HEAD OF "P" BRANCH

A.F.O. 3779/44

RESTRICTED

(FOR OFFICIAL USE ONLY)

Not to be communicated to anyone outside H.M. Service

ADMIRALTY FLEET ORDER

FORCED LUBRICATION SYSTEMS—OPERATION AND MAINTENANCE

ADMIRALTY, S.W.1,
20th July, 1944.

The following Order having been approved by My Lords Commissioners of the Admiralty is hereby promulgated for information and guidance and necessary action.

By Command of Their Lordships,

H. V. Markham

To all Commanders-in-Chief, Flag Officers, Senior Naval Officers, Captains and Commanding Officers of H.M. Ships, Vessels and C.O. Craft (see A.F.O. 3758/44) Superintendents or Officers in Charge of H.M. Naval Establishments, and Admiralty Overseers concerned.

Note.—The scale of distribution is approximately half that shown in the Admiralty Fleet Order Volume, 1941, Instructions, paragraph 10.

3779.—Forced Lubrication Systems—Operation and Maintenance

(D. 012348/44.—20 Jul. 1944.)

General.—As sustained operation of machinery at high output under war conditions may lead to rapid deterioration of the oil in forced lubrication systems, it is of the greatest importance that the instructions contained in E.M., Art. 78, relative to the operation and maintenance of F.L. systems should be carefully observed. Moreover, as turbine lubricating oils, other than S.M.L.O., may have to be supplied to ships, certain further precautions are necessary, and the following supplementary notes and instructions are promulgated for guidance.

2. *Contamination.*—The most important source of trouble with forced lubrication systems is contamination of the oil with water, either salt or fresh: the former may be caused by leakage of salt water into the system through coolers, oil drain tanks or pipe connections in bilges, and the latter by condensation of vapour from turbine glands, etc.

In small ships operating in heavy weather, salt water or spray entering the engine room may obtain access to the system through vent pipes, test funnels, etc., and the possibility of water entering the oil storage tanks through the deck connections of the filling pipes must not be overlooked.

The presence of water in the oil not only increases frictional resistance and causes premature breakdown of the oil film, but may also result in corrosion of bearing journals or of other ferrous parts in the system, particularly those which are periodically exposed to the atmosphere.

In addition, water and oil may emulsify and the resultant sludge may be sufficient to choke filters, block oilways and lead to complete breakdown of the oil supply to bearings.

Every precaution must therefore be taken to prevent entry of water into the system.

Frequent and careful observation should be kept on the drain tanks and centrifugal separators to detect any abnormal increase in the water content of the oil. If tests show presence of sea water in the system it is essential that the earliest possible action be taken to locate the source of contamination, to rectify the defect and to clean the whole forced lubrication system, including the oil coolers.

The principal source of access of fresh water into the forced lubrication system is excessive supply of steam to the turbine glands. The glands are so designed that they will be correctly packed when a small positive pressure shows on the gauges connected to the outer gland pockets, and it is unnecessary to increase the supply of gland steam until steam escapes into the engine room.

Another possible source of fresh water contamination is by condensation on pipe connections to sight flow indicators and from test cocks to drain funnels if the oil temperature is low. To prevent this, the pipe connections should be arranged to slope downwards away from the sight flow indicators or funnels and the vertical leads into the indicators and funnels should be made as short as possible.

In cold climates, the flow of circulating water through the oil coolers is to be regulated so as to maintain the oil outlet temperature at about 80° F. when steady running temperatures have been attained.

3. *Operation of Centrifugal Separators.*—The centrifugal separators should be used to the fullest possible extent to remove water from the oil system.

They should be in use at all times when steam is on main engines and periodically in harbour. After shutting down, the separators should be run until no water is discharged from the purifier.

In ships provided with separate settling tanks, opportunity should be taken, as convenient, to transfer to the settling tank all the oil from the forced lubrication drain tanks of each unit in turn. After heating and allowing time for separation of any water and/or sludge the oil should be passed through the separators and returned to the system.

When in harbour, forced lubrication systems should be flushed round daily, if possible, while the main engines are turned.

Centrifugal separators should always be run at the designed speed, as any reduction in speed due to belt slip or other causes will result in reduced efficiency of separation.

In general, the best results will be obtained by operating the machine at about 50 per cent. to 75 per cent. of the maximum the machine will handle without overflowing. The output of the machine should be adjusted by means of the suction valve on the separator pump. In certain types of machine a restriction is fitted on the return pipe to the drain tank to limit the flow to the maximum designed capacity. Such restrictions should not be removed or enlarged.

The removal of water and impurities will also be facilitated by reduction in the viscosity of the oil under treatment. The preheater should therefore be regulated so that the oil enters the machine at approximately 160° F. and at not less than 140° F. Higher temperatures should be avoided, as oxidization and breakdown of the oil would thereby be increased.

It is important to use a gravity disc or ring dam of the correct size. Best results will be obtained with a gravity disc of the next size smaller than that which will permit some oil to be discharged with the water.

When starting up the machine it is essential that the bowl should be primed with distilled water while the machine is running up to speed. The water forms a seal and prevents the oil from being discharged through the water and sludge spout and at the same time ensures the removal of water soluble acids and some of the finer impurities.

Frequent examination of the bowl is essential. The frequency of cleaning depends upon the amount of foreign matter, dirt, grit, rust particles or sludge in the oil. It should be appreciated that the bowl separates and retains the heavier solids. If these are present in excessive quantities the water outlet may become choked, and this may lead to an incorrect assumption that the oil is free from water. Generally the bowl shell and discs should be examined once a watch and cleaned if necessary. Experience will show whether longer periods can be allowed between cleanings. Cleaning should always be carried out after the oil is run through for batch purification from the settling tank and on stopping after shutting down main engines.

Cleaning can normally be effected by lifting out the distributor, together with discs, after removing or lifting covers and scraping out the dirt accumulated in the bowl shell.

Further cleaning of the bowl parts is generally not necessary, but if impurities have entered between the discs they can be cleaned after the bowl has been re-assembled and before separation is continued by running the separator up to full speed with empty bowl, thus causing the impurities between the discs to be thrown out into the sediment space. Generally it is not necessary afterwards to stop the separator for removal of these impurities, but the separation can be continued at once, taking care first to reduce the speed and to fill the bowl slowly with water.

In the case of exceptionally dirty oil it may be useful to place the distributor with discs in warm water, or warm oil, where they should remain while the bowl is being cleaned; the impurities deposited on the discs will then be thrown off more easily. Should, however, this procedure not be quite effective, the set of discs must be taken apart and each individual disc cleaned with a brush.

Samples of the oil and the effluent from the water discharge should be taken once a watch and tested by observing the clarity of the cleaned oil and the amount of oil in the water. The water should be tested for salinity with silver nitrate.

4. *Topping-up Systems.*—Oil which has been in use for long periods, particularly when operating at high powers or with high bearing temperatures, may become oxidized. Products are formed which, though soluble in the used oil, are insoluble in new oil. When new oil is added to a system containing oil which has been in use for some time it will tend to throw oxidization products out of solution. These may be deposited on bearing surfaces and gear teeth in the form of lacquer or, if the quantity of new oil added is large, will form sludge which may choke oil passages and filters. The new oil may also loosen deposits in pipes and coolers, so contributing to sludge formation.

Systems should be kept topped-up by the addition of small quantities of new oil at frequent intervals, rather than by making large additions. Except in the event of loss of a large quantity of oil due to accident or damage, additions should be limited to not more than 10 per cent. of the capacity of the system at any one time.

5. *Alternative Grades of Oil.*—Admiralty special mineral lubricating oil (S.M.L.O.) should normally be used for charging forced lubrication systems.

If S.M.L.O. is not available, U.S. Navy oils symbol Nos. 2190T or 3050 may be accepted in that order of preference.

S.M.L.O. is a straight mineral oil of paraffinic base produced by the acid treatment process, having the following main characteristics :—

(i) Specific gravity—not exceeding 0·880.

(ii) Viscosity Redwood No. 1 at 70° F., not more than 700 secs.
at 140° F., not less than 105 secs.
at 200° F., not less than 50 secs.

(iii) Acidity expressed in milligrams KOH per 100 gms. of oil.

(*a*) Inorganic acidity—nil.

(*b*) Organic acidity—not exceeding 10.

(iv) Sulphur—not exceeding 0·2 per cent. and generally free from water, ash and suspended matter.

U.S. Navy symbol 2190T is a solvent refined oil of slightly higher viscosity than S.M.L.O. and comparable viscosity index, containing anti-oxidant and anti-rust additives.

U.S. Navy symbol 3050 is a solvent refined straight mineral oil made from paraffinic base stock, generally similar to S.M.L.O., but of slightly lower viscosity.

Ships replenishing at ports abroad, where neither S.M.L.O. nor either of the U.S. Navy oils referred to above are obtainable, should demand oil complying as closely as possible with the characteristics of S.M.L.O. quoted above.

Particulars of the oil supplied and of the stock from which it is blended should be obtained from the suppliers and confirmation that the oil is suitable for mixing with S.M.L.O.

6. *Mixtures of Different Grades.*—When mixing oils of different grades the instructions contained in paragraph 4 above relative to limitation of additions to not more than 10 per cent. of the capacity of the system must be carefully observed. New oils of similar type, e.g. S.M.L.O. and U.S. Navy symbols 2190T and 3050, may be mixed in storage tanks in any proportions. It should be observed, however, that dilution of 2190T with S.M.L.O. or 3050 will reduce the effectiveness of the anti-oxidant and anti-rust additives contained in the former. Naphthenic oils should not be mixed with paraffinic base oils if it can possibly be avoided, as there may be a tendency for increased sludge formation when systems containing oil of paraffinic type are topped-up with naphthenic oils, and vice versa. Whenever a system is topped-up with oil of a grade different to that in use, a careful watch should be kept on the oil separators, and if any undue discharge of sludge is observed, steps should be taken to change all the oil in the system at the first convenient opportunity.

7. *Oil Changes.*—When changing over to oil of a different grade it is preferable, if circumstances permit, to drain the system completely and clean sumps and drain tanks. Before refilling the system it should be flushed through with a small charge of the new oil, which should then be discarded. On both occasions care should be taken to drain the oil out of thrust and adjusting blocks, which will normally remain full when the system is drained down.

8. *Reports of Difficulties.*—Reports of any difficulties experienced are to be forwarded to the Admiralty, including particulars of the oil in use and source of supply. Samples of both used and unused oil should be taken and held for future examination if required.

9. *Samples.*—Care and judgment are necessary in taking oil samples, otherwise erroneous conclusions may be drawn from the results of their examination. The following principles should be observed :—

(i) Samples must be taken so that they are fully representative of the particular oil it is desired to test, e.g. samples of oil in a forced lubrication system must be collected from oil in circulation and not from a stagnant part of the system, such as a drain tank.

(ii) The most meticulous care must be taken to avoid any possible source of contamination. Sample containers should preferably be clear glass bottles or jars which can be visually examined for cleanliness. They should be thoroughly washed out several times with distilled water and left until completely dry before taking sample. The slightest trace of dirt or moisture will invalidate the test. Tin containers may only be used if they are known to be completely free of rust or any solid impurities. Cork or glass stoppers should be thoroughly cleaned and dried before fitting in place, and should be fitted immediately after the sample is taken.

(iii) When taking a sample from a cock in an oil system, sufficient oil should be allowed to run to waste to clear the cock and pipe of any contaminating material. The sample container should then be rinsed and washed out at least three times with oil from the system before finally taking the sample. The container should then be immediately corked and labelled with particulars of where the sample has been taken.

(iv) In general, samples of used oils should be accompanied by samples of the original oil to enable a determination to be made of any deterioration in quality. The original oil should be collected from the top of an oil storage tank or drum, as samples taken from the bottom of a tank are liable to contain water and will not be representative.

(v) The containers must be carefully labelled, stating all relevant particulars of the source and nature of their contents, together with the length of time in service in the case of used oils.

10. *Cleaning Systems.*—In cases of severe sludging or on other occasions, e.g. during large repairs or after severe contamination with fuel oil or sea water as a result of accident or damage, thorough cleaning of the entire system is essential.

In general it will be necessary to strip down all parts of the system for cleaning, but it may be permissible to adopt chemical cleaning processes, in which case proposals are to be submitted to the Admiralty for approval, stating full particulars of the process which it is proposed to adopt.

11. Additional copies of this Order may be obtained from the Editor of Fleet Orders.

(*E.M., Art. 78.*)

(*C.A.F.O. 1221/42 and A.F.Os. 447/41, 1194/41, 3394/41 and 6174/42 are cancelled.*)

(67919) Wt. 8092/2356 14,000 7/44 Hw. G.338/10.