pride with which these small teams maintain their aircraft. But you should not run away with the idea that they are left to their own devices. Far from it. Comprehensive rear-echelon support is provided and this includes an elaborate system for monitoring maintenance standards and exercising tight control over the whole maintenance process. The flights are also inspected frequently. Indeed a study of one LEANDER

Class frigate showed that her flight underwent either a formal or quasi inspection about every two and a half months by one authority or another.

Perhaps big brothers are rather too much in evidence, but you may still conclude that we have well-motivated people endowed with ample guidance and support based on sound principles of flight safety and good husbandry. But is this guidance and support not the very prop which is likely to be knocked away in wartime? In peace we try to eliminate the need for local engineering judgement and improvization. In war, those are the very qualities we are going to need. How best to develop those qualities or to compensate for the lack of them, must form a prominent part of our forward thinking and I hope that they will engage your attention in seminar this morning and in later discussion.

The Surface Fleet Weapons Systems—Captain J. M. L. Hughes, FWEO

The Fleet Weapon Engineer Officer reviewed the performance of weapon equipments currently at sea and emphasized that performance must be looked at as a whole against a realistic war environment; results achieved in the more limited scenario of exercises must be examined critically and not always accepted at face value.

Much of CAPTAIN HUGHES's remarks were of a security classification which does not permit publication in this *Journal*. However, it can be said that he considered at length the strengths and weaknesses of current weapon equipments and the difficulties that occur in the new classes of ships when less experienced personnel are required to operate and maintain increasing numbers of more sophisticated equipments.

There are encouraging signs in the increased reliability of the newer equipments entering the Fleet and weapon improvement programmes are achieving similar gains for existing equipments. It was suggested that big financial savings and improvements in availability are there to be gained if we develop more accurate methods for predicting the requirements for equipment spares.

Present estimating for spares is based on random failures and yet current analysis in the Fleet shows that random failures only account for 10 per cent. of the spares usage. Is the answer to extend the basis for the initial estimate of spares? Is there a need for closer monitoring of spares usage in the development stages? Should stock buys be based on supply or demand? How can errors be more rapidly eradicated from the system? Could feedback from ships to DGST(N) be improved?

What of Fleet Engineering?

Performance

This last year has shown that the engineering resources of the Fleet when properly applied can lift the weapon performance some way above the datum performance set by the NSR with the possibility of even greater improvement next year. This despite 50 per cent. of the artificers (70 per cent. of CEAs) being in their first sea job. This improvement has come about by application of good engineering principles and discipline.

Maintenance

A better maintenance regime is yielding considerable improvements in increased availability, reduced work load, and reduction in spares usage.

The regime has been in being in the WE world for just over two years with the introduction of performance servicing logs and will be recognized by all as 'maintenance by condition'. It acknowledges the need to:

(*a*) monitor performance;

(*b*) reduce stress, temperature, voltage swings, corrosion;

(*c*) measure wear and replace worn out parts.

The Fleet is starting to ask itself how can systems be maintained in War?

Self help is the order of the day. Young WEs are coming to realize that millpond-still water is not a prerequisite for setting gyro rates. Stars, moon, and sun are distant objects and can be used to check the alignment of weapon systems.

The Fleet is devizing means of analyzing its own firings, becoming more self-critical and seeking solutions to its own problems.

Much engineering capability lies dormant in the Fleet and is not stimulated by reliance on the MOD and industry to solve its problems.

Certainly the true measure of the problem is only finally exposed at sea in the operational environment and naval engineers must continue to study war at sea, actively seeking solutions to the many engineering problems that it poses, and remembering that engineering solutions must be adequate and timely, at minimum cost.

Intelligence

In much that we do, there is a need to identify the intentions and capability of the enemy. Are we as naval engineers adequately aware of the need? For not to know the true requirements of the market place is the likely recipe for disaster when launching a new product.

Up-date of Capability

Another feature of warships, as vital as their capability to fight in war, is the ability to maintain their credibility. It is important to be able to modernize warships to match the threat. Current warship design is a major factor in the time taken to achieve weapon update.

Summary

The Fleet would expect further improvements to the overall fighting capability of its surface warships to result from continuing attention in the following areas:

(*a*) achievement of more balanced weapon fits;

(*b*) adequate engineering (particularly system engineering);

(*c*) design and management of software;

(*d*) update capability of warships.

Although it is clear that our design authorities are aware of the problems, the Fleet needs to be reassured that appropriate action will be taken in the right time scale.

Marine Engineering—Captain E. Maclean, FMEO

There is a tendency to imagine that the problems which we face in the sphere of engineering standards, reliability and effectiveness are unique to today. However, in recent history, events show that in 1875 Disraeli concealed from the House despite pressure from the First Lord—George Hunt, a farmer—that:

> 'The majority of our most powerful battleships and cruisers are in various stages on the stocks, whilst the ships which have returned from foreign service with rotten boilers, broken down machinery, obsolete armament and shipwright defects to be made good are blocking our harbours waiting for repairs (which were indefinitely postponed for economic and party purposes), the annual amount voted being altogether inadequate to the completions of the ships building and the requirements of those standing in need of repairs.'

The First Lord's relief, W. H. Smith of *Pinafore* and neswpaper fame, inherited a Navy in which Admirals believed that this craze for iron ships would eventually give way to common sense and English oak. Smith knew from his commercial experience that following the introduction of steam and iron ships nothing would ever be the same again. By 1876, the *Warrior* built and gunned for £376 000 had already cost in repairs and maintenance £125 000. This was a fantastic sum since six of Nelson's wooden walls could have been built for the former price.

And so since starting upon this presentation I have moved from the 'all is lost' stance to feeling that perhaps we have the concepts right, but that the engineering detail and the back-up deserves our vigorous attention, and that life in the Royal Navy which is an on-going thing has ever been thus. However, at what would a latter-day W. H. SMITH—an ARNOLD WEINSTOCK or FREDDIE LAKER—be looking? The 'down time' of ships, the causes and prices, on the assumption that in general on the mechanical and structural sides ships would be meeting their design requirement. Probably they would also be looking at the methods employed to meet the design requirements to see if these were the most effective —again a matter of engineering detail. It is after all possible to shut the door of a house hydraulically, but with what benefit, when the present simple well-proven means are quite adequate.

I intend to look very briefly at the middle ground of marine and hull engineering and suggest those areas, the proper investigation of which could yield the greatest benefit assuming of course that, with engineering still an unfashionable profession, we have the human resources to do so.

Reliability

The LEANDERS, 50 per cent. of the surface fleet, are mechanically and structurally reliable. They have to be. They are well proven in their operational time—such as it is—but with weaknesses which we as yet have failed to cure. Are we aiming for the moon in expecting a class of ship to be troublefree? I think not. We should not be deluded by 'time taken to refit' which has political as well as military significance and I believe that refitting times in hand are quite capable of being shortened and indeed the maintenance package itself reduced.

Typical examples of engineering which could well stand improvement in LEANDERS are:

(*a*) turbine gearing couplings;
(*b*) feed regulators;
(*c*) steam alternator governing and auxiliary drives;
(*d*) TWL feed pump;
(*e*) boilers—safety against explosions.

Remember of course that although reliable, these ships are still demanding in terms of the load upon artisans and we can only measure reliability taking the availability of the artisans into account.

In the Type 21s/42s—good runners they tell me—we have seen problems in the major areas of:

(*a*) gearing—tooth failure and rim bolt slackening;
(*b*) CP screws—dirty systems and screw failure;
(*c*) D/G failure—fuelling problems in general and our failure perhaps to appreciate the running hour problem;
(*d*) Auxiliary Boilers—again running hours.

Hulls—in terms of reliability—are good but who really wants to water ballast and do we really need such demanding painting and preservation schemes? Attempting to put a quart weapon into a pint weapon pot has not helped the ballasting problem.

Operability

In general our ships are capable of being operated with reasonable effort but each class has its own specific problems and diversity of ships at the moment causes heavy training loads. The man who makes the steam—the POMEM—still carries a disproportionate share of the overall operating load and his re-engagement rate bears this out.

It is encouraging that the ME world when monitored at Portland shows consistently that its operating standards are higher than in other branches. The fact that it *has* to perform, undoubtedly helps this.

Maintainability

Leave aside the Health and Safety at Work Act and Asbestos Regulations which clearly have in themselves made maintenance more difficult overall, the maintainability of the Fleet in the Steam Navy has seen no radical change over many years. If anything, it has become less maintainable because of increasing reliance upon U by E spares, the reduction in onboard machine tools and the increasing complexity of equipments. Has this increase in complexity, much of it associated with improved power/weight ratios, been justified? This we can consider at the seminar.

The new generation of COGOG ships have shown a marked change in maintenance problems—no steam leaks and the mention of feed loss causes not a flutter in the MEO's pulse. But I have seen in the COGOGs a welter of gadgetry, filtration interlocks, and the like all of which may or may not be essential and all of which require maintenance. Certainly there is bad engineering in the designs and we know this and hopefully will get on top of it. The principle of maintaining the plant has changed too and is now that of 'pick it off the shelf and fit it'. Just as well perhaps because we carry too few men onboard to make it and fit it—even if they could make it. But bearing in mind the fact that my WE colleague tells me that there is no such thing now as the 'near miss', perhaps in halving the number of men at risk at sea the MEs are in the van!

Performance

Ships in general perform well if we consider performance to be the ability to meet the laid down criteria for speed, range, and sea keeping. We have adequate occasions on which to monitor these criteria and, although we have a few ships with downrated machinery, most come up on time with their full power trial reports. But how easily do they achieve this? Can we do better? If so, it is design and good engineering to which we must look for this improvement.

And so Gentlemen, I intend to lead my seminar into the theme:

'Do we promote the right hard/software for the Fleet' on the basis that our concepts in the propulsion and structural worlds relative to Staff Requirements—and many would query these—are right but there are areas to which we must devote resources in order to put the gloss on what we already have before we leap off to the next generation of equipment.

I look forward to a vigorous if orderly representation of your views.

And finally may I quote LORD MELVILLE, the First Lord of the Admiralty who said in 1828 that, 'Their Lordships felt it their bounden duty, upon national and professional grounds, to discourage, to the utmost of their ability, the employment of steam-vessels, as they consider that the introduction of steam is calculated to strike a fatal blow to the naval-supremacy of the Empire'.

Be comforted by the fact that few engineers have ever been that wrong.

Sea Training—Rear-Admiral A. J. Whetstone, Flag Officer Sea Training

Let me say, first, how privileged and honoured I am to be invited to join such a vast and august array of engineering talent to discuss fleet engineering standards. Like myself, my window is small, for example the view does not embrace more than one at a time of my old war-horses—and sometimes the one is no more than a tiny and elusive German U-boat. The big ships too tend to stay clear of Portland if they possibly can. But I do now see most of the surface fleet at one time or another and a goodly proportion of the surface fleets of some of our major European allies as well. The Dutch, the Germans, and now the Belgians believe Portland gives good value for money and indeed more than pay their way.

In the next twenty minutes, with the help of my Chief Staff Officer (Engineering), I hope to give you a peep of what we see through our Portland window. An all round look in low power. Thanks to our submariner friends, we will also attempt to peep out of CSST's periscope from Faslane. There is never a dull moment and, like Billy Butlin, we keep our customers happy by keeping them occupied! We run a variety of holiday packages to suit our customers and the choice varies from a seven-week basic operational sea training (BOST) for the luckier ones, to a meagre one or two-day staff-covered OST for those who are too busy to come and savour the delights of Portland for longer.

The continuation operational sea training (COST) is our newest offering and we believe it is proving to be successful in helping to raise fleet standards—and that includes engineering standards. All too often in the past, ships heaved a sigh of relief after completing their BOST and then the rot set in—at least as far as standards were concerned. Now, they come back again to us, some more often than others, for a re-assessment of standards and a re-charge. But if ships are to achieve any benefit from the COST period, it is important that they arrive in a fully-operational state, both materially, organizationally, and with regard to personnel training.

Our European friends need the re-charging of a COST even more than we do. In the Federal German Navy, for instance, the changeover in their junior rates, the vast majority of whom are conscripts, is never less than 25 per cent. every four months and sometimes higher. We in the R.N. should count our blessings. The remarkable thing is how keen and efficient our allies are despite this handicap.

Portland has its drawbacks as I'm sure you all appreciate. Situated where we are in the busy Channel and where the weather is often lousy and all too many training serials are lost because of either the weather or one of the many other environmental features which increasingly plague our programme. But even so despite these constraints I still see through my window what probably no other Admiral sees and that is the whole ship enacting its various roles from the simplest harbour exercise to the ultimate test in a multi-threat environment, albeit a limited one. All are convinced in what are, as near as we can make them, war conditions. We see the British and Allied ships operating and learning to operate, to common standards and uniform proceedings. In our assessments we stick rigidly to fleet standards, in fact I regard myself as one of the Commander-in-Chief's guardians of operational standards, but of course there are lots of others involved in the standards game as well as FOST.

Now for the crunch, how well do we meet these standards? Are we getting better or worse? How do we compare with our allies?

Our main areas of concern are: above water warfare, underwater warfare, and action information organization. A cynic might say we are good at everything except fighting! Why are these areas our Achilles heel? Perhaps the answers have already been given to you in the preceding presentations but without going into detail these are my views—you can thrash this around in the seminars afterwards.

Firstly, the equipment does not appear to be reliable so that far too many training serials are lost because the equipment is down or degraded. It is a fact that in my five months at Portland, I have only twice seen the Mark 8 Gun fired and for the rest of the time the serials have been lost because of defects or because of weather conditions. All too often too, I'm afraid, for similar reasons, sonar performance has not been what it should; there is, by the way, still a lack