THE CONDUCT OF FULL POWER TRIALS

BY

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An unsatisfactory Full Power Trial is a waste of time and money; it is hoped that the following notes may help Engineer Officers to avoid the more common mistakes and, while not exhaustive nor applying to any particular class of ship, may serve as a useful ' aide memoire '.

The prime object is to obtain the designed full power from the main engines without exceeding the maximum forcing rate of the boilers. The secondary objects are to ensure that all auxiliaries in connection with the main machinery are capable of performing their duty and that the Engine Room personnel are familiar with operating the machinery at high powers.

Failure to reach designed speed or r.p.m. is a secondary consideration and (apart from lack of power) is usually due to conditions not under the immediate control of the Engineer Officer such as :—

State of sea and wind, and depth of water ;

State of ship's bottom ;

Displacement.

The power produced by the main engines is a function of the steam flow through them, as indicated by the pressures at the H.P. 1st stage reaction belts and the condenser vacua. If the turbine is in good condition, full power is reached when these pressures correspond to those laid down in L.C.A.F.O. 250/52 for each type of ship. If however the turbine clearances have become excessive, it is unlikely that these conditions will be reached without exceeding the forcing rate of the boilers. This is because the steam is being passed through the turbines without doing its full amount of work, hence more is required. The same applies if the steam temperature is lower than designed.

It is clear from the above that failure to achieve full power will be due to any combination of the following :—

Lack of steam pressure at manœuvring valves ;

Poor vacuum ;

Low steam temperature ;

Large clearances in turbine.

As the last item is beyond the scope of these notes it will be ignored, and the other three items will be dealt with in turn.

Lack of Steam Pressure at Manœuvring Valves

This is due to two main causes :—

(*a*) Reduced output from boilers ;

(*b*) Excessive steam consumption by auxiliaries.

Reduced output from boilers.—This will be caused by any of the following :—

(i) Boilers dirty, internally or externally.

(ii) Bad combustion (excess air, dirty sprayers, misalignment, etc.).

(iii) Too low an oil temperature or pressure at sprayers, or fluctuating oil pressure.

(iv) Low feed water temperature.

Excessive steam consumption by auxiliaries.—This will be caused by any of the following :—

(i) Auxiliary machinery in general, worn and with enlarged clearances.
(ii) Circulators running too fast.
(iii) Boiler room fans running too fast (air leaks in boiler rooms or casings).
(iv) Evaporators on live steam.
(v) Running any auxiliary with too many controllable nozzles open (thus lowering initial steam pressure).
(vi) Too much steam on air ejectors.

Poor Vacuum

This will be caused by :—

(*a*) Dirty condensers ; grease on steam side and/or scale on sea-water side of tubes.
(*b*) Choked weed traps, tube plates or tubes.
(*c*) Too much auxiliary exhaust steam being admitted to condensers.
(*d*) Excessive airleaks.
(*e*) Inefficient air ejectors.
(*f*) Air locking of sea-water spaces in condensers.
(*g*) Condenser water level too high.
(*h*) Circulators running too slowly (very unlikely).

Low Steam Temperature

This is usually caused by too high a water level in the boiler and/or superheater drains not fully opened up. A defective steam trap may produce the same effect. Dirty superheater tubes also have an obvious effect on steam temperature.

Preparations

It will be seen that many of the above factors are not only interdependent but cumulative. To detect and remedy any of these symptoms it is of the greatest importance that all readings required on form S.346, ' Report of Trials of Main Machinery at Sea ', are not only capable of being taken, but taken accurately. This requires careful and personal checking well before the trial, it is equally important to ensure that the personnel know where to take their readings, and in fact can read them correctly.

To ensure the greatest chance of carrying out a successful trial, the following points should therefore be attended to, it being assumed that the machinery is reasonably free from ordinary defects, steam and water leaks, etc., and that the boilers and condensers are not dirty.

Well prior to the Trial

Engine Room

Check the following :—

(i) That the thermometer pockets at the top of the condenser are clear of dirt and that thermometers 0–212°F. are available and will fit.
(ii) That Kenotometers are fitted if available and working correctly and that the sensitive vacuum gauges have recently been calibrated and are registering accurately.

(iii) Particularly that the H.P. 1st stage reaction belt pressure gauges have been calibrated and register accurately, and that all the other pressure and temperature gauges in connection with the manœuvring valves and H.P. receivers are working correctly.

(iv) That the feed heater discharge thermometer pocket is clear of dirt and a 0–250°F. thermometer is available.

(v) That the air ejector suction and extraction pump suction temperature thermometer pockets are clear.

(vi) That the air ejector sea-water spaces have been vented and the main condenser water space vents all open.

(vii) That air ejector stage drains are opened up and led to the correct places.

(viii) That all tachometers are registering correctly.

Boiler Rooms

Check the following :—

(i) That the habitability vents, if fitted, can be shut off and are sealed tight.

(ii) That the ventilation and air supply arrangements for diesel generators shut off efficiently.

(iii) That all foam tube and bilge ejector screwed caps are in place and screwed tight.

(iv) That all boiler casings are really tight and all cotter pins in place.

(v) That all air lock doors and hatches are airtight.

(vi) That smoke mirrors are in place, correctly adjusted, and the lights burning.

(vii) That there are no holes in deckhead or bulkheads (unblanked cable glands, bolt or rivet holes, voicepipes, etc.).

(viii) That the thermometer pockets are clear and thermometers available for the main stop valves.

(ix) That all sprayers are really clean with undamaged orifices and in correct alignment, and that the shut-off tubes or flaps are working correctly and not distorted.

(x) That the fan nozzle controls are understood and free to work.

(xi) That the fan tachometers are registering.

(xii) That the oil fuel pump air bottles are full of air.

(xiii) That the uptake pyrometers, if fitted, are registering.

General

Accurate readings will not be obtained unless all high temperature thermometer pockets are filled with soft solder, and low temperature pockets with oil. Ensure that enough thermometers are available plus spares for breakages. Those not normally in use should not be fitted until required, to reduce breakages and losses.

During Preliminary Steaming at High Power

The following should be checked :—

(i) Condenser circulating water temperature rise, and condensate temperature, for indications of bad heat transfer ; and circulator speeds, for choking of inlet gratings or tube plate fouling.

(ii) Air ejector suction temperatures with temperature corresponding to vacuum in condenser ; if the suction temperature is appreciably lower than this (over 8°) it is an indication of a large air leak.

(iii) That boiler room fan speeds and air pressures are reasonable and level ; and that there is no suspicion that the oil fuel heaters need cleaning, or that there is any restriction in the flow of oil from heater outlet to sprayers. If there are no suitable pressure gauges, this can be checked by comparing the fuel consumption by tanks with that by sprayer output chart.

(iv) That the feed regulators and feed controllers are operating correctly at high power.

(v) That all readings which will be required during the trial are registering and giving reasonable results.

During actual Trial

All previous points should be looked into during work-up, and in addition the following points should receive careful attention :—

(i) The boiler pressure must be kept up to the maximum. The best way of doing this is to relieve the boiler room staff of all responsibility for steam pressure once the work-up has started, and control it entirely by the opening of the main throttles. The boiler room staff can then concentrate on maintaining a steady oil fuel pressure and temperature, and on correct combustion of the fuel.

(ii) Circulators are the most wasteful single item of auxiliary machinery, and must be run at the lowest possible speed using the minimum of trailing steam. If this does not maintain adequate vacuum (27·5 in.) the fault lies elsewhere.

(iii) Boiler room fans are the next most wasteful in steam. Speeds must be kept as low as possible and the turbines should be nozzled down where possible so that they are just keeping a clear funnel with the master control valve wide open. (Leaking casings are the usual cause of high fan speeds being required.)

(iv) Every effort should be made to keep the Closed Exhaust off the main condensers. It should be used entirely in the feed heater and evaporators, and in fact, the gain in efficiency when used for feed heating more than offsets any increase in auxiliary steam consumption, up to a limit of 16–17 lb/sq. in.

(v) Only the designed amount of ejector steam should be used ; more than this is only likely to flood the venturis and make them less efficient.

(vi) Keep the water level in the feed heater as low as possible to keep the feed water temperature up.

(vii) All other steam users should receive careful consideration to reduce steam consumption.

Final Points

Most ships are designed with their boiler power slightly in excess of the maximum envisaged demand for steam. It therefore depends on the state of the main and auxiliary machinery whether the limit of power is reached first in the main engines or boilers. The better the condition of the main engines and auxiliary machinery the more likely will the main engines reach their limit (L.C.A.F.O. 250/52) and the boilers conserve a margin of power. If the main engines are badly worn or more likely, the auxiliary machinery in poor condition, then the boilers will reach their maximum forcing rate before the engines have got to full power. In either case, once the limit is reached the trial may be assumed to have started, and the rest of the trial should be spent

endeavouring to improve steam consumptions of auxiliaries, and other conditions such as feed heater outlet temperatures, circulator speeds, combustion in furnace, etc. In this connection, it has been found recently that a vacuum of 27·2–27·5 in. is the optimum, and that it is wasteful of steam to attempt to improve this. It is also better to make a bit of smoke than to use excessive air to clear it.

A point often neglected during a Full Power Trial is the desirability of keeping the lubricating oil temperature above 100°F. (B.R. 16, Art. 57, para. 3). This must depend to a certain extent on the behaviour of the bearings at high power, but apart from the considerations of water contamination mentioned in B.R. 16, an appreciable saving in steam and consequent small gain in r.p.m. will result in keeping the temperature as high as possible.