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ELECTRICITY IN THE NAVY

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Aim

The aim of this lecture is to give you some idea of the role that electricity plays nowadays in the Navy and the variety of problems which are associated with the fulfilment of that role.

Outline

I am sure that some of you at least have seen a merchant ship, if not a Naval ship, whereas a few will have seen a Naval ship as well. You could not have failed to notice the very large number of electric cables that run along the bulk-head, along the overhead deck, in fact in any conceivable position throughout the ship. You probably had wondered as to the purpose of all this tentacle like growth. The fact that miles and miles of electric cables are required on these ships is a fair index of the extensive use to which electricity is put in the Navy. Some appreciation of the working of the ship's Electric World will be obtained by looking into the generation and utilisation of electrical energy on board I. N. S. DELHI in brief. What applies to the DELHI applies generally to other Naval ships in proportion, though the details of course vary.

Generation

The DELHI has 4 steam turbo-generators of 250 k.w. each and 2 diesel generators of a capacity of 150 k.w. and 50 k.w. respectively. Normally 2 steam turbos are run and they are capable of supplying the cruising load of the ship. For action load, it is the normal practice to run all the steam turbos. The diesels are used as a stand-by.

All of these generators generate 220V D.C., but a surprisingly large variety of electrical supplies is required to operate the various electrical gadgets. Thus apart from the 220V D. C., other supplies are also generated, such as 24V D.C. ; 230V 50. cycles single phase A.C. ; 400V 50 cycles 3 phase A.C.; 50V 50 cycles single phase A.C.; 120V 333 cycles single phase A.C.; 50V 1100 cycles single phase A.C.; 180V 500 cycle single phase A.C. etc. All these supplies are obtained by the use of suitable motor generators and motor alternators, but for use in emergencies, however, suitable batteries are provided for supplying 24V D.C. to all fire control equipment and the emergency wireless sets.

Distribution

The distribution of the main 220V D. C. supply is effected by what is termed the "Ring Main System". The ring main is made up of 2 armoured cables of adequate current carrying capacity which run side by side and form a totally closed ring round the ship. Thus in the DELHI, starting from the main switch board and moving forward they go along the various breaker passages along the

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port side till they reach station 35 (the Ford Pump Lobby), then turn and go aft through a variety of breaker rooms, cable passages, etc. along the starboard side of the ship till station 164 (Aft Gyro Room). Here they turn back again and passing through similar places along the port side of the ship, they join themselves at the main switch board. A variety of fuse release switches, ring main breakers etc. are placed in this ring main and the whole in effect forms a completely watertight busbar system. Any of the 4 turbo generators can be parallelled with any or all of the remaining through the ring main. Energy is tapped off the ring main through fuse release switches. One fuse release switch feeds a number of breakers which are called branch breakers. The current carrying capacity of these branch breakers varies from 125 Amps to 500 Amps. An idea of the size of this system will be obtained when I tell you that the total number of such branch breakers on DELHI is 118. All the switch gear can be controlled centrally from the main switch board as well as locally. From the branch breakers energy is supplied to the various equipments through suitable distribution boxes, junction boxes etc.

Utilization.

The customers who want all this electrical energy are as follows :—

(a) *Engine room and Auxiliary machinery*—This comprises a variety of pumps, such as oil fuel service pumps, fresh water pumps, brine pumps, fire and bilge pumps, forced lubrication pumps, *etc.* In addition, auxiliary equipment, such as steering motors, cold room compressors, air compressors, *etc.* are also electrically driven. Majority of the equipment is drip-proof, but in a few special applications, the motors are totally enclosed. The total number of such motors in DELHI is about 90 and the horse power ranges from 5 to 50.

(b) *Ventilation and Cooling.*—Ventilation on board a ship is very important. There are about 125 impeller fans varying in size from 35″ to 5″ and fresh air is fed into various compartments and foul air removed by means of suitable trunking. Apart from this, there is a large number of ceiling and table fans, water coolers, air conditioners, *etc.*

(c) *Fire Control*—Electricity is used to move the Gun turrets either electro-hydraulically or by means of remote power control metadyne system. It is used in hoisting shells upto the turrets, in wind speed and direction instruments, in running fire control tables, *etc.* apart from actually firing the shells.

(d) *Navigation.*—Navigators want electricity to run gyro compasses, speed and distance logs, plotters, search lights, echo sounders, etc.

(e) *Communication—external.*—As will be appreciated, a complex variety of U.H.F., V.H.F., H.F., M.F., transmitters, transreceivers, receivers, D.F. sets *etc.* is required on a ship. On DELHI the equipment is distributed in about 4 positions on the ship and to facilitate operation, a special control system is provided whereby the required number of sets can be controlled from large number of positions in the ship.

(*f*) *Communication—Internal.*—This comprises telephone communications, broadcasts etc. and there are 20 different systems in the DELHI worked electrically and/or electronically. This does not take into account a number of Hummers, Alarm bells, and such other systems.

(*g*) *Radar.*—A variety of warning and gunnery sets is fitted in DELHI. We have 3 warning sets and 3 gunnery sets in addition to the usual I.F.F. It is also proposed to instal a separate navigational set. The output of these sets is fed to PPIs, Sector displays, 'A' displays *etc.*, in various parts of the ship.

(*h*) *T. A. S.*—DELHI being a cruiser has not got much A/S equipment apart from one detecting set and one listening (Hydrophone) set. The other ships, such as Frigates and Destroyers have more modern detecting sets such as type 144 and depth finding set type 147B. Torpedoes are fired electrically.

(*i*) *Degaussing (DG)*—This Forms a small but very important Part of the electrical installations of the Ship.

(*j*) *Miscellaneous.*—This includes equipment like the Cranes, Winches Capstans, Galley services, General Lighting *etc.*

As aforesaid, the above remarks apply to the other ships of the Navy, such as Destroyers, Frigates, Minesweepers etc. in proportion. On board the Minesweepers, however, secondary batteries are used on a large scale. Thus each Sweeper has 200 cells of 600 AH capacity connected in parallel banks of 100 each. Secondary batteries also form a vital part of the equipment of submarines, though there are none in the I.N.

Administration.

1. *Conditions and requirements*—I might draw your attention here to the motto which the Damage Control people use to illustrate the aim of a Naval ship. This is " To Float, To Move, To Fight". It will be realised from the foregoing that, in achieving this aim, electricity plays a very vital role. It will be appreciated that the electrical equipment is required to work under the following adverse conditions :—

(*a*) *Extreme heat*—The overall temperature in the Engine Room of a ship at sea is in the region of 115°F.

(*b*) *Extreme dampness*—As will easily be seen the relative humidity in a ship is very high and the equipment also comes directly into contact with water that is often mixed with oil.

(*c*) *Vibrations.*—This is continually present when a ship is under way.

(*d*) *Movement and Shock.*—The equipment has to withstand a considerable amount of rolling, pitching, etc. as well as shocks due to gun fire, depth charges, etc.

Under the conditions mentioned above, the equipment is expected to fulfil the following basic requirements :—

(*i*) must be able to run continuously at sea.

(*ii*) must be reliable under action conditions.

(*iii*) must be economical.

(*iv*) must be as light as possible.

(*v*) must have an adequate reserve of power.

R. N. System.

In the R. N., the design installation, maintenance etc. of electrical equipment which will meet the above conditions is accomplished in the following fashion :—

(*a*) *Director of Naval Electrical Department (DNLD)*.—He is a Rear Admiral (L) at the Admiralty who is responsible to the 2nd Sea Lord (Chief of Personnel) for all the personnel of the Electrical Branch, their training etc.

(*b*) *Director of Electrical Engineeri ıg (DEE)*—This officer is on the Staff of the 3rd Sea Lord (Controller) and is responsible for directing the development of all power electrical equipment.

(*c*) *Admiralty Engineering Laboratory, Electrical Department, West Drayto ı and*

(*d*) *Admiralty Signal and Radar Etablishment, Haslemere.*—These and other allied laboratories conduct reseereh into and development of their respective subjects.

(*e*) *Director of Radio Equipment (DRE), Director of Compass Department (DCD). Director of Underwater Weapons (DUW)*.—These and such other officers at the Admiralty deal with interpretation of Staff requirements and laying down equipment policy in respect of their subjets.

All equipment is designed to Admiralty specifications which are normally based on corresponding B. S. S.'s suitably altered to meet the peculiar requirements of the Service. Needless to say that these Admiralty Specifications are always being amended and enlarged as new equipment is invented and developed. This task is enormous and to give you an idea of its magnitude, I would like to state that the DEE's Department consists of 115 superior officers, 250 draughtsmen, 80 clerical staff and 60 Superior Officers who are seconded for Dockyard duties. The department is organised into 5 branches, *viz.*

(*a*) Shore establishment and Finance.

(*b*) Design and Development.

(*c*) Ship production.

(*d*) Supply and Production.

(*e*) Armament control and communications.

Similar remarks also apply to the A.S.R.E. which is a huge establishment dealing with research, development, production and supply of radio equipment for the Navy.

Present Position in the Indian Navy

In the Indian Navy, the position is rather different. At present the Electrical Branch is very short-staffed and is in its infancy and thus an organisation anywhere nearing the Admiralty pattern is a dream of the future. At the Naval Headquarters the Director of Electrical Engineering is responsible for the electrical material of the Indian Navy and also advises the Chief of Personnel on problems connected with the electrical personnel. Due to a variety of reasons, in the Indian Navy we have been forced to adopt a policy of "keeping things going". The majority of the Indian Navy equipment is about 10 years old and replacements are not forthcoming from the U.K. Any indigenous production is out of the question at the moment. Thus the immediate aim of the Electrical Branch is to nurse the equipment as far as possible and keep it going. This puts added strain on the branch, as it means increased maintenance, make-shift arrangements etc. In this respect we always welcome the co-operation of the scientists in finding ways and means to maintain the equipment in a running condition. For example, majority of the I. N. ships are fitted with Gyro compasses which use mercury in their "follow up" systems. Due to the peculiar conditions in Indian waters some trouble has been experienced in its working as an insulating film forms on th surface of the mercury and the follow up system breaks down. The Admiralty have overcome this by using an electronic follow-up. Such equipment is not available for I. N. use, nor is it cheap. Can the Scientists help ? This and some similar problems have been and are being referred to the Defence Science Organisation.

Indigenous manufacture

An attempt is being made to utilise electrical equipment which is manufactured in this country for Naval use. A start is being made in a limited field where manufacturing capacity already exists, thus the items selected are :—

(*a*) secondary batteries.

(*b*) lead covered cables.

(*c*) indicating instruments.

(*d*) carbon brushes.

(*e*) electric lamps.

A start from scratch has to be made as no specifications are available at the moment for use of this equipment in the Service. Specifications will have to be prepared in conjunction with the Indian Standards Institution and a testing organisation will also have to be set up.

Future trends

Increasing use of electricity.—It is obvious that electricity is being more and more widely applied to equipment on board Naval ships. An idea of the increase in its application will be had if it is realised that a destroyer built in 1932 had an installed generating capacity of 100 k.w. whereas the Daring class destroyers built recently have an installed capacity of 1160 k.w., an increase of 1000%.

Similarly, a Leader class cruiser (a class to which DELHI belongs) built in 1932 had an installed generating capacity of 1000 k.w. Such a cruiser if built today will have to have a capacity of 4400 k.w.

Change over to A.C.

This increasing electrical load raises the question as to whether the D.C. system should continue. Though having a large number of advantages over the A.C. system, the increasing load make it necessary that a higher voltage, system should be used in order to cut down the current ratings for the cables and a change over to the AC system is inevitable in the future. As a matter of fact a beginning has already been made in the R. N. where the Daring Class destroyers have a 440V 60 cycles 3 phase system as their basic electric supply. This change over was effected by the U.S. Navy in 1932 and by the Japanese Navy in 1940. The other Navies however still utilise the D.C. system.

New uses

Apart from the high falutin equipment such as Guided Missiles, which is still in its development stage and which will not reach the Indian Navy for some considerable time, it is evident that the trend is towards improved fire control by using electronic analysers, use of television, improved anti-submarine sets, electric propulsion of ships, etc. The swiftness with which these developments take place in the I. N. and the extent to which it can keep in step with other navies is dependent, amongst other things, upon the cooperation between the Naval Electrical officers and the Naval scientists and the Electrical Industry of the country.