NOTES FROM SEA

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Turbo Generator Maintenance

Maintenance schedule E.55.B 6M.1 states:

Examine mechanism for wear of:--

- (a) Overspeed trip gear linkage
- (b) Governor weights and linkage (do not strip unless performance is erratic)
- (c) Vacuum trip gear
- (d) Lubricating oil safety device.

During a recent maintenance period this item was carried out. On the subsequent trial the turbine started hunting and no amount of adjustment would stop it. Subsequent examination of the governor weight linkage disclosed wear greatly in excess of the maximum laid down.

There had been no sign of erratic running before the examination and the note in item (b) of the schedule seems to have been translated as: 'Don't strip and don't look at it'.

Comment

Planned maintenance should be spiced with some good engineering common sense and the schedules should be used as a guide, not the law.



FIG. 1—ALLEN 500KW G.T.A. ISOLATING VALVE FOR STARTING FUEL RELIEF—VALVE 'D'

Allens 500kW Gas Turbo Alternator Failure

On the isolating values for the starting fuel relief value (value 'D') fitted to Allens 500kW G.T.A.s, the spring carrier is positioned by means of a small circlip recessed into the spindle; the recess being in the order of 0.01 in. deep. On three occasions this circlip was strained from the recess, resulting in the carrier plate sliding down the spindle and cutting the 'O' ring seal. This was eventually overcome by the manufacture of a modified spring carrier to act also as a circlip retainer, the circlip lugs being ground off to fit the annulus (see FIG. 1). This arrangement has now been running satisfactorily for 1,500 hours and it is suggested that it could well be incorporated as a standard modification.

Comment

A standard modification based on this principle is now being incorporated for these valves. The similarity between FIG. 1 and the official drawings of the modification (Nos. GZ638812-3) can be seen and it will be noted that the circlip has also been modified to make it more effective.

Overheating of Main Engine Gearing Bearings

On proceeding to sea the main engine lubricating oil temperatures were closely watched as the cooler thermostatic control valve Thrustat units had been renewed the previous day. For some 90 minutes speed was not increased above 88 main shaft r.p.m. and all oil and bearing temperatures remained normal. As soon as higher revolutions were ordered, however, the starboard main gearing bearing temperatures rose rapidly. Putting the lubricating oil cooler to hand control, increasing the main circulator speed and increasing the gearbox bearing oil supply all failed to bring the temperatures down. During this period the port gearing temperatures remained normal.

The lubricating oil and circulating water systems were checked and vented. Finally the starboard gearing inspection covers were removed. The quantity of oil being supplied appeared to be normal and nothing untoward could be seen in the condition of the gearing itself. The shaft was therefore trailed and used only at low speeds to manœuvre the ship into harbour on the following day.

After the turbines had cooled the starboard gearing covers were removed and two of the hottest bearings examined. Both were in good condition. Next, the main oil distribution valves and lubricating oil cooler and system were examined without any defects being discovered. During a final check on all systems the starboard main oil sluice valve on the side of the drain tank was found to be only two thirds open. In order to determine that this valve was operating correctly the ship was ordered to empty the drain tanks. Examination of the valve from the inside of the starboard drain tank showed that it was working normally throughout its travel.

The ship then proceeded to sea for trials during which no further overheating of the starboard gearbox was experienced. It was concluded that the slight restriction in the drain line corresponding to one third of the valve travel was sufficient to raise the oil level in the gearbox sump and to allow churning and thus causing overheating of the bearings to take place. It was not discovered how the drain valve became partially closed.

Comment

The values on both drain tanks have now been locked in the fully open position.

Overspeed Trip Mechanism Failures in Turbo-Driven Auxiliaries

The Ship Maintenance Authority have received a large number of reports of overspeed trip mechanisms which failed to operate. Some examples are:—

- (i) H.M.S. *Hampshire*—feed pump blew up
- (ii) H.M.S. Pellew—casing of the turbine ruptured injuring a P.O.M.(E)
- (*iii*) A.F.E.S.—feed pump blew up, a turbine blade cut through the cap of the operator.

It was significant that the majority of the failures had occurred in machines lubricated with OEP-69, the failure being attributed to seizure arising from the deposition of a brown gumming substance on the working parts. S.M.A. forwarded a detailed report to D.G. Ships in which it was emphasized that there was a case for very early action to re-design and that all new trip mechanisms should be:—

- (a) Readily accessible without the need to remove large covers or drain sumps and gearcases to gain access, but that access covers should be of sufficient size to enable work to be carried out;
- (b) Reliable enough to warrant testing at a minimum of four-monthly intervals with examination at eight months;

(c) Readily interchangeable preferably with a sealed and pretested unit which requires no subsequent adjustment.

With regards to existing machinery, it was considered that early attention should be given to improving existing designs and that such modification be published in an orderly fashion and given highest priority.

In reply D.G. Ships stated that:

- (i) Weir's single bolt trip mechanisms were being or had been re-designed for modern ships, incorporating a fluted bolt.
- (ii) Action was in hand to reduce oil sludging and water contamination of the oil.

Allen's 400kW Turbo Alternator

H.M.N.Z.S. *Taranaki* reported a major failure of a steam turbo alternator caused by the blocking with sludge of the lubricating oil supply to the flexible coupling.

A 'warning telegram' (S.2022a) was sent by S.M.A. to all ships fitted with this equipment stating that this failure had occurred. Within two weeks H.M.S. *Victorious* replied that as a result of this warning the oil supplies to the flexible coupling had been checked and found to be partially blocked. *Victorious* considered that a similar major failure had been averted.

Failure of Astern Control Valve

A Type 12 frigate recently collided with a jetty while manœuvring alongside when the $3\frac{1}{4}$ in. astern control valve became inoperative. A locking screw slackened causing the guide and key to fall out, allowing the valve to turn but not to lift. The fault was that no indent was drilled in the spindle to accept the end of the locating screw.

S.M.A. sent a warning S.2022a to all equipment holders. DCI(N) 1089/65 has been issued drawing attention to the need for care when assembling the guide arrangements. A warning note will also be included in BR.2111(1).

Hydro Extractor—Failure of Hydraulic Brake

A rating working in the laundry of a Type 12 frigate was recently injured when he put his arm inside a hydro extractor before it stopped. Investigation showed that the safety arrangements and the hydraulic brake were not efficient. Further enquiries among other ships showed that there was a common defect of deterioration of rubber components due to using incorrect hydraulic fluid, and in some cases, safety interlocks had been disconnected.

Comment

Maintenance schedules have been amended to indicate the correct hydraulic fluid. BR.3811 has also been amended. Safety interlocks are fitted for very good reasons.

Failure of Flexible Rubber Discharge Pipes

The switchboard of the Diesel generating compartment of a frigate was flooded when the flexible rubber discharge pipe on an adjacent fire pump failed. Investigation showed that there have been several similar failures of rubber flexible connecting pipes and the design and application are still under investigation. However, the inquiry showed that the need for careful alignment of pipes and the checking of rigid/resilient mountings are very important whenever flexible pipes are fitted.



Fig. 2

Economizer Element Failure

A recent failure of one economizer element was investigated by the Dockyard Laboratory, Devonport, who found the failure and widespread cracking in the other elements due to corrosion fatigue.

The interesting part of their findings was that in each tube affected by corrosion fatigue the spacer fin was inadequately welded to the tube wall, and, conversely, where the fins were securely attached the deterioration was absent.

FIG. 2 shows the cracking and the incomplete welding.

Steam Drain Failure

When a Type 14 frigate was blowing soot, the drain pipe beneath the plates burst. The

cause was established as severe external corrosion.

Comment

Action is being taken to amend BR.3000 to cover the examination of systems before long refits. General Requirements for Machinery (Eng.) are being amended to increase the size of certain pipes in future construction.

Arrester Gear Unit Failure

Recently, in an operational aircraft carrier, an arrester gear unit reset itself on completion of a 'run out' causing an aircraft to be dragged back and to be damaged. The cause was found to be extreme wear of a detent causing the local reset lever of the three-valve manifold to lock itself in the reset position.

Comment

Maintenance schedules have been revised to include an eight-monthly inspection of the component.

Diesel Engines—Foden F.D. Series—Blower Bearing Failures

A number of blower bearing failures were reported from coastal minesweepers. Investigations established that the probable cause was lack of lubrication of the bearing on initial starting after engines had been idle for a long period.

Remedy

DCI 597/64 informs all users to pour oil over the rocker gear and blower bearings before starting after prolonged standing.

Catapults—Piston Valve Packing Failure

Two aircraft carriers each reported main jigger accumulator internal fires and charring of piston packings of catapult launch valve accumulators. The defect was considered due to grease igniting the packings.

Comment

Trials are at present being conducted in H.M.S. *Ark Royal* using terylene packing and in H.M.S. *Victorious* using asbestos packing to determine the most suitable fire-resistant packings.

Main Boiler Failures

In recent months a large unit of the Fleet suffered two consecutive failures to one main boiler resulting in considerable damage to the tubes through overheating. After a lot of investigations this was found to be due to water shortage brought about by faulty gauge glasses. It may come as a surprise to many readers that a large ship with plenty of expertise on board should have been caught out in this elementary manner. However, the gauge glasses in question, the plate type manufactured by Dewrance, are very tricky things and they can easily malfunction for a variety of reasons. These have all been covered by various instructions to the Fleet at one time or another but some have lapsed over the course of years and there is no doubt that a new résumé of them would be timely.

What most young engineer officers are probably not aware of is an unfortunate tendency of all boiler gauge glasses to do exactly the opposite to what one would wish of them, i.e., to fail safe. If for some reason or other the steam and water connections are shut off internally by error, then the gauge glass will most probably go on showing half a glass of water. This phenomenon is due to condensation effects inside the gauge glass that continue to take effect even after the connections are partially closed or blocked, etc. Any gauge glass showing half a glass of water is (a) either out of action, or (b) showing a correct level, but to make sure that this is the case the gauge glass must be tested.

A handsome contribution from the Herbert Lott Trust Fund awaits the ingenious inventor who can overcome this inherent weakness and design a new type of gauge glass that invariably shows empty as soon as any interruption, however small, occurs in either the steam or water connections between it and the boiler or what have you.

Main Engine Oil Systems—Rapid Rise in Bearing Temperatures

A very rapid rise in main gearcase bearing temperatures has occurred in Type 12 frigates on a number of occasions. Bearing temperatures have risen from normal operating temperatures to approximately 200 degrees F in less than a minute. The cause has been established as flooding of the main gearcase with lubricating oil when two forced-lubrication pumps are in use with the ship rolling appreciably. It is assumed that with the gearing operating in a flooded gearcase, the bearing loadings may be increased and/or displaced and together with the aeration of the lubricating oil caused by the churning effect caused the temperatures to rise.

The cure was, rather alarmingly, to stop the motor driven forced-lubrication pump.

Main Engine Oil Systems—Failure of a Lubricating Oil Control Valve

An alarming failure of a main engine lubricating oil cooler 'Waxtrol' temperature control unit recently occurred at full power in a *Daring* Class destroyer. Lubricating oil pressure disappeared almost entirely at the bearings having been shut off by the Waxtrol temperature control unit as it moved over to what should have been the 'Full to Cooler' position. The Waxtrol unit was found to be wrongly assembled such that it completely closed off the oil supply pipe.

After Effects of Trichlorethylene Cleaning of Heat Exchangers on Boiler Salinities

During basin trials after a bring-forward period from reserve in a *Daring* Class destroyer, boiler salinities rose rapidly after extraction pumps were started. No indication of the contamination was given by either nitrate tests of feed tanks, etc., or by salinometers.

The source of contamination was finally established as being due to slight traces of trichlorethylene remaining in the systems after degreasing of the main condensers. These traces remained despite considerable effort to flush the systems through on completion of degreasing.

B.R.3001, Article 0502(2) gives warning of this source of contamination but does not refer to the fact that contamination due to this cause is not revealed by salinometers or by normal nitrate tests.

Hunting of Main Engine Lubricating Oil Systems

Severe hunting of the main engine lubricating oil system arose during postrefit trials in a Type 12 frigate. This persisted whether the turbo or motor driven forced-lubrication pump was in use and was of an amplitude of 6 to $7\frac{1}{2}$ lb/sq in.

The oscillation was finally eliminated, or reduced to negligible proportions, by re-adjustment of the lubricating oil supply control valves to gearing sprayers and turbine and gearing bearings. This had the effect of altering the position at which the pump was operating on the pump characteristic from an unstable to a stable position.

High-Speed Running of FFO Pumps in Type 81 Frigates

Instances have occurred in Type 81 frigates where full power has not been achieved due to the restricted output of the FFO pumps. This is due to one of two reasons:

- (a) A defective pump unit, which may be temporarily overcome by a reduction in fuel temperature but which will require the fitting of a replacement pump unit at the first opportunity. Full power should be achieved with a pump speed of 6,500 to 6,800 r.p.m. at 180 degrees F temperature. As the H.P. pump wears, the speed will rise. The maximum safe speed is 7,500 r.p.m. as at higher speeds a danger of overspeed tripping exists during rapid manœuvring; or
- (b) The incorrect setting of the overriding speed governor limiting the speed and therefore the output below the desired value.

The function of the speed governor is to 'catch' the pump should the automatic controls fail and later permit the control of the supply pressure when steaming in manual control. (It should be noted that this is different from the County Class where the overriding governor is separate from the manually controlled throttle valve.)

To permit satisfactory working of the automatic controls, the governor must not come into operation during normal running and should therefore be set 300 r.p.m. above the maximum speed required by automatics. Because the governor requires to be altered during flashing up of the boiler it must be reset each time steam is raised. The speed governor should be set with the pump in automatic control by opening the recirculating valve until the desired pump speed is reached. The governor should then be adjusted until the governor oil pressure drops below the relay oil pressure. The recirculating valve can then be closed leaving the governor setting such that it will be brought into use at the required speed.

Inadvertent Starting of G6 Gas Turbine Turning Motors

A case of uncontrolled starting of G6 gas turbine turning motors occurred due to an electrical fault on the starting circuit.

One earth was present on the turning motor starting circuit when a second earth appeared on an item of electrical equipment remote from the first, in the ship's galley. The two earths completed a circuit through the contactor operating solenoid causing the motor to start and rotate the gas generator without the necessary lubricating oil supply. Due to the operation of the 'hold on' contacts the motor continued to revolve after the remote earth had been removed.

Investigation indicated that rotation occurred for approximately four minutes but in the bearing examination which followed no resultant damage was found.

Inadvertent Turning of Propeller Shaft During a 'Cold' Move

In a COSAG ship a propeller shaft turned, without lubricating oil supply, due to failure to ensure that the shaft locking gear was effective while shifting berth with tugs. In these ships the main shaft turning motors, which act directly on the steam turbine, take the place of locking gear. In this instance, the person responsible for engaging the turning gear failed to appreciate that the turbine manual clutch was disengaged, thereby nullifying the effect of locking the turbine stationary. Fortunately the shaft movement was noticed early and the resultant examination proved the bearings undamaged.

Condenseritis

Salt contamination of the feed system of an old destroyer has proved very difficult to trace. Contamination is only evident while steam is on the main engines and is particularly evident during the flashing up period. All recognized checks and tests have narrowed the defect down to the main condenser. While it is known that the tube packing is below standard and requires complete overhaul at the next refit, Canterbury and Frobisher tests, including the use of fluoride and ultra-violet light, have failed to detect leakage from any tubes or packing.

Current thought is that the leakage is occurring along the tubeplate stay bolts due to corrosion or erosion of the back face, aggravated by the relative working of the faces during the flashing-up period. Verification and rectification of such a defect will involve complete removal of the tube plates.

Exhaust Steam Range Bellows Pieces

Flexible bellows pieces fitted to the exhaust steam range have been shown to be vulnerable to damage unless treated with respect. In particular, care must be taken to ensure that they are not subjected to any mechanical stress, i.e., neither the bellows piece nor the adjacent pipework should be used for a slinging point, nor should any great force be required for installation alignment.

It has been further found that the bellows pieces require to be lagged before use. The lagging, as well as serving as heat insulation, acts as a damper on the high-frequency vibration frequently set up with the passage of steam. This vibration emits a high-pitched shrieking and if allowed to continue will result in fatigue failure.



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FIG. 3



FIG. 4

Failure of a Main Steam Joint

A dangerous failure of a main steam joint recently occurred in a *Daring* Class destroyer. The ship was shutting down at the time with one boiler only connected. The leak developed suddenly on the boiler side of the main bulkhead valve and in about 20 minutes reached such proportions that it became necessary to shut the main stop valve, resulting in a complete blackout.

FIGS. 3 and 4 show the condition of the spiral wound gasket removed from the joint. Complete disintegration had occurred and the backing ring was found to be fractured. It was noted that the backing ring had been incorrectly fitted, apparently being forced into position within the circle of securing studs causing the outer surface to the dented. It is assumed that the backing ring either fractured when fitted or subsequently. Main engines were being prepared for sea when the boiler-room turbo alternator slowed considerably in speed but then returned to normal. Two or three minutes later the turbine exhaust and labyrinth was found to be glowing red. The machine was tripped immediately. Failure of the turbine thrust bearing was suspected and this was confirmed on investigation.

The second boiler was being connected at the time. Water levels in both boilers were steady at $\frac{1}{3}-\frac{1}{2}$ glass throughout this period and the boiler was connected slowly, auxiliary first and then, some fifteen minutes later, to main. It is assumed therefore that the pressure in the first boiler was slightly greater than that in the second and that this caused water which had accumulated in the main steam range, on the range side of the second boiler main stop valve, to flow back into the auxiliary superheated steam range and pass over to the turbo alternator turbine. When this occurred the drains adjacent to the main and auxiliary stops were open to trap.

Had the trap on the drain from the range side of the main stop been bypassed, it seems likely that the accumulation of water and the consequent damage would not have occurred.

Note by C.-in-C., Home Fleet, Technical Staff

The subject of operation of steam drainage arrangements and the arrangements provided in Type 12 frigates is being raised officially by the Commanderin-Chief, Home Fleet.

Seizure of Water-Lubricated Feed Pump

A recent seizure of a turbo Water-lubricated feed pump in a Type 12 frigate occurred due to insufficient differential pressure between the exhaust steam pressure in the turbine casing and the lubricating water supply pressure. This occurred after an interesting sequence of events. The pattern of events seemed to be as described below, although the facts are not strictly corroborated by the ship's written report.

The ship was steaming auxiliary, with both turbo extraction pumps in use, the deaerator in use and the TWL feed pump feeding the boiler taking suction from the deaerator extraction pump discharge. The turbo extraction pumps were taking suction from the main condensers, the level in the latter being maintained by gravity flow through the make-up valve from the main feed tank. Both evaporators were in use on closed exhaust with coil drain to reserve feed tanks—the only method of disposal in this particular Type 12 frigate. The condensate from the turbo generator in use was discharging to the main feed tank. The harbour service feed pump was in use, at intervals, transferring water from the overflow to the main feed tank.

Watchkeepers noticed that the main feed tank level was falling slowly and was reading about $2\frac{1}{2}$ -2 tons. Shortly afterwards an electrical failure of the harbour service feed pump occurred. The overflow tank then slowly topped up.

Shortly after this, one turbo driven extraction pump tripped due to the low level in the main feed tank, presumably because the overriding speed governor failed to function correctly. The TWL feed pump was stopped at this stage and an attempt was made to feed the boiler with the reciprocating feed pump on overflow tank suction. For some reason not known this was unsuccessful and suction was changed to reserve feed tank suction. The TWL feed pump was then restarted on reserve feed tank suction but was shut down shortly afterwards because of the noise and vibration coming from it.

The ship's report states that during this period the deaerator had topped up and that the high-level trips had operated. It is unlikely however that this had happened, a more likely occurrence being that the deaerator was in fact empty. In the circumstances pertaining it is possible that a quick glance at the gauge glass gave the impression of a full glass whereas in fact it was empty. This could well have happened as a result of the one turbo extraction pump tripping, the other one remaining under control of the override speed governor but with a starved suction due to a low level in the main feed tank. The consequent low discharge from the turbo extraction pump could then allow the low-pressure switch to operate on the deaerator, quickly causing the deaerator to empty. This would of course result in a reduction in the deaerator extraction pump discharge pressure. With this state of affairs existing, it is likely that the differential pressure at the TWL feed pump suction, with the pump stopped, became insufficient and overheating of the bearings occurred, causing eventual seizure.

The whole cycle of events stemmed from the failure of the watchkeepers to maintain a sufficient working level of water in the main feed tank.

It was unfortunate that the warning lamp on the differential pressure alarm unit on the pump had not been connected since the installation of the pump during the previous refit.

Misalignment of Sigmund Allen Main Feed Pump

The Sigmund Allen main feed pump consists of a Curtis wheel turbine assembly which drives a two-stage pump through epicyclic gearing. A toothed flexible coupling allows axial expansion between the turbine and the gearbox input drive.

During a ship's recent refit the complete pump was removed, split at the pump coupling and the pump, and the turbine ends were despatched to their respective manufacturers for repair. The complete assembly was then assembled at the turbine manufacturer's works where a successful full-load trial was carried out in the presence of the Naval Engineer Overseer and the ship's Marine Engineer Officer. The pump was then reinstalled as a complete unit in the ship, used during S.A.T.S.(ME) when a large repair trial was carried out, and run during the first two weeks of the Portland work-up. Due to minor defects the pump was not then used again until the ship sailed for a foreign station.

Two days after sailing the pump started to vibrate while on load and was stopped. Examination of the thrust and journal bearings failed to reveal any damage. The pump was run up again to about half speed but considerably more vibration was experienced. The epicyclic gearbox was removed and found to be extensively damaged. On checking the alignment between pump and turbine it was discovered that the pump was 0.018 in. out of alignment with the turbine in the vertical plane and 0.005 in. in the horizontal plane. It was therefore necessary to remove the complete pump from the ship again for realignment.

It is probable that the pump and turbine ends had both been refitted satisfactorily as the performance of the unit was very good. Nevertheless this auxiliary was very quickly rendered useless due to carelessness in aligning the two component halves together.

Condenseritis in Turbo Alternator

While in harbour, a *Leander* Class frigate reported condenseritis in the boiler-room turbo alternator. This report was accepted at its face value and a fluorescene test lamp was provided. Results of a Canterbury test to 10lb/sq in. pressure carried out by ships staff were inconclusive but fluorescene was alleged to have been observed in both ends of the condenser. With the help of Base

staff, both end doors were removed and a further test was applied. There was no leak. The doors were replaced and the machine was run up and put on lead. The extraction pump discharge was clear and has remained clear.

Comment

Four working days were spent in investigating a defect which almost certainly did not exist. When the turbo-alternator watchkeeper first reported a heavy cloud, no quantitative tests of salinity and alkalinity were taken. Had this been done it is very probable that the cloud would have been shown to have been caused by a boiler priming.

The 'moral' is classic and elementary—care in the diagnosis of a defect is essential if nugatory work is to be avoided in dealing with it.