RESEARCH AND DEVELOPMENT

A survey of the current activities of Admiralty Signal Establishment.

One of the major difficulties in producing a progress report dealing with activities in an Establishment with so wide an interest as A.S.E. is that it is impossible, in any one article, to include the whole field in readable form.

On the other hand it is essential that officers and men who are engaged on the operation and maintenance of existing equipment should be given a general idea of the research which is now taking place and which will undoubtedly form the basis of future development.

It is to fulfil this need that the present survey has been designed, and it is intended to include a similar survey in all future issues of the Naval Radio Review.

During the past six months, much of the effort of the Communications Department has been directed towards the installation of equipment in H.M.S. *Vanguard* for the forthcoming Royal Cruise to South Africa. Progress in Navigational Radar has been largely restricted by a re-organisation of the staff and laboratories concerned. As a result, while some research has continued in both these fields, the main work completed has been in the nature of preparation for forthcoming events, and it is likely that significant advances will have been made by the time the next of these articles appears.

The Royal Cruise will provide enormous opportunity for obtaining data on propagation phenomena, new systems of automatic telephony and telegraphy, novel transmission techniques (such as Common Aerial Working), as well as facsimile and secrecy equipments which may later come into general use in the Fleet. The cruise of H.M.S. *Vanguard*, besides its diplomatic value, will be one of the most extensive practical tests of Naval Communications Development ever staged.

It has already been mentioned that a re-organisation of the staff and laboratories engaged in Navigational Radar research has taken place. Before this occurred however, the Pilot Model of the Mercantile Marine Radar Set, was completed and installed in H.M.S. *Fleetwood*.

Following preliminary trials in home waters, the ship sailed to Norway, where a series of successful demonstrations was carried out among the fjords.

On return to Portsmouth, the radar was removed from H.M.S. *Fleetwood* and reassembled at Admiralty Signal Establishment Extension, Eastney Fort East, where it is now to be used as a standard for the type testing of commercially produced sets. Thus, although development work on the Pilot Model has ceased, the responsibility for the maintenance of a high standard in Navigational Radar for the Mercantile Marine still rests with A.S.E.

In the field of Thermal Detection, perhaps the most significant advance during the past six months has been the development of a successful Infra-Red picture receiver. The group responsible for this work is also concerned with visual signalling.

One very important item of research being carried out by the Communications Department is the theoretical and experimental investigation of propagation on all wavelengths, both in the Ionosphere and the Troposphere.

One application of this research is the determination of the powers necessary in ships' H/F transmitters to provide communications over various distances and in various parts of the world, taking into account the expected noise level in the reception area. It has been found, for example, that to give communication over 60% of the 24 hours only medium powers are required. For the full 24 hours, however, the powers necessary increase rapidly.

It is important here to note that the Naval Staff requirements, as far as they have been established to date, specify world-wide range for all but minor war vessels. This must be interpreted to mean, in practice, that ships must be able to communicate to their nearest shore station from any position at sea in any part of the world. In actual range, this condition reduces to approximately 5,000 miles.

Again, the present Naval requirements are for telephony and automatic telegraphy, both of which require much higher powers than does the existing form of hand operated morse signalling. It seems probable from the results of analyses made so far that powers of about 5KW. (radiated) will be needed to satisfy the requirements completely.

Equal in importance, and closely associated with the previously mentioned research, is a comprehensive investigation into the design and performance of all transmitting and receiving communications aerials, with particular regard to increasing their efficiency and at the same time reducing size, complexity of rigging, and the overall number of aerials needed in any one ship.

One of the reasons why shipboard communications aerial systems are at present rather complex and not highly efficient is the wide ranges of frequency which they have to cover. In attempting to improve the situation it will be necessary to consider very seriously whether at least some aerials could be accepted to work over more restricted frequency ranges.

A further point which requires attention is the best construction of various classes of ships, particularly in details of superstructure, positioning of masts and location of offices, to allow the best overall operational efficiency, due regard being paid to the relative importance of radio as compared with other items of ships' armament and equipment.

Yet another aspect of this problem is the need for a more complete knowledge of the electrical noise levels in different parts of various classes of ships, so that the least noisy sites may be chosen for receiving

aerials, and so that the field strength of a signal needed to overcome the noise may be ascertained.

The abolition of aerial trunks, a subject of long standing, is incidentally receiving attention. From the points of view of saving in space and of avoiding a flooding risk which many senior Naval Officers think very serious, there is good reason why this matter should be pursued with high priority.

As regards short range and ship-to-air Communications, many discussions on the basic principles of the requirements to be met by the new V.H/F-U.H/F equipment have taken place both among A.S.E. staff and with the Admiralty. It is the opinion of many of the staff that the requirements of the future can best be met by a series of equipments operating within the frequency range 100-800 mc/s. One of the ruling factors in new designs is that the ability to work with the Americans must be provided, and a mission has been to the U.S.A. to establish a common technical foundation on which the future may be built. The report of this mission, which has now returned, will shortly be available.

In March of this year, the Institution of Electrical Engineers is to hold a Radio Communications Convention, on similar lines to the Radio-location Convention which took place early in 1946, and a most important activity at present going on in the Communications Department of A.S.E. is the preparation of papers for this occasion.

The papers will include all the original work of the Department carried out during the war, and will illustrate the development of naval radio equipment for Communications and Direction-finding practically throughout the usable frequency spectrum, showing how the techniques then developed bear upon the future.

It is perhaps true to say that progress in radar, and particularly defensive radar, is more dependent than any other work in A.S.E. on the nature of parallel developments in the basic methods of naval warfare, and in this connection it is worth mentioning that the experimental and research groups concerned are already thinking and planning in terms which may best be described as of the " Missile Era." As yet, these plans are mainly on paper, and the problems involved are not merely those of radio and physics, but include also the more subtle questions of the processes of the human mind. Already much fundamental research has been carried out, and an entirely novel system of Target Indication (in its fullest and most modern sense) is under active consideration.

Again in connection with future developments in radar technique, the Radar Department has begun an extensive preliminary examination of problems involved, and the possibilities of achievement in the development of radar transmitters having greatly increased powers to meet the ranges likely to be required to deal with future weapons.

In a more immediately practical field, the radar display development group has for some time been seeking a solution to the difficulty of the two dimensional presentation inherent in the normal Cathode Ray Tube equipment. The value of a single display unit, in which a third dimension is incorporated, can be enormous, and two ways of approach are at present being tried. In the first, a truly three-dimensional effect is achieved by a somewhat complex mechanical assembly of cathode ray tubes and screens, while the second system, which is sub-divided into a number of different techniques, employs a type of graphical representation not dissimilar to that of three-coordinate geometry.

In view of the growing need for improvements in the accuracy and intelligibility of radar displays, a great amount of experimental work on the visibility of echoes on intensely modulated displays is under way, and at the same time considerable advances are being made in the elimination of " sea clutter " and like interference from all types of presentations. Most important in this work is the experimental use of Secondary Emission Valves in radar receiver amplifiers, and already very great improvements in performance have been achieved.

Besides direct developments in radar itself, the problems of Countermeasures are receiving considerable attention, though the enormous difficulties involved in defeating modern centimetric equipment have set a limit to the speed of progress. None the less, equipment for jamming radar on S-Band is under construction, while higher frequency systems are under active consideration. Radio countermeasures against known and expected types of missiles have also been proposed, and, in a few cases, some experimental work has been carried out.

An important defence against radar is the art of " Radar Camouflage," and research into the nature of radio-absorbent materials, together with considerations of the least " noticeable " structures for radar targets, has been proceeding for some time. This research not only affects the problem of defence against radar, but is providing valuable data in connection with the " echoing " properties of various types and designs of target, and may eventually lead to a fundamentally sound understanding of the present rather empirical theory of " radar cross-sections."

A rather unusual commitment which, though it has no direct application in actual warfare, is of considerable importance in peacetime exercises, is connected with the development of practice targets for Proximity Fused Shell.

This type of shell which operates by virtue of radiated energy reflected from its target, will not explode until a certain minimum amount of energy is returned, and, since the usual practice targets (particularly rocket propelled ones) are much smaller than those likely to be encountered in a real action, they may not reflect enough to operate a shell's fuse at all. Hence, small transmitters are under development which, when fitted to targets, will produce enough power to detonate shell within a reasonable area, and these transmitters, since they are, in fact, miniature jammers, are providing valuable data on the requirements which will have to be met if and when it becomes necessary to devise radio countermeasures to enemy proximity fuses.

Three interesting advances have recently been made in equipment for experimental use, namely a *High Speed Oscillograph*, in which a " Time Scale Factor " of 250 inches/microsecond has been achieved, a *Picture Signal Generator*, which is a device for elec-

tronically reproducing any P.P.I. photograph on an actual P.P.I. screen, and equipment for automatically recording radar information on film, thereby eliminating the " Personal Equation " from trials results.

An original aid to navigation, which has been called the " *Radio Lighthouse*," was suggested, developed, and experimenatlly tested within the past six months. The system is one in which a narrow radio beam rotates in a manner similar to that of a normal lighthouse beam. The transmission is made up of pairs of pulses, whose " spacing " in time varies according to the direction in which the beam is pointing, so that any ship receiving the signal, by measuring this spacing, can immediately tell her bearing from the " lighthouse."

Finally, an item of pure research, which promises to become a major commitment for some considerable time, is the investigation into the causes, nature, and effects of Galactic Noise. This investigation is as yet in its early infancy, but it is possible that a detailed account may be available for the next issue.

Throughout this survey of current activity within A.S.E., it will have been noted that there is a growing tendency to devote time to analysis of projected systems and the problems of the future, rather than to hasten the material development of particular equipment.

In this way it is believed that when new projects are finally undertaken a fairly exact assessment will be possible of what their value under operational conditions will be, and that this value will represent a real advance upon any existing equipment ; it is in fact well recognised that scientific effort, as well as all other kinds of technical resources, is not available for modifications to existing apparatus or for short term improvements.