HERITAGE RAILWAY ASSOCIATION

GUIDANCE NOTE

WASHOUT PLUGS

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

Endorsement
This document has been developed and fully endorsed by Her Majesty’s Railway Inspectorate, a directorate of the Office of Rail Regulation

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1. Introduction

This Guidance Note is one of a series dealing with Locomotive Boilers that were produced by the 2006-8 meetings on “Steam Locomotive Boiler Codes of Practice.

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.

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 H.M.R.I. and H.R.A. 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.

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; an explanation of terms used is available in document HGR-B9000.

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. Units

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.

3. Personal Protective Equipment

Before undertaking any works a risk assessment must be conducted.

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.

The equipment must be

- In accordance with the latest Protective Equipment at Work regulations.
- Properly assessed before use to ensure it is suitable.
- Maintained and stored properly
- Provided with instructions on how to use it safely
- Used correctly by employees.

4. Inspection

In the event of finding any plugs are suspect seek guidance from the boiler Competent Person before proceeding with any replacement.

5. General

To facilitate the inspection and cleaning of boilers at regular intervals most designs of boiler incorporate several washout plugs, the number and location of the plugs will vary with the boiler design. These plugs take the form of a solid billet of alloy, usually bronze, one end having a tapered thread to engage in a matching thread in the boiler shell and at the other end a raised head, usually square, for driving the plug, see diagram:
6. Competency

The manufacture, inspection and fitting of washout plugs are safety critical tasks. Only those trained, deemed competent and authorised should be responsible for the inspection of plugs and plug holes, and refitting of washout plugs. Records should be kept of the action taken at each washout and by whom.

7. Maintenance plan

The boiler maintenance documentation should reference the identification and location on the boiler of each washout plug, preferably in pictorial form on a plug diagram (see below). Each plug should be stamped with its reference number in accordance with the plan to ensure that it is always replaced in the correct location.

8. Materials

Washout plug material must be immune from the effects of corrosion caused by boiler water. Brass and its alloys containing Zinc are not to be used. Acceptable alloys are:

BS1400 LG2; BS1400 LG4; SAE 660 (ASRM B271 1996A C93200).
9. Tabulation of standard plug sizes

To accommodate the progressive wear of the threads in boiler plates washout plugs are manufactured in a range of sizes. The plugs usually associated with locomotive boilers are detailed in Table 1.

**TABLE 1**

<table>
<thead>
<tr>
<th>Plug type</th>
<th>OD small end</th>
<th>TPI Taper, inc</th>
<th>Length</th>
<th>Dia</th>
<th>Length</th>
<th>AF</th>
<th>M/F</th>
<th>Length small to large</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR STD</td>
<td>1 3/8&quot; to 2&quot; by 1/16&quot;</td>
<td>12</td>
<td>1:08</td>
<td>1 5/8&quot;</td>
<td>-</td>
<td>-</td>
<td>1 1/4&quot;</td>
<td>M</td>
</tr>
<tr>
<td>GWR</td>
<td>1 5/16&quot; to 1 9/16&quot; by 1/16&quot;</td>
<td>12</td>
<td>1:08</td>
<td>1 1/2&quot;</td>
<td>-</td>
<td>-</td>
<td>1&quot;</td>
<td>M</td>
</tr>
<tr>
<td>LMS</td>
<td>1 7/16&quot; to 2&quot; by 1/16&quot;</td>
<td>12</td>
<td>1:12</td>
<td>1 1/2&quot;</td>
<td>-</td>
<td>-</td>
<td>1 1/4&quot;</td>
<td>M</td>
</tr>
<tr>
<td>LNER extra long</td>
<td>1 3/8&quot; to 1 3/4&quot; by 1/8&quot;</td>
<td>11</td>
<td>1:09</td>
<td>2 3/4&quot;</td>
<td>1 5/8&quot;</td>
<td>1 1/2&quot;</td>
<td>1 1/4&quot;</td>
<td>M</td>
</tr>
<tr>
<td>LNER long</td>
<td>1 3/8&quot; to 1 3/4&quot; by 1/8&quot;</td>
<td>11</td>
<td>1:09</td>
<td>2&quot;</td>
<td>1 5/8&quot;</td>
<td>7/8&quot;</td>
<td>1 1/4&quot;</td>
<td>M</td>
</tr>
<tr>
<td>LNER ordinary</td>
<td>1 3/8&quot; to 2&quot; by 1/8&quot;</td>
<td>11</td>
<td>1:09</td>
<td>2&quot;</td>
<td>-</td>
<td>-</td>
<td>1 1/4&quot;</td>
<td>M</td>
</tr>
<tr>
<td>SR long</td>
<td>1 3/8&quot; to 2 1/4&quot; by 1/16&quot;</td>
<td>12</td>
<td>1:08</td>
<td>1 5/8&quot;</td>
<td>Tapered</td>
<td>1 5/8&quot;</td>
<td>1 1/4&quot;</td>
<td>M</td>
</tr>
<tr>
<td>SR short</td>
<td>1 3/8&quot; to 2 1/4&quot; by 1/16&quot;</td>
<td>12</td>
<td>1:08</td>
<td>1 5/8&quot;</td>
<td>-</td>
<td>-</td>
<td>1 1/4&quot;</td>
<td>M</td>
</tr>
<tr>
<td>SR sunk</td>
<td>1 3/8&quot; to 2 1/4&quot; by 1/16&quot;</td>
<td>12</td>
<td>1:08</td>
<td>1 7/8&quot;</td>
<td>-</td>
<td>-</td>
<td>11/16&quot;</td>
<td>F</td>
</tr>
<tr>
<td>Austerity</td>
<td>1 7/16&quot; to 1 3/4&quot; by 1/16&quot;</td>
<td>12</td>
<td>1:12</td>
<td>1 1/2&quot;</td>
<td>-</td>
<td>-</td>
<td>1 3/16&quot;</td>
<td>M</td>
</tr>
<tr>
<td>BSPT</td>
<td>1&quot;, 1 1/8&quot;, 1 1/4&quot;, 1 1/2&quot;, 1 3/4&quot; nominal</td>
<td>11</td>
<td>1:16</td>
<td>1 5/8&quot;</td>
<td>-</td>
<td>-</td>
<td>1 1/4&quot;</td>
<td>M</td>
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</table>

Other ranges of sizes have been adopted by manufacturers in the past; however those tabulated represent the majority remaining in use and are to be recommended.

The dimensions are as detailed in the figure to the right:

It is important that the boiler records and plug diagram (see section 7 above) detail which plug type(s) is(are) in use on the boiler.
10. Thread form

Threads sizes will vary according to design but usually the threads are of Whitworth form. The TPI of the thread is always measured along the centre line of the plug. There are two methods of cutting the threads on the tapered portion of the plug, either a) square to the taper of the thread, this allows modern full form threading tips to be used, or b) square to the centre line of the plug, this requires especially ground full form chasers to cut the correct profile thread (see figure below).

Both methods are acceptable, however it is important that the two thread forms are not mixed up and that both boiler thread and plug are to the same standard, only one type should be used on any single boiler. Washout plug taps are available to either form. It is important that the boiler records and plug diagram (see item 7 above) detail which form is in use on a boiler and that the plugs and any spares are appropriately marked. The marking on the head of the plug shown in the figure to the right will assist identification.

- **PC** – Thread cut perpendicular to the centre line.
- **PT** – Thread cut perpendicular to the taper.
11. Thread sealant

Plug threads should be sealed with a lubricating sealant such as graphite grease, no hard setting sealant or jointing compound is to be used as this builds up over time in the thread forms and is difficult to remove from plug and hole. Suitable graphite grease compounds are petroleum jelly based, compounds with linseed oil are hard setting and not suitable.

The use of PTFE and PTFE tapes can cause toxic fumes at elevated boiler temperatures (300+ °C) and their use should be avoided in locations where elevated temperatures may be encountered.

12. Removal and cleaning

Period of removal: A list of plugs to be removed at each and every washout should form part of the boiler records and plug diagram, and a list of the plugs to be removed at annual exam should also form part of the boiler records and plug diagram, all plugs are to be removed at overhaul.

Plug cleaning: Plugs are to be cleaned with a fine hand wire brush to remove all deposits of graphite grease and scale to leave a bright surface suitable for inspection.

Hole cleaning: Holes are to be cleaned with small wire brush, or tap if necessary, paraffin or similar solvent used with a tooth brush will leave a surface suitable for inspection.

Storage of plugs: Use a partitioned tray to avoid plug threads becoming damaged by bruising.

13. Inspections and faults

Worn threads gradually result from the constant removal, cleaning and refitting of washout plugs. Plugs will suffer from pulled threads, ripped or lost threads, wasting in the centre section and twisted squares. Any such defect will render the plug scrap and it must be replaced, scrap plugs should be destroyed to avoid being reused, or re-worked if salvageable. The limit of wasting in the centre can be gauged by using a straight edge from end to end of the thread, the maximum permitted clearance is 0.010". Pulled threads will require a suitable gauge for threads cut square to axis, this must be especially manufactured to suit the purpose, for threads cut square to face a normal gauge will suffice but should only be 3 threads long.

Holes, will suffer from ripped or lost threads, corroded threads, cracking in plate and cross threaded holes. 4 complete consecutive turns of full form thread in the boiler plate without any damage is the absolute minimum acceptable. Note a tapered thread cut by a tap will always leave a line where the tap stopped cutting, this may on occasions be mistaken for a crack, if necessary use the tap to advance the point of cut by a small amount and re-inspect. Any holes with signs of damage or being tapped cross threaded should be re-tapped on the correct alignment to the next size up, removing all trace of the damage or cross threading.

When tapping threads use a sharp tap in conjunction with a cutting compound, ensure the tap is perpendicular to the plate and advance the tap by up to ½ turn per cut and back off as required to free swarf.

Avoid the end of the tap causing damage to internal components within the boiler, such as pipes and stays. For threads in new plate an appropriate taper reamer should be used to prepare the hole to the correct taper prior to tapping to avoid excess use of the tap. When inspecting holes sufficient light must be available to illuminate all of the surfaces and if necessary a mirror to inspect parts of the thread not visible directly.

Fit of plug in hole, the plug must always enter into the water space by at least 2 full threads to avoid the build up of scale against which a plug may bottom, particularly where a doubling plate may be fitted to the boiler. If necessary relieve the threads in the doubling plate to avoid the plug bottoming. When fitted the plug should have at least 2 full threads clear on the outside of the boiler. The plug should not protrude so far into the boiler that there is a risk of it fouling any internal components.
14. Fitting

The boiler records and plug diagram should be consulted during re-fitting to ensure that the correct plug number is always refitted into the correct hole number, this avoids fitting the wrong plug to a hole. Plug threads should be coated with Graphite grease, see thread sealant above, no hard setting lubricant or jointing compound is permitted.

Firstly insert the plug into the hole and tighten by hand, if cross threading is suspected rock the plug by hand when it is about 4 turns from tight, if satisfactory it should have the same amount of play in every direction, continue to tighten by hand as far as possible. To fully tighten use a purpose made square socket which is a good fit on the square of the plug, push the socket hard up against the end of the square to avoid damaging the plug or twisting the square. When fitting plugs it is important that it is done as a single operation on each and every individual plug without distraction, the plug is either ‘out in the tray’ or ‘fitted tight’. Do not put all the plugs in hand tight and follow around with the socket. For most standard sized plugs an 18” T bar on the square socket will give an appropriate torque when operated by hand (approximately 250Nm (185 ft. lbs.)), do not over tighten by using an extension on the T bar handle.

15. Testing

Plugs are to be inspected for leakage when the boiler is first steamed following the removal of any washout plug. If any leakage is detected no attempt is to be made to tighten the plug whilst the boiler is in steam. A further check on the tightness of the plug may be made when the boiler is cold, if necessary drain the boiler of water, remove the plug, inspect, clean and refit.

16. Re-working plugs

If a plug thread becomes damaged then no repair is possible except to remove material by re-cutting the thread and reduce it by one or more sizes.

17. Cap type washout plugs

Some boilers use a cap type washout plug (see below), where the boiler thread is male and the cap thread is female and blind. Most of the above guidance applies to these, however in addition it is important to ensure that the male thread seals in the bottom of the cap.
18. Plug hole taps

Taps for cutting plug hole threads are available from various manufacturers. When specifying the tap required the following details are to be provided to the supplier:-

- Small end diameter (usually 1/8" less than the plug small end)*
- TPI along the centreline (usually 12 see Table 1)*
- Inclusive angle of thread (usually 1:8 see Table 1)*
- Length of cut (usually 3")
- Number of flutes (usually 5)
- Pitch tolerance (usually plus or minus 0.001" over one inch)
- Material to be cut
- Thread form (usually Whitworth)*
- Thread, square to centreline (PC) or square to taper (PT)*

The tap is to be clearly identified with the details marked*.

19. References

SL/SW/20 BR Standard washout plugs.
GWR 101077 Standard plugs and stays for locomotive boilers.
GWR 134284 Chart of regional washout plugs BR(W) 1954.
LMS “Red book” section B12.

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