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Boiler & Engineering Skills Training Trust

Please note that this Content may change.
These boiler training modules, incorporating sections of the HRA/ORR boiler code of practice, were prepared in 2013 as part of the HLF funded BESTT training plan project and will be progressively reviewed and updated by the BESTT Technical Committee.

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Boiler & Engineering Skills Training Trust

Patch Screws

Proposed Syllabus 2013

To be used in conjunction with:

HRA Guidance Note HGR-B9025- Is01

BESTT acknowledges the support of the HRA for allowing the use of the Guidance Notes

Proposed BESTT Syllabus Assessment Plan

Module: BESTT 9025

Patch Screws
This module is to used in conjunction with HRA Guidance sheet BS9025–Is01

Aim
This unit will give the learners an understanding of the function of Patch Screws used in boilers.

Introduction

This unit will give practical knowledge of:

- Materials
- Plate Preparation
- Copper & Steel patch screws
- Sizes
- Method of fitting
- Tooling of patch screws

Learning Outcomes
The numbers in parenthesis refers to the HRA Guidance note section.
Learning outcome 1 could be delivered in a classroom environment.

LO1

1. Know thoroughly the use of correct PPE for the tasks (3)
2. When to use a patch screw (4)
3. Materials (5)
4. Plate preparation (6)
5. Copper patch screws in copper plate (7)
6. Thread in one or both plates (7)
7. Steel Patch Screws in copper plate (8)
8. Steel Patch Screws in steel plate (9)

LO2

1. Maximum size of Patch Screws (11)
2. Method of fitting (12)
3. Fit 5 screws under supervision (12)
4. Tooling (12)
5. Tightening of steel patch screws
6. Steel Patch Screws to steel plate (13)
7. Wasted Copper firebox laps (14)

Proposed BESTT Syllabus Assessment Plan

On completion of the module the trainee should be able to use correctly and safely the following equipment:

- Countersink tool
- Hand grinder
- Pneumatic tooling
- Radial Arm Drill
- Magnetic Drill
- Taps

Assessment

Learners could demonstrate competence in this unit by:

- Documental evidence
- Photographic evidence
- Witness statements e.g. written or verbal statement from a competent person stating that they have completed tasks satisfactorily.
- Underpinning knowledge questions e.g. written questions, multi choice answer sheets, on-line tests, and assignments.
- Practical training tasks

BESTT acknowledges the support of the Heritage Railway Association in allowing us to use their Guidance Notes in this Syllabus.

Ref No: HGR-B9025
Issue No: 01
Issue Date: June 2012

HERITAGE RAILWAY ASSOCIATION

GUIDANCE NOTE

PATCH SCREWS

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.

Endorsement

This document has been developed with and is fully endorsed by Her Majesty's Railway Inspectorate (HMRI), a directorate of the Office of Rail Regulation (ORR).

Disclaimer

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Supply

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Copies are available electronically via its website www.heritagerailways.com

Users of this Guidance Note should check the HRA website to ensure that they have the latest version.

Table of Contents

1. Introduction

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.

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 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.

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.

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.

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.

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 that the original designs were documented have been used.

The term “p.s.i.” is used to indicate pressures in pounds per square inch.

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 Personal Protective Equipment 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 those undertaking the work.

4. General

Patch screws also known as set screws or lacings.

Wherever practical all joints in the inner firebox or outer shell should be made by riveting. However, some times this might not be possible, then copper or steel patch screws may be fitted to the inner firebox, but only steel patch screws to the outer shell.

Approval by the competent person for any patch screw fitting is required before any work commences.

5. Material

Copper patch screws manufactured from Grade C107or C105 copper.

Steel patch screws manufactured from Grade 080A15 steel.

All threads to Whitworth form

Proposed BESTT Syllabus Assessment Plan

Section Number	LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
3	LO1 1	Understand the importance of using the correct PPE	Demonstrate the correct use and care of PPE	Workshop	
4	LO1 2	Nomenclature	Describe where a patch screw would be used instead of a rivet	Classroom	
5	LO1 3	Materials	Be able to select the correct materials for use	Classroom	

6. Plate Preparation for Inner Firebox Joints

Any firebox plate work to be fitted with patch screws must be fully closed prior to any tapping operation otherwise a troublesome patch screw repair may result, causing leaks.

Only the best and most careful workmanship is acceptable, and only light caulking and fullering should be required.

The firebox plates are closed by removing a maximum of three rivets and leaving one rivet in place up to the final length of joint to be patch screwed.

Free running bolts are then threaded into the middle of the three holes by means of a piece of flexible wire and a piece of string looped around the first thread portion of the bolt.

Any suitable aperture, washout plug hole, etc., can be used for the threading process, bolts may be required to be threaded up a joint from rivet hole to rivet hole until the bolt is at its required location.

When all the bolts are secured and tight the remaining rivets can be removed.

It is good practice to lightly tool around the holes and bolts with a small pneumatic hammer and flat tool, then re-tighten the bolts to remove any sediment trapped and so make as clean a joint as possible.

If a flange and/or wrapper insert have been fitted, it is good practice to fit free running bolts to every new hole and, in addition, holes either side of the insert.

In certain conditions it may be possible to wedge the joint closed (see HRA Section Wedge Riveting) prior to threading the bolts into the joint, then removing the bolts in reverse after the joint is closed. In these cases remove one bolt then remove alternate bolts.

The joint must be closed correctly prior to fitting any patch screws.

7. Copper Patch Screws for use with Copper Plate

Standard copper patch screws are manufactured in a number of different diameters and lengths depending if the patch screw is inserted into two or three thicknesses of copper plate. Standard sizes are shown in Diagram 1. Sometimes 12 t.p.i. thread may be encountered, the same principles apply.

X	Y	
	For two thicknesses of plate	For three thicknesses of plate
1”	1 1/8”	1 3/4"
1 1/16”	1 1/8”	1 3/4"
1 1/8”	1 1/8”	1 3/4"
1 3/16”	1 1/8”	1 3/4"
1 1/4”	1 1/8”	1 3/4"

Thread to be continuous in plates as shown.

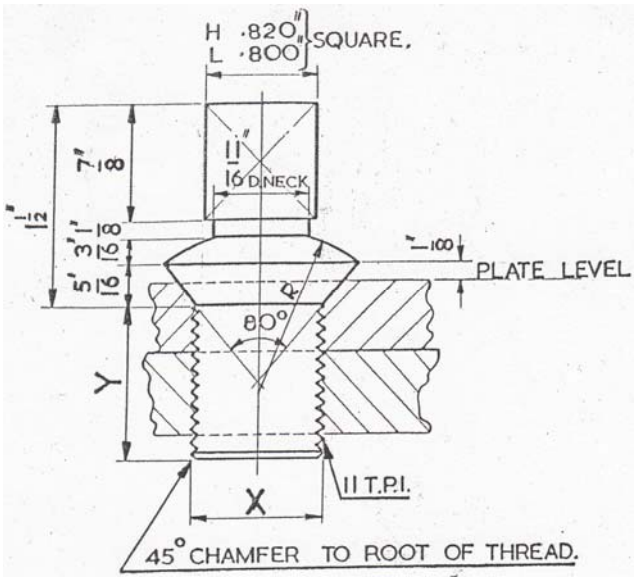


Diagram 1 Standard copper patch screw sizes

Standard practice is to use 3/4” rivets in 13/16” holes or 7/8” rivets in 15/16” holes as new in copper firebox lap joints.

Proposed BESTT Syllabus Assessment Plan

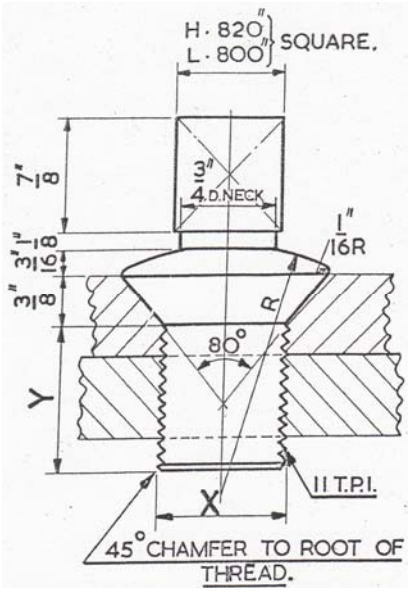
Section Number	LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
6	LO14	Plate preparation prior to patch screws being used	Describe the process prior to inserting a patch screw into a closed joint.	Classroom	
7	LO15	The shape and form of patch screws	Draw all the features of a copper patch screw.	Classroom	
7	LO16	Thread passes through both or one plate	Discuss with a competent person the thread in one or both plates methods.	Classroom	

Rivet replacement with copper patch screws results in patch screws of 1”Dia or larger being fitted, size will depend on hole condition, and historically as a BR running shed intermediate repair for small quantities only.

When boilers went to BR works for repair if it was not practical to repair any lap joints with rivets, patch screws would be fitted in large quantities, usually on the copper door plates and lower legs of the copper tube plates.

8. Steel Patch Screws for use with Copper Plate

X	Y	
	For two thicknesses of plate	For three thicknesses of plate
1”	1 1/8”	1 3/4"
1 1/16”	1 1/8”	1 3/4"
1 1/8”	1 1/8”	1 3/4"
1 3/16”	1 1/8”	1 3/4"
1 1/4”	1 1/8”	1 3/4"



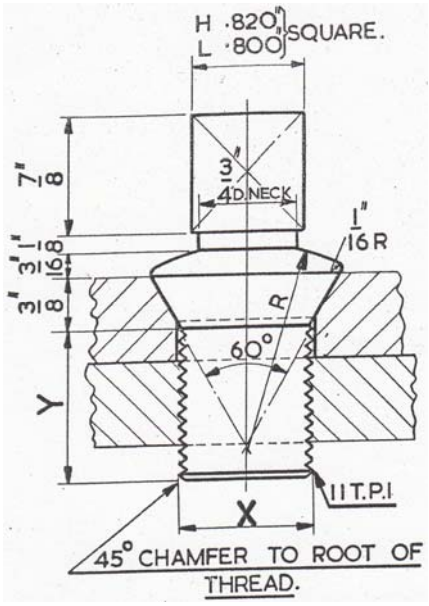
Thread to be continuous in plates as shown.

Diagram 2 Standard steel patch screws for use in copper plate

Diagram 2 shows standard steel patch screws for fitting in copper plate, common WR practice prior to changing for rivets at the boiler’s heavy general repair in works. Special care should be taken when fitting steel patch screws in copper plate work otherwise stripping of the thread in the copper plate may occur.

9. Steel Patch Screws for use with Steel Plate

X	Y	
	For two thicknesses of plate	For three thicknesses of plate
7/8”	1 1/8”	1 3/4"
15/16”	1 1/8”	1 3/4"
1”	1 1/8”	1 3/4"
1 1/16”	1 1/8”	1 3/4"
1 1/8”	1 1/8”	1 3/4"
1 3/16”	1 1/8”	1 3/4"
1 1/4”	1 1/8”	1 3/4"



Hole in countersunk plate to be drilled clear as shown.

Diagram 3 Standard steel patch screws for use in steel plate

Diagram 3 shows a standard steel patch screw for fitting in steel plates. Note the different countersink angles of 80 degrees and 60 degrees for copper and steel plates.

The drawing for steel plate work shows the top plate with no thread.

Proposed BESTT Syllabus Assessment Plan

Section Number	LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
8	LO17	Use of Steel Patch screws in copper plate	The difference between steel and copper patch screws. Sketch a steel patch screw for use in copper plate	Classroom	
9	LO18	Use of Steel Patch screws in steel plate	Sketch a steel patch screw for use in steel plate. Explanation of the difference	Classroom	

This procedure was modified as 'good practice' to both plates to be threaded to eliminate any engineering reliance on patch screws to draw the plates together.

10. Non-Standard Patch Screws

Some BR works fitted copper fireboxes with ¾ riveted copper sides instead of copper welding the sides into a firebox. These riveted sides would be jointed with 5/8" rivets in 11/16" holes, any replacement of rivets will result in 7/8" or larger patch screws being fitted as hole condition dictates.

Because none standard patch screws are fitted heads of a smaller finished size will result.

On ex BRWR boilers some steel patch screws have 8 TPI instead of the BR std of 11 TPI. These patch screws are located in the bottom holes of the copper door and tube plates in the inner firebox and also where odd rivets have been changed by shed staff for steel patch screws as a running repair, they may also be found on all four corners of the outer steel casing joining the foundation ring. The holes, when under repair, can be converted, if required, to 11TPI but care must be taken to ensure a good thread form is obtained prior to fitting of any converted patch screw.

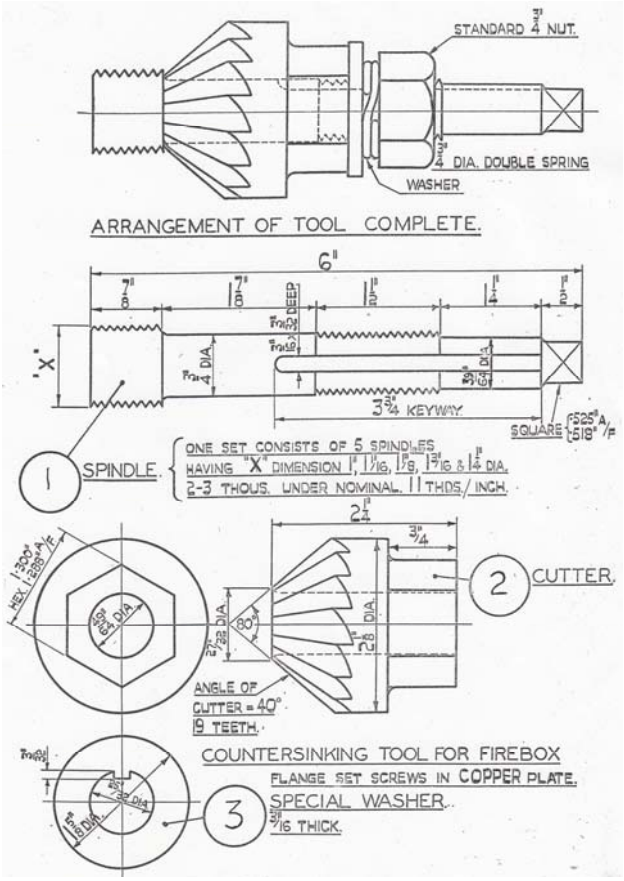
11. Maximum Size of Patch Screws

Due to hole condition, a patch screw larger than stated in Diagram 1 may be fitted up to a maximum size of 1.3/8" only as a one off fitment subject to consultation with the competent person and in isolated areas of a lap joint, never as a full joint. Any flanges fitted with these oversized patch screws are weakened and lap fractures can start prematurely.

Any large patch screws fitted should have their location recorded in the boiler maintenance log and plate condition monitored at boiler washout examination by the responsible persons and any deterioration reported to the competent person at once.

12. Method of Fitting Patch Screws to Fireboxes

Diagram 4 Typical countersink tool used for copper laps



The closed holes are countersunk to a depth of approx. ¼", then the holes are tapped through both plates and the hand countersinking tool shown in Diagram 4 (No1 Countersinking Tool for - roughing only - in copper plate) is screwed into the hole to ensure the final countersink is true to the hole.

The patch screws are inserted by a square headed hand wrench approx. 2'-0" long and then they are all tightened up, the securing bolts are removed and the process continued until all the patch screws are fitted in place, no impact wrenches are to be used.

Proposed BESTT Syllabus Assessment Plan

Section Number	LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
11	LO2 1	Maximum sizes of Patch Screws	Understand why there is a maximum size for a Patch Screw. Examination at wash out	Classroom	
12	LO2 2	Fitting Patch Screws	Explain the method of preparing the plates and fit patch screws into copper lap seam	Classroom	
12	LO2 3	Fitting Patch Screws	Fit five patch screws under supervision	Workshop	
12	LO2 4	Tooling	Explain the purpose of tooling. Tool down 5 patch screws you have fitted	Classroom Workshop	
12	LO2 5	Tightening of steel patch screws	Undercut the head with a grinder before shearing and explain why. Why you wouldn't chip off surplus material?	Workshop	

a) Tooling copper patch screws

The square head of the screw is then pulled off using the hand wrench; any excessive head remaining can now be removed by grinding or by pneumatic chiselling in a clockwise direction only (THIS IS TO RETAIN PATCH SCREW TIGHTNESS), the screw head is then pneumatically rough tooled down to the plate.

This process is then repeated on the second patch screw, and upon completion moving back to the first patch screw head which can then be pneumatically tooled with smooth tools and finally lightly caulked to the plate, this is then repeated on the third patch screw then all the other patch screws in turn, checking the tightness of any screws not yet tooled as the job proceeds.

It is good practice to tool the completed lap joint by using rough and smooth fullering tools of full form only.

b) Tooling steel patch screws

Care must be taken when fitting steel patch screws into copper firebox joints because of the possibility of excessive over tightening causing stripping of the threaded hole.

After the first patch screw has been tightened a grinder is used to undercut the reduced portion below the square head of the screw.

The square head of the screw is then pulled off using the hand wrench; any excessive head remaining can now be removed by grinding not chipping, (AS THIS CAN DISTORT THE THREAD) the screw head is then pneumatically rough tooled down to the plate.

This process is then repeated on the second patch screw, and upon completion moving back to the first patch screw head which can then be pneumatically tooled with smooth tools, no caulking is required, this is then repeated on the third patch screw then all the other patch screws in turn, checking the tightness of any screws not yet tooled as the job proceeds.

It is good practice to tool the completed lap joint by using rough and smooth fullering tools of full form only.

13. Steel Patch Screws to Steel Plate

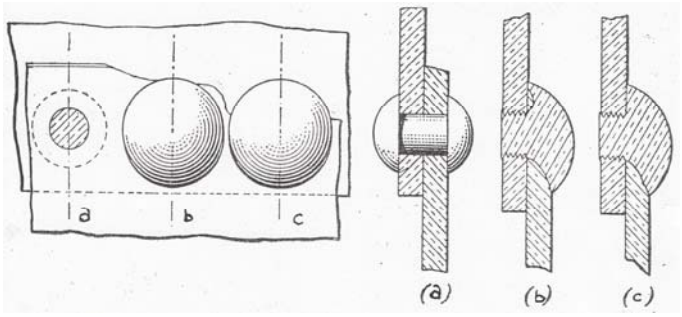
In steel firebox's after Rivets are removed and bolts fitted, steel patch screw joints are treated the same as for copper fireboxes, but Patch screws fitted to steel plate work are countersunk to an angle of 60 degrees not 80 degrees.

Any excess material left on the patch screw heads should be ground off, then pneumatically tooled and caulked.

All patch screws fitted to patches on boiler shells should be fitted so that the joint produced is not reliant on any subsequent seal welding for steam tightness.

14. Wasted Copper Firebox Laps

Copper flange sections sometimes burn away in service and cannot be returned to original thickness of cross section by cutting back and tooling the flange edge.



After consultation with the competent person, it is sometimes possible to fit copper patch screws to make a wasted flange serviceable for a short timescale fig (5).

This repair should only be undertaken to enable the boiler to reach its next heavy general repair and not beyond.

Diagram 5 Wasted Firebox Lap Repair

Proposed BESTT Syllabus Assessment Plan

Section Number	LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
13	LO2 6	Steel Patch Screws in Steel plate	Understand the differences between this operation and that carried out using copper screws in copper.	Classroom	
14	LO3 7	Wasted Laps	Draw a diagram of how Patch Screws can be used to reinforce worn lap seams.	Workshop and Classroom	

15. References

British Railways Instructions Relative to Boilers 1959

International Correspondence School; Boiler inspection and repair part1+2.

Repairing of Locomotives Part 2, Boiler and firebox repairs

Institute of Locomotive Engineers Paper 17; Locomotive boiler examination, defects and repair.

Institute of Locomotive Engineers Paper 250; Locomotive boiler defects and their repairs.

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BESTT
Patch Screws - Module 9025 Is01

Assessment Record for: **Training Centre:** **Year: August 14 – July 15**

LO1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	8	
Supervisor Initials and date when completed									
LO2	**1**	**2**	**3**	**4**	**5**	**6**	**7**		
Supervisor Initials and date when completed									
LO3									
Supervisor Initials and date when completed									

Witness Statement

The trainee has completed the Learning outcomes to a satisfactory standard

Signed: Internal Supervisor **Print Name:** Internal Supervisor **Date:** December 14

Verified by BESST Assessor **Name:** TBC **Assessor Number:** 12345 **Date:** December 14