

BOILERS

WEAR AND WASTE TESTS

BY

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Every year, approximately eight hundred forms S.356 and S.356(b) are received at the Admiralty reporting the wear and waste tests of boilers of H.M. ships and shore establishments. The reports are rendered in accordance with B.R.16 (1950), *Engineering Manual*, Arts. 231 to 241.

The annual cost involved for the wear and waste testing of boilers, both in man-hours and material, is quite appreciable, but the work is essential to determine :—

- (a) The serviceability of the boilers
- (b) The expected remaining durability
- (c) The knowledge of any repairs that should be carried out concurrently with the wear and waste test, or of those repairs that should be included in a future refitting programme of the ship or service
- (d) The advance notice of any material that it may be necessary to provide so that it is available for carrying out repairs at a programmed refit of the ship or service.

The wear and waste testing of boilers at regular intervals is a means whereby the serviceability of the pressure parts is determined and the availability of the boilers guaranteed. No less important is the examination of the funnels, uptakes, boiler casings, boiler feet, securing and expansion arrangements.

Wherever possible, a wear and waste test report should be complete ; a report that does not include the full examination of a boiler, due to shortage of time and/or manpower to effect the complete work, may convey a condition quite different from the actual state of a boiler. Durabilities assessed as a result of such an examination may be unreliable and misleading.

Reports of wear and waste tests of boilers are received at the Admiralty from many Administrative Authorities at home and abroad, and scrutiny of the reports reveals that there are differing opinions as to the amount of work that should be carried out when boilers are periodically examined for wear and waste test. In general, tubes should be removed and, if necessary, holes drilled to determine plate thickness, in one boiler of every four installed, on each occasion of testing, the boiler to be selected for this test in rotation in the group. The remaining boilers in the installation should be examined visually. The number of tubes to be removed from a boiler, cut up and gauged, as stated in B.R.16, Art. 234, should be considered as the minimum. Transverse lanes of tubes may be selected by the examiner for removal from a water-tube boiler to determine the extent of internal pitting ; in addition, other tubes may be removed from the front and back ends of the boiler and from other areas in which external corrosion may be suspected. Tubes should also be removed from other boilers in the installation and, if necessary, holes drilled, if the condition of the boilers is considered to be different from that of the boiler selected, in rotation, for the test.

It is important that, although only one boiler of every four fitted need be fully wear and waste tested, it is a requirement that the durability assessed on completion of the test should be satisfactory for all the boilers fitted. Durabilities assessed at a wear and waste test cancel the assessment at the previous test, but when assessing a durability, due regard should be taken of the minimum gaugings of tubes and of any plate wastage revealed at all former

occasions of wear and waste testing of the boilers and of any tube renewals effected.

It is desirable that wear and waste tests of boilers should be carried out during a refit period, and it is a requirement that defects, if existing, should be revealed as early as possible in the refit so that repairs may be effected with the minimum delay in the programme of completion for the ship. In general, wear and waste testing of boilers is a combined operation, the ships staff being responsible for cleaning the boilers in readiness for inspection, the Administrative Authority for the ship arranges for the boilers to be examined, tubes and holes to be marked for removal and drilling, respectively, and the dockyard undertake the work of removing, cutting up and gauging the tubes, also the drilling of holes and the removal of cores, and the preparation and replacement of the tubes.

The tube gaugings are a very early requirement in a refit because, if gaugings reveal the necessity for tube renewals, the earlier this knowledge is available the more likely it is that arrangements may be made to effect the renewals without interference with the ship's completion programme. Delay in the past in obtaining tube gaugings, has been due to the time taken to cut up the tubes longitudinally when using a slow band saw. With a high-speed band saw, now being installed in each boiler shop in the dockyards, the time required for cutting up a set of, say, fifty tubes for a wear and waste test may be reduced from approximately fifty hours to something much less than five hours.

There is no short cut in obtaining the gaugings of tubes in respect of internal pitting ; it is necessary to cut the tubes longitudinally for gauging. Trials have been carried out using an electrical probe to determine the depth of pits in tubes *in situ*, but results were not satisfactory. Further investigations are in hand.

External wastage of tubes adjacent to the drum tube-plate, due to the presence of damp deposits, may be assessed quickly by dealing with the short length of of a tube showing maximum wastage—a length perhaps no longer than six inches. Visual inspection of the tube after removal from the boiler should reveal whether the wastage is in an advanced stage, and the necessity for the renewal of a batch of tubes could be determined without delay. If the tube is dealt with in the normal way, by cutting and gauging the whole length of the tube, a delay would occur in arriving at a decision to remove extra tubes. External wastage of tubes adjacent to water-drum tube-plate, particularly at the ends of the drums, is regrettably common in the smaller ships due to access of water from above. The wastage may be said to be heavier at the back-ends of the boilers, no doubt the result of rain and sea water gaining access to the funnel and to faulty rain water catchments in the uptakes allowing water to soak the hygroscopic deposits which form between the tube necks over the drums. Wastage of the tubes also occurs at the front end of the boilers and may be attributed to overhead leakage from valves, etc.

With the introduction of water washing water-tube type boilers externally, a quicker and better clean should be achieved if the operation is carefully planned. It is of great importance, however, in order to minimize corrosion, that special care is given to the removal of wet deposits from the remote corners of the tube nests which are not of easy access, and to dry out the boiler thoroughly immediately after washing.

Scrutiny of so many wear and waste test reports reveals occasional shortcomings in the examination of boilers. Wear and waste tests of boilers are arranged to be carried out during a refit, whenever possible, and the following examples show how a favourable opportunity to examine for defects and to effect repairs may have been lost :—

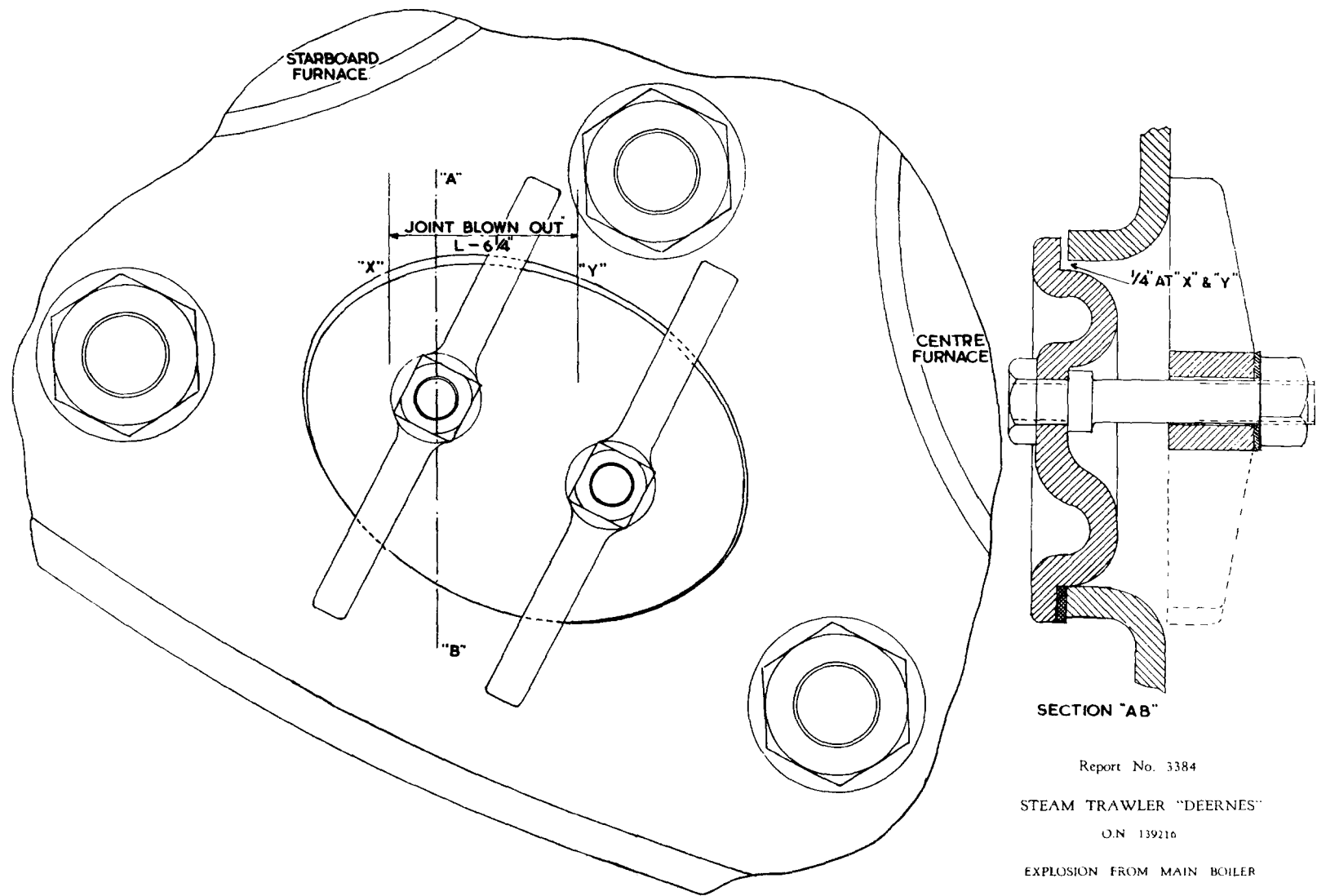


FIG. 1—DETAILS OF MANHOLE DOOR

Report No. 3384
 STEAM TRAWLER "DEERNES"
 O.N. 139216
 EXPLOSION FROM MAIN BOILER



FIG. 2—APPEARANCE OF SECTION OF PLATE SHOWING CRACKING

(a) *Water Tube Boilers*

Tubes were removed from a boiler, cut up and gauged, and, in accordance with B.R.16, App. 8, the tubes were assessed a durability of four years. The durability was quite satisfactory in view of the minimum gaugings recorded, but a recommendation was made that at the earliest opportunity the front and back-end casings should be removed from the boilers, in order that the tubes in those areas might be examined for external wastage.

Comment

A durability of four years for the tubes was assessed without regard to the condition of the tubes in the vulnerable areas for external wastage and the durability was of doubtful value.

(b) *Cylindrical Return-Tube Boilers*

Manhole doors were reported to have clearance between the door spigot and manhole orifice, in excess of the maximum stipulated in B.R.16, Art. 199, and it was recommended that the doors be refitted at the earliest opportunity.

Comment

No doubt the fit of the doors was verified only when they were fitted immediately before the boilers were closed for filling, and too late to effect repairs within the refit period. Delay in checking the fit of manhole doors is usually due to the presence of electric and pneumatic leads passing through the manholes during the boiler examination and repair. Manhole and handhole doors should be checked for fit early in a refit, so that there is time to effect necessary repairs or renewals.

The detail of the fit of a manhole door fitted in a commercially operated trawler is shown in FIG. 4. The excessive clearance between the spigot of the manhole door and the manhole flange resulted in a portion of the jointing material being blown out, and the explosion caused the death of the boiler attendant.

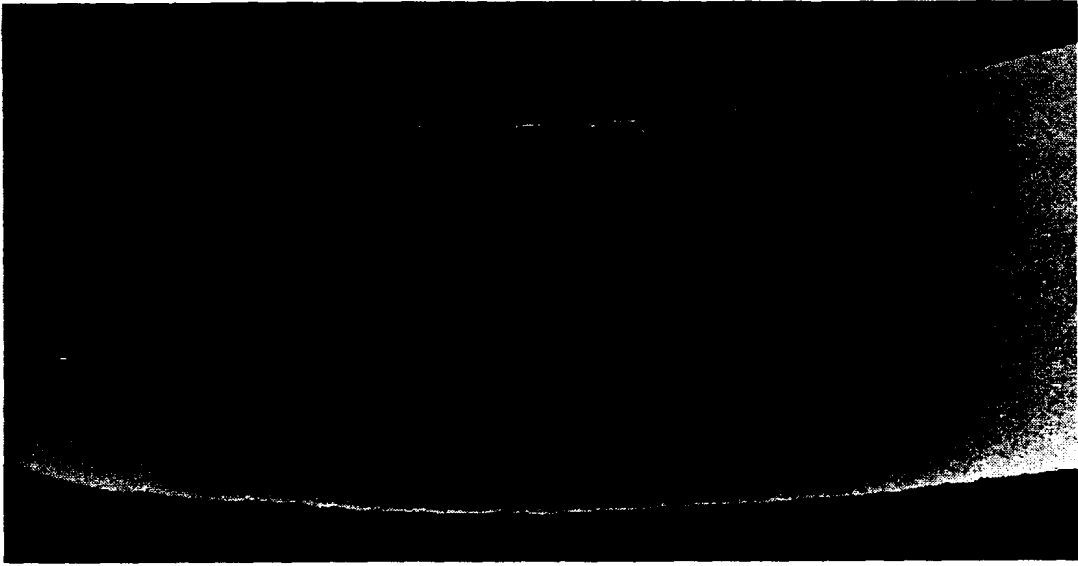


FIG. 3—MACROSECTION SHOWING CORROSION FATIGUE CRACKS OF PLATE AND THINNING OF PLATE AT POSITION OF CRACKING

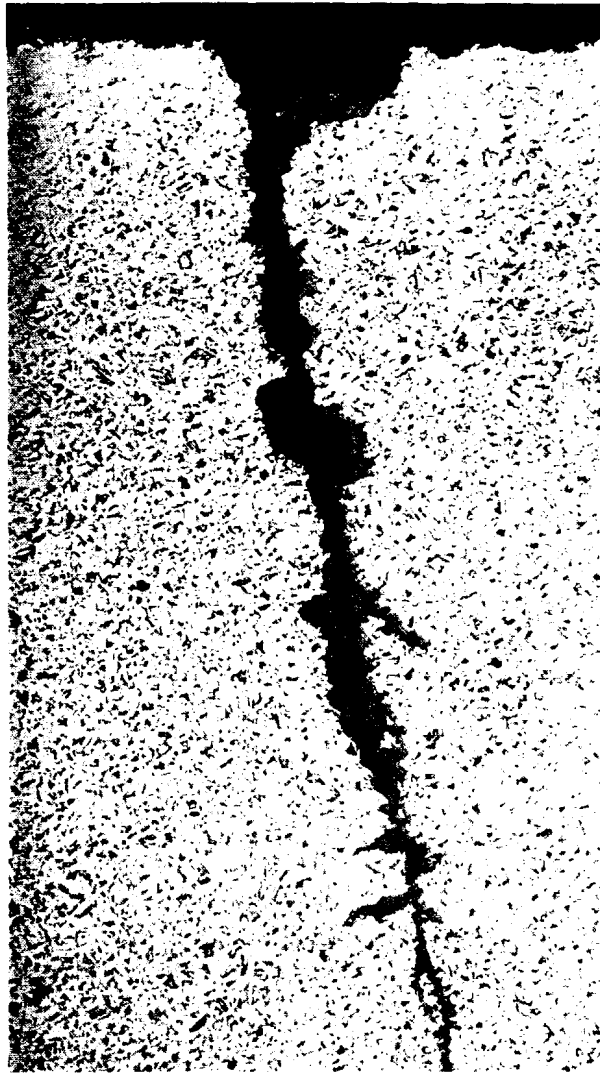


FIG. 4—MICROGRAPH SHOWING CHARACTERISTIC CORROSION FATIGUE CRACK AND GENERAL MICROSTRUCTURE OF STEEL

(c) *Cylindrical Return-Tube Boilers*

Grooving in the bend of boiler end-plate flanges visually examined only, and a recommendation made that a core be removed at the earliest opportunity.

Comment

It is not easy to assess the depth of combined grooving and cracking by visual examination. Some degree of accuracy might be determined by the study of the position of the defect, overall length, whether intermittent or continuous and whether active. Removal of a core during a wear and waste test would determine the seriousness of the defect and afford opportunity for repairs and the assessment of a reliable durability.

FIGS. 2, 3 and 4 show grooving and cracking in the radius of boiler end-plate flanges. It will be seen that visual examination only, would be insufficient to evaluate the defect. Grooving in the bend of plate flanges may be examined radiographically, and cores should be removed along the line of grooving in order that the depth of the combined grooving and cracking, also the remaining sound plate thickness, may be determined.

Faulty rain water catchments in the uptakes have been previously mentioned in connection with the wastage of tubes externally at the drum ends, and occasionally wear and waste test reports include a paragraph to the effect that when investigating the cause of the damp deposits over the drum it was revealed that the rain water catchments were faulty, with troughs perforated and drains choked. Wastage of tubes externally, due to damp deposits in the less accessible areas for cleaning, is a real problem and the maintenance of the rain water catchments in a satisfactory condition is essential to ensure a longer durability for the tubes at the ends of the drums.
