HERITAGE RAILWAY ASSOCIATION

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BOILER CODE OF PRACTICE (BCOP)

# GUIDANCE NOTE

# STEAM HEATING APPARATUS

## 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).

## Disclaimer

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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) Although not part of the locomotive boiler, the steam heating apparatus for carriages will contain steam. It is therefore a pressure system within scope of the Pressure Systems Safety Regulations 2000: SI 2000 128 (PSSR) with its associated Approved Code of Practice, "Safety of pressure systems", (L122). Many of the considerations in respect of inspection that apply to boilers and other pressure systems also apply to carriage steam heating apparatus.

e) This guidance aims to set out good practice for the arrangements and fittings, and inspection of steam heating apparatus.

f) 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.

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

### 2. Recommendations

a) This guidance note is issued as recommendations to duty holders.

b) Where managements 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 concerned and a formal minute is recorded of both the reasons for and the decision reached.

### 3. 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 that the original designs were documented have been used.

### 4. Personal Protective Equipment

a) Before undertaking any work, a risk assessment must be 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. Compliant with the latest Personal Protective Equipment (PPE) 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.

### General points concerning Steam Heating

a) To provide heating to locomotive hauled trains, steam is used as a medium to convey heat from the locomotive to individual carriages along the train.

b) This document is split into 2 sections:

   a. Equipment associated with the locomotive – considered as an Intermediate System (L122).

   b. Equipment associated with coaching stock – considered as a Minor System (L122).

c) Steam consumption of a heating system is approximately 100lbs of steam per hour per coach.

**5. Competency**

The inspection, fitting and repair of steam heating apparatus is a safety critical task. Only those trained, deemed competent and authorised should be responsible for the inspection, fitting and repair of steam heating apparatus. Records should be kept of the action taken and by whom.

**6. Materials**

a) Pipework – Steel pipe to BS 1387 or equivalent.

b) Fittings – Malleable iron to BS143/1256.

c) Steel pipe and fitting threads to BS21.

d) Flexible hoses – Steam hose to BS5342 type 2 class A.

e) Copper – C106 BS2871.

**7. Inspections**

Systems of both locomotive and coaching stock should be inspected as a minimum annually for damage, corrosion and leakage. This is in addition to the statutory inspections of the locomotive boiler by the Competent Person. Hoses should be inspected for signs of deterioration and replaced if found defective. Leaking joints, drip valves and thermostatically controlled heaters that constantly blow steam must be repaired.

**Section 1: The Locomotive**

**8. Description**

Steam is taken from the locomotive boiler at saturation temperature and delivered via a shut off valve, under the control of the fireman, to the heating system. Downstream of the shut off valve, it is usual to have either a pressure reducing valve or a constant output pressure valve to provide steam at typically 40 to 60psi. Some systems have neither and output pressure is regulated by the fireman, using the shut off valve. Downstream of the reducing valve is a gauge to measure pressure and a safety valve to limit maximum pressure. Pipework takes steam to the buffer beam of the locomotive and a final shut off valve before the flexible hose linking the locomotive to the coaching stock.

**9. Boiler supply**

The steam supply should be taken from a high point within the steam space of the boiler such as the dome or manifold to avoid water entering the pipe. Typically, the copper pipe should be of at least ¾" bore and clipped to provide support within the boiler. Its location must not impede free circulation of boiler water. Any joint or expansion where the pipe exits the boiler must be sound to prevent boiler water entering the pipe if it falls below the water line.

**10. Shut off valve.**

At the point where the internal pipe exits the boiler there must be a means of closing off the steam supply from the boiler by means of a steam valve (diagram 1). If this valve is the only means of regulating the pressure to the system, the operating thread needs to be finer than usual to ensure the operator has the necessary degree of control over the downstream pressure. If this valve is only used as an isolation valve, the pipe downstream may be of ¾" or 1" bore. If the valve is used to regulate the pressure, the pipe downstream should be of 1 ½" bore.

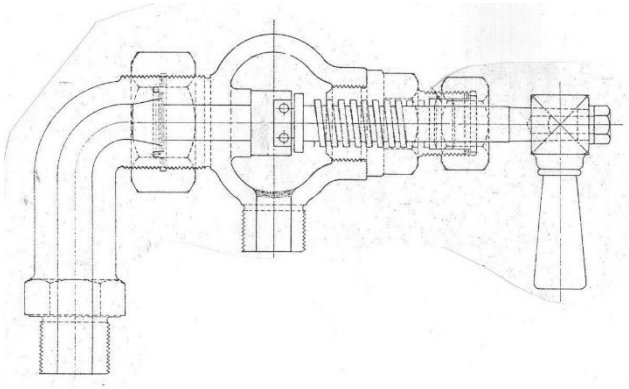


***Diagram 1. GWR shut off valve***

**11. Pressure reducing valve or constant pressure valve**

There are two types of valve to automatically regulate the system pressure:

a) The first does so by reducing the boiler pressure by a fixed amount. This valve is a simple spring loaded poppet valve on a seat which opens at a fixed pressure differential. The pressure differential may be adjustable, or it may be fixed. In either case, any change in boiler pressure will be reflected in the heating pipe pressure. Valves used by the LMS were of this pattern and incorporated a manually operated stop valve at the top.

b) The second uses a more complicated valve which ensures a constant output pressure independent of boiler pressure and flow rate. The output pressure may be fixed within the design of the valve, such as the BR standard pattern (Diagram 2) or adjustable as used by the GWR and others in the 'Masons' valve (Diagram 3). In both types of valve, it is important that the internal workings are manufactured to the tolerances defined by the original manufacturer. It is also important that these items are protected against frost.

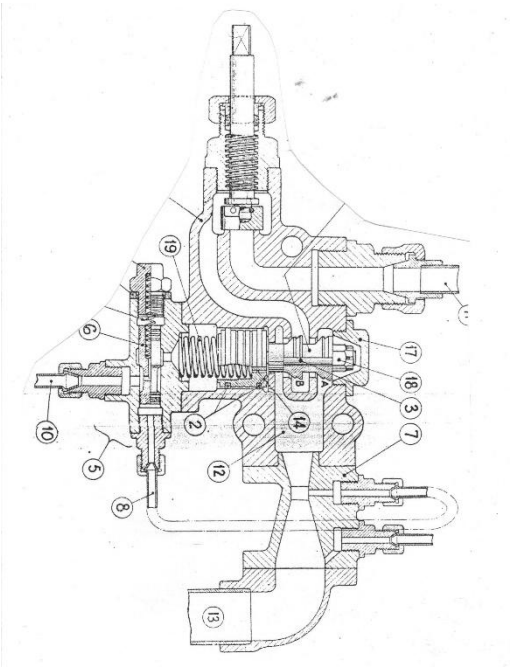



***Diagram 2. BR reducing valve***

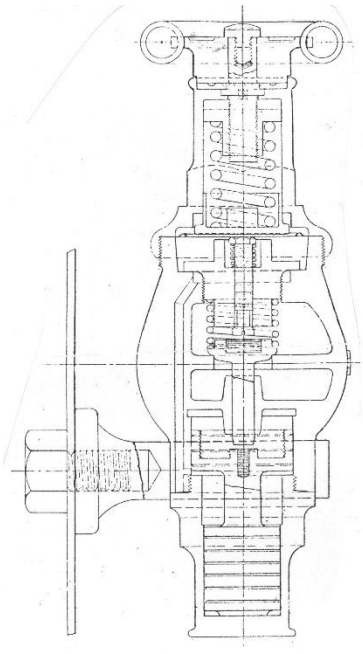


***Diagram 3. GWR Masons valve***

**12. System pressure and pressure gauge.**

a) Most steam heated coaching stock contains thermostatically controlled heaters which limit the steam consumption once the heater has reached working temperature. Because of this and the reduced length of trains now running, a pressure of 40psi is sufficient to maintain a flow to the end of a rake of vehicles. Allow about 80-100lbs of steam per hour per carriage to heat a train.

b) Within the cab of a locomotive there must be a pressure gauge to indicate the pressure within the system downstream of the reducing valve. This gauge must indicate the maximum allowable pressure that can be created within the system. This gauge should be tested annually to confirm that it is reading accurately.

**13. Safety valve**

The pressure within the system downstream of the reducing valve should be limited by a safety valve; this is set at the maximum operating pressure of the system (Diagram 4), typically 60psi. This is to protect pipework on the locomotive, flexible couplings, carriage pipework and heaters. This safety valve is often made part of the buffer beam shut off valve. The safety valve should be tested annually against a calibrated test gauge to confirm that it is operating correctly.

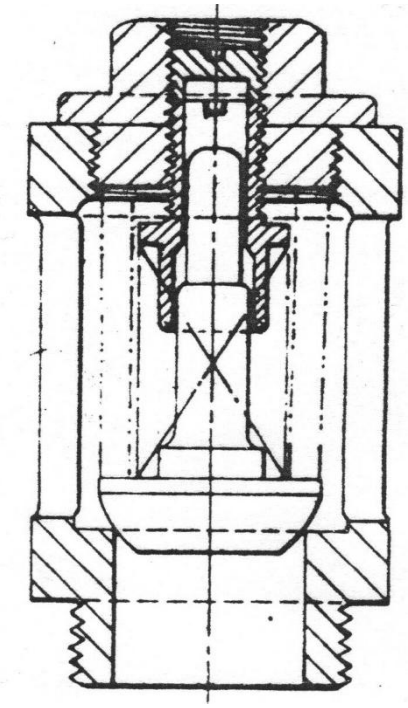


***Diagram 4. GWR steam heating safety valve***

**14. Pipe work and drip valves**

Locomotive pipework may be of either copper or steel with screwed or flanged and bolted joints. It is important that the pipe runs are arranged to fall to a low point where an automatic drip valve is incorporated. On the locomotive this drip valve(s) is normally of the weighted type that falls open and drains the pipe until pressure is created. (Diagram 5)

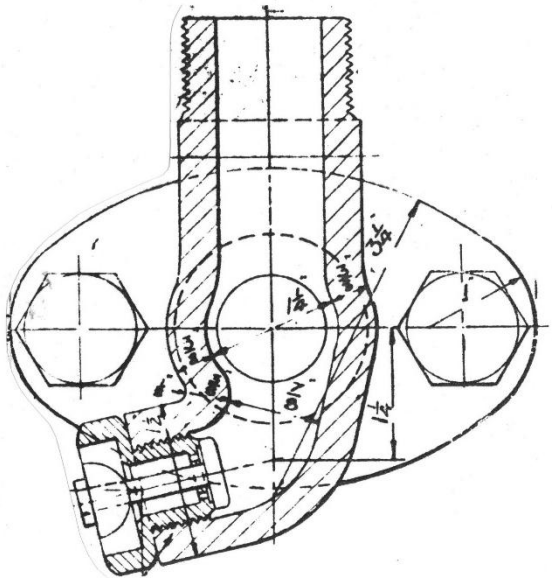


***Diagram 5. Weighted drip valve***

**15. Buffer beam shut off valve.**

The buffer beam shut off valve seals the system when that end of the locomotive is not coupled to any stock. The valve also incorporates a bleed port for the purpose of venting the flexible hose to atmosphere. This ensures that the hose is at atmospheric pressure and uncoupling can be done safely. BR pattern valves seal by means of sliding gate valve (Diagram 6) and incorporate a thermostatically controlled drip valve. Other patterns seal by means of a tapered plug cock.

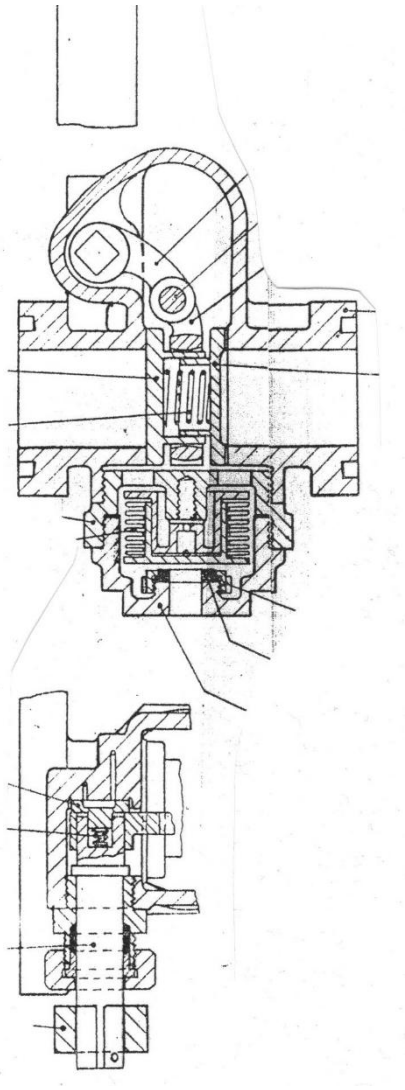


***Diagram 6. BR Buffer beam shut off cock and drip valve***

**16. Flexible coupling hose with connection and drip valve**

The flexible hose should be of a design that is safe for use with steam. Industrial steam hose to BS 5342 type 2 class A may be used or hose that is manufactured to original railway specification. Hoses are clamped onto the end fittings with bolt type clamps. Worm drive clips of any sort are not suitable. The end connections (Diagram 7) incorporate a weighted drip valve to drain off condensate at the lowest point.

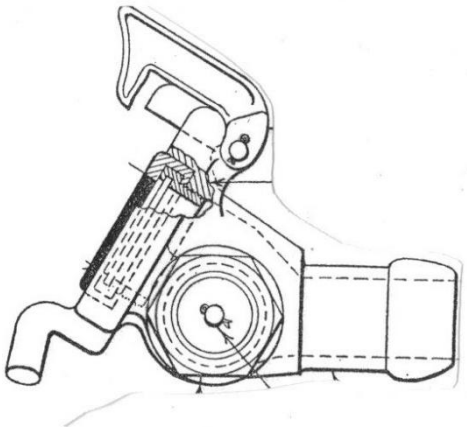


***Diagram 7. Hose connection***

**Section 2: The Coaching stock**

### 17. Flexible coupling hose with connection and drip valve

The flexible hose should be of a design that is safe for use with steam. Industrial steam hose to BS 5342 type 2 class A may be used or hose that is manufactured to original railway specification. Hoses are clamped onto the end fittings with bolt type clamps; worm drive clips of any sort are not suitable. The end connections (Diagram 7) incorporate a weighted drip valve to drain off condensate at the lowest point.

### 18. Buffer beam shut off valve

The buffer beam shut off valve seals the system when a carriage is the last steam heated vehicle in a train. This final valve should be kept shut once tested. The valve also incorporates a bleed port for the purpose of venting the flexible hose to atmosphere. This ensures that the hose is at atmospheric pressure and uncoupling can be done safely. BR pattern valves seal by means of sliding gate valves (Diagram 6). Other patterns seal by means of a tapered plug cock.

### 19. Drip valves

To drain pipework on the carriage, it is necessary for the system to have a fall to a low point at which a drip valve (or “steam trap”) is fitted to drain condensate from the system. These drip valves are generally of the thermal element type (as fitted to the valve in diagram 6) where an internal bellows expands and closes a small port when the temperature of the bellows reaches 100 degrees C. Where original fittings are not available, modern small “steam traps” are commercially available.

### 20. Pipework

The main steam pipe which is normally of 2” bore runs from one end of the underframe to the other. This supplies steam to a 1” bore auxiliary steam pipe. The auxiliary steam pipe in turn supplies all the compartment and body side heaters. At the point at which a heater pipe rises up through the floor of the vehicle, steam pressure is reduced to atmospheric pressure either by means of a choke in the pipe or by means of the thermostatic control valve within the heater. Pipework is normally steel with threaded malleable iron fittings for the main and auxiliary pipes. The smaller supply pipes to individual heaters are thick wall small bore copper pipe with brazed ends and screwed unions. Pipework is usually insulated throughout but, if used intermittently, this insulation is at risk of absorbing moisture and corroding the steel pipes. For heritage railways operating with shorter trains the loss of heat from uninsulated pipes is not severe and uninsulated pipes are easier to inspect for condition. It is important to ensure that the insulation on these pipes is not asbestos related. If that is the case, specialist contractors would need to be called in to remove the asbestos safely. See Section 25 for more information.

### 21. Passenger valves

Where fitted, passengers are able to control the temperature of their environment by means of a heating on/off tap. This controls the steam supply to the inlet of the heating element and incorporates a drain which discharges under the floor. The drain also serves as a vent to atmosphere in the event of the valve spindle leaking.

### 22. Heater elements

a) Heating elements are of two basic types; thermostatically controlled and constant flow. The thermostatically controlled heater contains an expansion tube and valve such that when the entire heater reaches 100 degrees C an inlet valve closes the steam supply (Diagram 8).

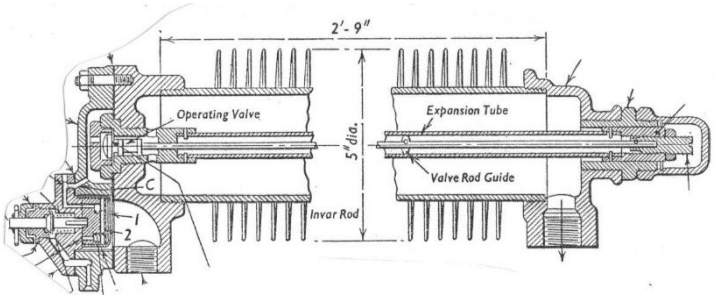



***Diagram 8. Carriage heating element***

b) The constant flow heater is supplied by steam which passes through a small choke of approximately 1mm diameter. In both cases, the chamber of the heater is open to atmosphere at the exhaust end which issues out under the floor. It is important that this exhaust is never blocked or allowed to rust up. If it did so, the heating element would contain steam under pressure.

c) Most vehicles have heater elements that are thermostatically controlled, one under each seat in compartment stock and eight per vehicle in open stock. Examples of heaters that are constant flow are those in corridors, toilets and vestibules. Toilet hot water heaters are also constant flow.

d) Designs of carriage heating systems vary with age and original manufacturer. The designs detailed above are typical of many remaining vehicles including BR Mk1's. Some carriages may have designs that vary from these, drawings of which may be sourced from such locations at the National Railway Museum of another heritage railway operating similar carriages.

e) The heater elements should be enclosed to prevent passengers and others contacting exposed hot parts.

**23. Pressure Ventilation system**

These units were fitted to some BR Mark II vehicles with heating supplied by steam or electricity. Only the former is covered by this section. A sketch of the unit and its controls is given in Appendix A.

**24. Testing of system**

a) The aim of the Pressure Systems Safety Regulations is to prevent injury from the hazards of stored energy and the scalding effects of steam. The regulations apply to steam at any pressure. For the purposes of these regulations a system means one or more pressure vessels (including boilers), any associated pipework and all protective devices. For simplicity, the locomotive is normally described as a pressure system which is then attached to various pipe systems (carriage heating) in which a hazardous relevant fluid with a stored energy and scalding hazards are contained. Whilst it is understood that the risks from stored energy are small, the systems need to be considered and inspected under these regulations so that it can be demonstrated that a correct system of maintenance and duty of care is in place and being adhered to.

b) A suitable carriage steam heating examination procedure is shown in Appendix B.

c) A written scheme of examination is required for each coach as this system can be considered as a ‘minor pressure system’. See Appendix C for an exemplar written scheme.

d) It is not necessary to test the entire system hydraulically, provided the system has been assembled or repaired correctly and all joints have sufficient engagement of thread. Testing under steam will indicate if any repairs are required. To do this, it is necessary to strip off all the lagging to inspect for corrosion, particularly under pipe clips and where pipes are obscured by bogies or parts of the vehicle structure.

**25. Asbestos**

a) Asbestos was commonly used as the insulating material on steam heat pipework.

b) Dutyholders have a duty to manage asbestos. Hence, they should know where it is, what condition it is in, keep records and ideally take steps to remove it or encapsulate it.

c) The removal of pipe lagging, millboard under the seats or asbestos rope/tape (calorifiers etc) should be undertaken by a licensed asbestos removal contractor - such works are enforced by HSE rather than ORR. If in doubt, seek advice from the local HSE office.

d) Asbestos within a coach is likely to be located in the following places:

- compartment coaches - there can be an asbestos panel on the underside of the seat base, plus on the floor area under the seat base, within the front grille and a couple of inches up the three side walls.
- open coaches - there can also be an asbestos panel on the underside of the seat base, plus there is usually an asbestos panel behind the long steam heater pipes on the wall. This is also the case for floor level corridor heaters within compartment coaches.

e) On coaching stock with steam heaters mounted within the toilet wall, there can also be an asbestos panel.

f) Additionally, though not steam heat related, there may be an asbestos, or a similar material, panel behind ETH heaters in compartment and open stock, including toilet heaters.

g) There may also be asbestos in the kitchen areas of buffet coaches or restaurant cars.

**26. References**

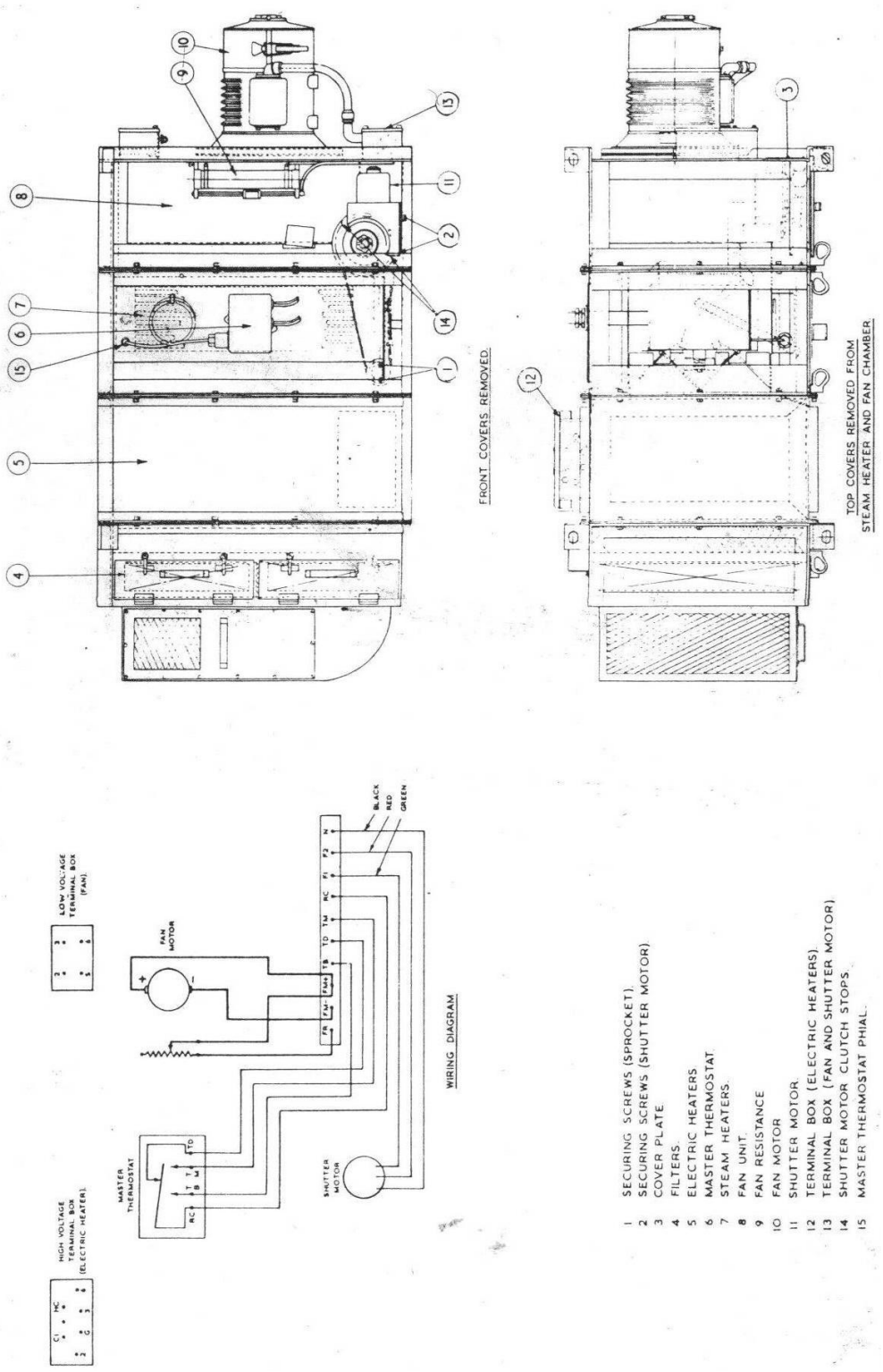
a) The Railway Executive: Instruction book for Standard Steam Locomotives 1951 and 1953 amendment.

b) L122 - Safety of pressure systems - Pressure Systems Safety Regulations 2000 - Approved Code of Practice. Downloadable copy available from HSE website www.hse.gov.uk/pubns/priced/l122.pdf

**Appendix A: Pressure system ventilation heater**

The diagram covers the general arrangement and controls. Detailed electrical controls are NOT covered in this document.



**Appendix B: Carriage steam heating examination procedure**

Vehicle number …… Date ……

1. Establish location and integrity of any asbestos; confirm that it is recorded in the Asbestos Register.
2. Undertake a Risk Assessment, to ensure that this procedure can be undertaken without disturbing any asbestos.
3. Inspect pipework for signs of external corrosion of the steel pipe and mechanical damage to copper pipe. Pay particular attention to areas around brackets, clips and where pipes pass through bulkheads and floors.
4. Inspect all radiators, control valves, heat exchangers etc, for damage and loose connections to pipework.
5. Inspect drip pipes, exhaust vents for radiator control valves, exhaust vents for radiators, and exhaust vents for heat exchangers to ensure that they are not blocked or broken.
6. Check condition and operation of shut off valves at vehicle ends.
7. Check condition of flexible hoses and hose clips.
8. Check condition and security of guards over radiators in areas accessible to staff and the public, particularly with the safety of children in mind.
9. With all radiator control valves turned off, test the vehicle using steam at working pressure (40psi). Inspect for the following defects:
    a. Leaks from pipework;
    b. Leaks from joints;
    c. Leaks from hoses;
    d. Drip valves not draining condensate;
    e. Drip valves not closing and blowing steam;
    f. Radiators getting hot; control valve not working; and
    g. Confirming that the hose vent is operational and vents the flexible hose to atmosphere when the valve is in the off position.
10. Open all radiator control valves. Inspect for the following defects:
    a. Leaks from control valves;
    b. Radiator not getting hot; control valve or thermostat not opening; and
    c. Steam issuing from vents; radiator thermostat not closing.
11. A working test should be made at specified periods to ensure that the system is safe. This working test should be carried out in a controlled manner in a safe location when not in service.
12. Record details of:
    a. Faults;
    b. Repairs;
    c. Name of examiner; and
    d. Date of examination.

**Appendix C: Sample Written Scheme of Examination**

***The Pressure Systems Safety Regulations 2000 S.I.2000 No. 128***

***Railway Carriage Steam Heating System***

<table>
<tr><td>Name and Address of Owner/User</td><td colspan="2">Safe Operating Limit:</td></tr>
<tr><td></td><td colspan="2">Pressure System Number: (Use carriage number)</td></tr>
<tr><td></td><td colspan="2">Location of System: (Railway)</td></tr>
<tr><td></td><td colspan="2">Description of System: Carriage Steam heating system</td></tr>
<tr><td>Parts of system requiring examination.<br><br>The carriage heating system comprising of flexible hoses fixed pipework, heating radiators batteries and associated control valves.</td><td colspan="2">Parts of system not requiring periodic inspection as it is not anticipated that deterioration will develop or that the items are of a size and nature as not to constitute danger in the event of failure.<br><br>The user’s attention is drawn to regulation 12 covering maintenance of pressure systems.</td></tr>
<tr><td>Periodicity of examinations.<br><br>1. Initial examination prior to entering service.<br><br>2. External examination every (XXX) months.<br><br>An internal examination of the heating batteries/radiators is not normally required see additional requirements.,</td><td colspan="2"></td></tr>
<tr><td>Preparation<br><br>Before any examinations are started a risk assessment should be completed which must include general safety as well as an Asbestos assessment. Safe access should be provided and personnel should be available to carry out functional tests as required by the competent person.<br><br>For the examination of the carriage heating system, the system should be presented in a cool and depressurised condition. It should be noted that pressure reducing and safety valves are normally locomotive mounted and controlled.<br><br>For the external examination the items should be at normal working pressure.</td><td colspan="2">Nature of Examinations<br><br>The Examination shall consist of a visual examination of the pipe both fixed and flexible radiators and heating batteries. Support structure shall be examined for corrosion, erosion, deformation, leaks and other defects. The system should be seen pressurised. All control valves, pressure gauges, drain trap pipe connections and water heater vents should be examined and proven serviceable. Note that protective devices are normally subject to examination under a separate written scheme of examination. All control functioning of protective devices should be ascertained to the requirements of the competent person. .</td></tr>
<tr><td>Review<br><br>This written scheme of examination is to be reviewed by the competent person and the User at intervals not exceeding 50 months.</td><td colspan="2">Additional Requirements<br><br>The competent person carrying out an examination may, at his discretion, call for additional testing/inspection.</td></tr>
<tr><td>Modification and/or Repairs<br><br>Any modifications and/or repairs to the system should be notified to the competent person.</td><td colspan="2">Scheme produced by:<br><br>Authorised Engineer /(CME)</td></tr>
<tr><td>Reviewed<br><br>_____<br><br>_____<br><br>_____</td><td>Scheme certified by:<br><br>(C&W Manager)</td><td>Date of certification:</td></tr>
</table>

***Health and Safety Executive***

***The Pressure Systems Safety Regulations 2000 S.I.2000 No. 128***

***Report of an Examination of an item within a Pressure System***

| | |
|---|---|
| Location of System if Different from Written Scheme of Examination | |

| | |
|---|---|
| Pressure System Number | |
| Date of Construction | |
| History of repairs Modifications Special and or Hydraulic Tests. | |

| | |
|---|---|
| Examination Carried Out | |

| | |
|---|---|
| Parts Inaccessible and restrictions to examinations | |

| | | | |
|---|---|---|---|
| Results of Examinations | | Condition of Protective Devices and Fittings | |

| | |
|---|---|
| Observations | |

| | |
|---|---|
| Date of Next Examination | |

| | | | |
|---|---|---|---|
| Signature of competent person | | Date of Report | |

---------- end of appendices ----------