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BOILER CODE OF PRACTICE

GUIDANCE NOTE

BOILER WASHOUT & EXAMINATION

Purpose

This document describes good practice in relation to its subject to be followed by Heritage Railways, Tramways and similar bodies to whom this document applies.

Development

This document has been developed by boiler experts in consultation with His Majesty's Railway Inspectorate (HMRI) a directorate of the Office of Rail and Road (ORR). The document HGR B9000 sets out the background to setting up the Boiler Code of Practice Committee (BCOP).

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1. Introduction

a) This Guidance Note is one of a series dealing with Locomotive Boilers that were produced by the "Steam Locomotive Boiler Codes of Practice" practitioners' meetings.

b) Railway locomotive boilers are designed to create, store and distribute steam at high pressure. The working life of such a boiler can be considerably shortened if due care is not taken at all stages of inspection, repair, running maintenance and day-to-day running.

c) In the past there have been a series of accidents and explosions due to work being undertaken without having due regard to the inherent risks involved. It is with that in mind that HMRI and HRA set up the series of meetings of boiler practitioners to discuss the issues, distil good practice and codify it into this series of Guidance Notes.

d) This guidance is written for the assistance of people competent to perform these tasks. In places the terminology used may be specific to such practitioners.

e) This guidance will also be useful to those in a supervisory or more general role. However no work should be undertaken unless the people concerned are deemed competent to do so.

2. Recommendations

a) This guidance note is issued as recommendations to duty holders with regard to Washout, Brick Arch, Firegrate and other Regular Servicing of Steam Locomotive Boilers.

b) Where duty holders decide to take actions that are not in agreement with these recommendations, following appropriate risk assessments or for other reasons, it is recommended that those decisions are reviewed by the senior management body of the organisation and a formal minute is recorded of both the decision reached and the reasons for reaching it.

3. Scope of this Guidance

a) The purpose of this guidance note is to ensure the proper maintenance of the boiler by all associated with servicing and examinations, thereby maximising the operating life of the boiler before repairs become necessary. This guidance is ONLY concerned with those actions that could adversely affect the life and / or the safe operation of the boiler.

b) Duty holders should consider all aspects of each of the sections covered before determining their procedures.

4. Dimensional Notation

a) The dimensions in this document are variously described in a mixture of imperial and metric units. Where practical, equivalent dimensions have been shown but in some cases the dimensions do not easily equate and so the units in force at the time the original designs were documented have been used.

5. Personal Protective Equipment

a) Before undertaking any work, a risk assessment must have been conducted.

b) Protective equipment is to be supplied and used at work wherever there are risks to health and safety that cannot be adequately controlled in other ways.

c) The equipment must be:

   i) In accordance with the latest Personal Protective Equipment regulations;

   ii) Properly assessed before use to ensure it is suitable;

   iii) Maintained and stored properly;

   iv) Provided with instructions on how to use it safely; and

   v) Used correctly by those undertaking the work.

6. Principles

a) To avoid damage to any boiler two principles are essential:

   i) If possible, the temperature of all parts of the boiler should remain constant;

   ii) If this is not possible, the rate of change of temperature should be as slow as possible throughout the operating cycle.

b) In practice these principles are difficult to achieve for locomotive boilers, but every effort must be made not to stray too far from the ideal. This can be achieved by:

   i) When cooling down a boiler for washing out, taking as long as possible.

   ii) When raising boiler pressure from cold, taking as long as possible.

   iii) Avoiding rapid changes in fire temperature, firing little and often, and avoiding excess cold air.

   iv) Adding feed water as steam is used; avoiding mortgaging the boiler then adding feed by using both injectors.

   v) Not using injectors at the end of the day to cool the boiler down.

WARNING

In the days of British Railways and their predecessors, washouts were often quite severe operations with cold water plunged into hot boilers and fires raised quickly to return the boiler to service. Even a hot water washout used water which was well below the temperature of the boiler. As a result, the rapid contraction of tubes, stays and boiler plate would set up considerable stresses. The age and value of boilers today demands that far greater care is taken than previously.

7. Cooling the Boiler

a) Depending upon the size of the boiler, sufficient time must be allowed for the boiler to cool gradually without some parts cooling faster than others. A typical method for most boilers is:

b) First day.

   i) Post notices/signs that the locomotive is stopped for washout.

   ii) Keep all dampers and doors closed.

   iii) Allow the boiler to cool naturally for 24 hours after the fire has died. After this period, most boilers will have lost all boiler pressure. The rate of cooling will have been around 5 degrees C per hour.

c) Second day.

   i) At the end of 24 hours, check that no residual pressure remains and that the water temperature is below 40 degrees centigrade before draining the boiler of water. Either open the blow down and slacken off a front lower mudhole door, or remove a washout plug from the side of the firebox. Care should be taken, as the boiler water will still be hot after the initial flow.

   ii) Post notices/signs that the boiler is empty.

   iii) After the boiler has been drained of water, allow the boiler metalwork to continue to cool for another 12 hours.

   iv) The boiler will now be at, or close to, ambient temperature.

   v) After this, no damage will result due to the boiler being exposed to washing out water, or air circulating through the open smoke box door.

d) Third day.

   i) Washing can commence at foundation ring level moving to the rest of the boiler toward the end of the day or left for the 4th day, depending on size of boiler and ambient temperature.

8. Equipment

a) A water supply (complying to the byelaws with class A air gap) of sufficient pressure and flow is required to successfully move scale from within the boiler. Nozzles need to be 15-20 mm in diameter and should be able to project a jet of water vertically some 8 to 10 metres into the sky. If the available flow is not sufficient then additional capacity and a booster pump will be required.

b) The person washing out will either need a control valve close at hand or the assistance of someone to turn the water on and off.

c) Nozzles will need to be of various types:

   i) Straight, short for fire box and long for barrel work.

   ii) Bent, both a long swept bend and also a short right angle bend.

d) The nozzles will need to be made of a material which does not damage the threads of the washout plug holes. Copper is ideal, whilst aluminium is useful for the long nozzles used at the bottom of the barrel. The material needs to be of thick wall construction to withstand the rough use.

e) Scrapers can be of brass or bronze to avoid damaging the copper fire box plate. If steel scrapers are used, they need to be handled carefully and the threaded hole protected by a brass or bronze bush.

f) Flare or lamp. The flare must not have an asbestos wick.

9. Washing out

a) Following cooling, the drained boiler is to be washed out in the following sequence:

   i) Ensure that a washout plug chart is available before removing plugs or doors. Check that plugs and holes are numbered in accordance with the chart.

   ii) Remove all accessible mudhole doors and external washout plugs to gain full access to the boiler barrel firebox sides and door plate. Do not remove washout plugs from within the smoke box at this stage.

   iii) All mud and scale in the foundation ring should be removed first to ensure that a clear route exists for the washing out water to exit the boiler at the lowest point. Visually confirm that the foundation ring is clear at the front, back and both sides.

   iv) Wash out the firebox crown through mudhole doors, side plugs, door plate plugs.

   v) Wash out the firebox side through side plugs.

   vi) Wash out the door plate through door plugs paying particular attention to the top of the firehole ring.

   vii) Wash out the foundation ring through doorplate, side and throat plate mudhole doors and plugs.

   viii) Wash out around the tubes and flues from above through any available mudhole doors or plugs.

   ix) Where fitted, wash out the feed trays through any available mudhole doors or plugs.

   x) Remove all plugs in the smoke box for access, again referring to the washout plug chart. If removed earlier, the smokebox required for access will now be full of water.

   xi) Wash around the back of the tube plate and then wash out the barrel. Start at the highest plug holes and, from the front, work slowly down the barrel.

   xii) Finally wash out the collected scale from the front of the foundation ring.

b) At each stage, the water must run clear before moving to the next plug or door hole. Keeping the nozzle moving will help flush out the scale. The sediment and scale will move from point to point and so it will be necessary to repeat parts of the process several times.

c) Some scale will be lodged in place and will require movement with rods. On platework and stays, scale will build up particularly close to the firebox. This will need dislodging using rods to chip off the scale. Research by the LNER concluded that 4/5ths of the temperature difference between the fireside of the copper and the boiler water was due to the layer of scale on the plate and 1/5th due to the copper plate. From this it will be seen that to avoid overheating the copper plate the waterside must be kept

clear of scale as much as possible. Not only does scale reduce the transfer of heat but it will also disguise any defects and corrosion of stays or plate work.

10. Record Keeping

a) Records need to be kept of:

   i) Plugs/doors taken out, by whom and on what specific date.

   ii) Washing out undertaken, by whom and on what specific date.

11. Examinations

a) In all cases, examinations should be carried out by persons with the necessary experience and training. Wherever possible, alternate examinations of a boiler should be carried out by different people. The results of all examinations must be recorded.

12. Examination of boiler cleanliness at wash out

a) When washing is complete, the boiler is to be examined by a person not involved in the actual washout using a flare, low voltage lamp or endoscope for cleanliness condition.

b) Follow the same sequence as washing out, checking for scale deposits especially around the crown stays and in the barrel. To check the barrel, the lamp or flare should be inserted up from the throat plate mudhole doors until it is visible when sighted from washout plug in the smokebox.

c) If there is a scale build up around the crown stays etc., this is to be removed by rodding, the deposits washed away and the area re-examined.

d) It is most important that the foundation ring is checked thoroughly for scale and mud deposits, both on the ring and also the adjacent stays. For most locos, the lamp or flare should be inserted into the doorplate openings at foundation ring level and sight up from the throat plate for both sides. Locomotives with bent foundation rings can be difficult to sight properly up the foundation ring even with the use of mirrors.

e) If there is scale in any part, the washing and examination process must be repeated.

f) A record is to be kept of the cleanliness checking, who did it and on what specific date.

13. Examination of water gauge frame

a) The water gauges are to be examined with all the parts removed and defects reported to the Responsible Person.

b) Check water gauge fittings and test cocks to ensure that all passages are clear and unobstructed. It should be possible to insert a round rod no more than 1.6 mm (1/16 in) smaller than the openings (or a square-section rod with a diagonal of the same dimension). Care should be taken when inserting the rods not to damage any internal pipes sometimes fitted inside the boiler behind the upper gauge fitting. In the case of fittings with coupled cocks, it should be possible to pass the rod through both cocks without moving the handle when the coupling rod is fitted and the cocks are in the open position.

c) Check gauge glasses for signs of pitting, wastage of ends, flaws or streaks - if these are found, the glass should be renewed.

d) The alignment of any refitted gauge frame fittings should be checked by passing a closely fitting rod through them - misalignment is a prime cause of gauge glass breakage.

e) Glass Changing

   i) Remove the old gauge glass and ensure that no traces of the glass or rubber are left on the collars or in the top and bottom fittings.

ii) The glasses are to be changed if;

(1) They have been in use for more than the period defined in the locomotive's maintenance schedule;

(2) If the length of service is unknown; or

(3) If the glasses are steam cut or cracked.

f) Refitting

i) When fitting the glass, make sure that glass is firmly seated within the bottom fitting rubber seal. Tighten this end first, then tighten the top nut.

ii) Remove any scale from the ball with fine emery or steel wool.

iii) Refit the ball and restrictor valve.

iv) Check the condition of the male and female threads on all components.

v) Lightly smear the threads of the clearing plugs and valve cap with graphite grease and refit.

vi) Check the condition of protector for defects.

vii) Confirm that all water ways through the trial cocks are clear, if fitted.

g) A record is to be kept of the inspection, change of glass, by whom and on what specific date.

a. Examination of fire box at wash out

a) Following cleaning and removal of firebars as required, the firebox must to be examined for defects. In particular, the following should be inspected:

i) Condition of platework, signs of bulging, overheating and wastage.

ii) Condition of lap seams, leaks, burnt plate, cracks from rivet/stud holes.

iii) Condition of lap seam rivets/studs for wastage.

iv) Condition of stay ends and stay nuts.

v) Condition of tube ends, burnt beads or beads lifted off the tube plate.

vi) Signs of leaks generally.

vii) Condition of foundation ring rivets, particularly in the corners.

viii) Stays - hammer test.

14. Examination in smokebox at wash out

a) Following cleaning and removal of spark arrester screens, the smokebox is to be examined for defects. In particular the following should be inspected:

i) Condition of tube ends.

ii) Condition of steam pipes.

iii) Condition of any small pipes for auxiliaries.

iv) General corrosion of smokebox, door, chimney, chimney bell and internal fittings.

v) Corrosion of rivet heads, particularly below the ash level.

vi) Security of all components, wastage of nuts/bolts/rivets.

vii) Security of chimney and blast pipe.

viii) Condition of blower assembly.

ix) The spark arrestor is to be examined for fit before removal and following removal it is to be examined for corrosion and the condition of the mesh.

15. Examination of boiler shell at wash out

a) Examine all threaded holes for washout plugs – see HGR-B9009-Washout Plugs.

b) Examine all threaded holes for fusible plugs – see HGR-B9008-Fusibile Plugs.

c) Examine mudhole door openings – see HGR-B9014-Mudhole Doors.

d) Examine condition of studs/nuts that secure fittings to boiler for wastage.

16. Examination of water spaces at wash out

a) Examine stays for wastage, particularly steel stays close to the copper firebox.

b) Examine the condition of tubes/flues for pitting/wastage, particularly near to feed delivery pipes/trays and close to the copper firebox.

c) Examine the foundation ring for wastage in the corners.

d) Examine platework for internal grooving cracking, where possible at foundation ring level.

e) Examine platework for internal grooving and cracking, where possible up the back head corners between washout plugs.

17. Examination of boiler fittings at wash out

a) Washout plugs – see HGR-B9009-WashoutPlugs.

b) Mudhole doors – see HGR-B9014-Mudhole Doors.

c) Fusible plugs – see HGR-B9008-Fusibile Plugs.

18. Record keeping

a) A record is to be kept of all aspects of the boiler examination, by whom and on what specific date. The record is to include the condition and each component and any remedial repairs undertaken and by whom.

19. Servicing at wash out

a) Fire Bars.

i) All conventional bars are to be lifted and clinker deposits removed. Defective bars are to be renewed and these new bars should be fitted next to the sidebars. The removable bar carriers are to be lifted, and the brackets and foundation ring cleaned.

ii) Rocking or drop grate sections are to be cleaned in situ, with bars changed as necessary.

iii) Ash build-up is to be removed from stay nuts by chipping or wire brushing.

b) Tubes.

i) “Bird’s nests” are to be removed from tube ends by chipping or wire brushing.

ii) Any blocked tubes are to be cleared by rodding or blowing with compressed air or steam only. The washing out of tubes with water is not recommended unless they are thoroughly dried afterwards.

c) Smokebox Servicing

i) Any oil/carbon deposits on the blastpipe are to be removed and, if a jumper top is present, this is to be checked for freedom of movement and cleanliness.

ii) The front tube plate is to be swept with a stiff brush to remove dirt from the tube ends and any rust build-up on the bottom of the tube plate is to be removed by chipping.

iii) Any blocked tubes are to be cleared by rodding or blowing with compressed air or steam only. The washing out of tubes with water is not recommended unless they are thoroughly dried afterwards.

d) **Brick arch**.

i) Arch to be checked for condition, cleaned if serviceable or replaced using either pre-cast bricks or refractory cement.

ii) Appendix “A” gives details for pre-cast brick-built arches.

20. Boxing up

a) Refit the following components:

i) Washout plugs – see HGR-B9009-WashoutPlugs.

ii) Mudhole doors – see HGR-B9014-Mudhole Doors.

iii) Fusible plugs – see HGR-B9008-Fusibile Plugs.

21. Testing.

a) Following completion of the boiler washout & examination the boiler is refilled and tested.

b) Fill the water space above the foundation ring and examine mudhole doors for leaks. Any leaking doors are to be tightened or the joints changed.

c) Continue filling the boiler to ½ a glass and examine mudhole doors for leaks. Examine the firebox and smokebox for leaks from plugs, doors, stays, rivets, seams and tubes. Also examine any plugs on the outside of the firebox. Add any boiler water treatment chemicals as may be required.

d) Remove notice/signs that the boiler is empty.

e) A small warming fire is lit to increase the boiler temperature over a period of hours or overnight.

f) If all is satisfactory, a fire may be lit under the arch and the temperature raised to boiling point but without pressure registering on the gauge. This should be over a period of up to 12 hours from cold to avoid differential expansion to parts of the boiler.

g) Depending upon the type of joint used, mudhole door nuts will require following up and tightening at this time. Follow the instructions from the manufacturer of the joint.

h) Examine the firebox and smokebox again for leaks from plugs, doors, stays, rivets, seams and tubes. Also examine any plugs on the outside of the firebox. Examine any pipework or fittings that have been subject to removal or repair.

i) Once pressure is registered on the gauge, steam may be raised over a period of 4-6 hours to maximum working pressure. During this time, operation of both means of feeding the boiler with water should be tested at the lowest workable pressure and regular observation made to check for leaks/defects.

j) At working pressure, the safety valves are to be tested followed by all of the other fittings. Both means of feeding the boiler water should be tested whilst blowing off.

k) Record result of boiler test, by whom and on what specific date.

l) Remove notices/signs that the locomotive is stopped for washout.

end of main document

Appendix A: Sample Brick Arch replacement procedure

a) Remove the old arch.

b) Examination

i) Examine the arch studs for wastage and report if defective.

ii) Before replacing the arch, if possible, hammer test the stays that are normally covered for breakages. If any are suspected of being broken then this is to be reported.

iii) The front lap seam is to be examined and, if necessary, fullered up before arch replacement

c) Reassembly

i) Consult the locomotive consumables chart for details of the arch bar lengths and the details of the type and quantities of the bricks required.

ii) The list of the type of brick is only a guide as each brick differs depending on the supplier.

iii) Distorted or wasted arch bars to be renewed.

iv) Erect the corner bricks with a wedge brick if required and then work back from the tubeplate. Trial each pair and, if necessary, chisel a piece out of the brick if it comes against a stay nut.

v) Each pair should either butt up in the middle or touch at the bottom, with the gap being filled with Fire Joint Clay.

vi) If it is only possible to get a pair of bricks to touch at the top when they meet, despite trying various combinations, one end should be covered with Fire Joint Clay and then fitted together. Alternatively, an over long brick can be cut down by using a stone cutting disc.

vii) Once all the bricks are erected the “C” ends of the last bricks, where the bars fit, are to be capped off with Fire Joint Clay.

viii) Record that a new arch has been fitted, by whom and on what specific date.

end of appendices

