Justification:
Instruction

(Design & Maintenance)

Private Owner Circular Letter 473 Issue 2

Title

Design and Manufacture of Laminated Springs

ENDORSEMENT & AUTHORISATION

Endorsed by:

D. Minshull, Senior Standards Engineer

Authorised by:

K. Stannard, International Vehicle Engineer

1. INTRODUCTION

POCL 473, Issue 2 updates the steel specifications applicable to the design and manufacture of laminated springs. It also removes redundant references to defunct suspension systems and reporting lines.

2. POLICY

Broken laminated springs shall only be replaced by:

- New springs suitably matching the other springs on the vehicle.
- Fully repaired springs that have been re-buckled.
- Used springs taken off another wagon and load tested prior to re-use.

3. DESIGN

New springs shall be designed to approved methods and standards. Particular care shall be taken to ensure that maximum stress levels are not exceeded.

The material for the spring plates shall be to BS EN10089 Grade 56Si+QT (BS970 Grade 250 A58)

Ribbed and grooved plates prevent lateral movement. Dimpling prevents longitudinal movement between the plates, either relative to each other or to the buckle. The form of the dimple shall give a firm location and not significantly raise the stress in the plates (see Drawing No. F-A1-7339). Riveting to prevent longitudinal plate movement is prohibited.

The steel specifications for spring buckles and spigots are shown below:

Flash butt or metal arc welded buckles	BS EN10083-1 GradeC30E or BS EN 10083-1 Grade C25E (BS 970 Grade 045M10 or BS 970 Grade 080A15)
Solid buckles	BS EN 10083-1 Grade C30E or BS EN 210083-1 Grade C25E (BS 970 Grade 080M30 or BS 970 Grade 070M26)
Buckle spigots	BS EN 10083-1 Grade C20E or BS EN 10025 Grade S275JR (BS 970 Grade 070M20 or BS4360 Grade 43A)

It is recommended that springs be designed without 'nip'. The second plate (on springs fitted in inclined link suspensions) shall be extended to wrap around the profile of the scroll eye of the top plate. This is to allow the second plate to hold the eye in position in the event of breakage. A gap of 6mm ± 3mm between the end of the rolled eye and the top plate avoids contact.

4. MANUFACTURE

To reduce the possibility of fatigue failure it is essential that the correct manufacturing processes are followed. Experience has shown the following to be critical:

a). Heat the spring plates uniformly in a temperature-controlled furnace to 950°C. Avoid decarburisation of the plate surfaces.

b). Keep the amount of adjustment to the shape of the plate, after heat treatment, to a minimum by pressing and rolling. Hammering of plates is prohibited. Ideally plates should be jig formed and quenched.

c). The form of the dimple shall be carefully monitored. Change the die when the profile produced allows more than 0.8mm total relative plate movement between adjacent plates in the same spring.

d). When rolling the eye, the end of the plate shall not be allowed to indent the top of the plate. The inside diameter of the eye should not vary more than 0.8mm along its length to minimise the bending stresses in the suspension pin.

e). Plates shall be at shop temperature when cut to length. The resulting burr shall be removed and the groove restored to its correct profile (if ribbed and grooved plates are used).

f). The radii of the inside corners of the buckle shall be carefully formed to avoid generating folds when it is closed upon assembly. Rolling the corners of the plate with a small radius assists in this respect.

g). Before assembly coat the mating faces of the spring plates with a suitable lubricant applied as a broad ribbon laid lengthwise along the centre line of the top side of each plate (i.e. along the groove in the case of ribbed and grooved plate springs) by means of an approved pressure grease gun. Sufficient grease shall be deposited so that on immediate separation of the plates it can be confirmed that the whole interleaf surface is covered, and such that after the spring is finally assembled a small amount of grease can be seen to have exuded uniformly from between the plates. When the spring has cooled apply further grease to fill all gaps around the buckle).

Suitable lubricants are:

- Renolit Aqua 2
- Renolit CXI –2
- Centaurus FLG1

h). The plates when rolled shall be reasonably straight and free from harmful defects both on the faces and on the edges.

5. New Replacement Springs

BS EN 10089 Grade 56Si+QT (BS970Grade 250 A58) shall be used for both ribbed and grooved sections and plain flat sections. This grade of steel is identified by a square end on each of the spring plates. When a spring is made from this steel the bottom plate shall be shortened when necessary, so that the square end does not foul the axleguard cheek plate.

Steel to BS EN 10089 Grade 46Si7+QT may be used but only if agreed by the Senior Standards Engineer, PWRA Management Group. This grade of steel is identified by a spear end on each of the spring plates.

Springs with 7 plates or more shall be manufactured using ribbed and grooved plate.

6. LAMININATED SPRING SUSPENSIONS

In order to maintain vertical wheel loads within acceptable tolerances it is necessary to ensure that the heights of laminated springs are controlled using the following method:

All new springs shall be lettered in paint on the top plate with the total spring height at a load of 2 tonnes. This height shall be recorded when the springs are unloaded in the test machine, after being subject to the maximum working load. Test machines shall be able to measure the spring load to within ± 1%. The total height of the spring shall be taken as the vertical dimension from the base of the buckle to the centre of the spring eye.

The replacement of one spring in any one pair of wheels is acceptable only if the tare weight of the wagon is 12 tonnes and above. If the tare of the wagon is below 12 tonnes it is essential that both springs on the same wheelset are replaced with springs that are matched. In the event of failure of a laminated spring in traffic, it is essential the replacement spring will maintain even wheel loads on each wheel of the wagon. The replacement spring fitted shall therefore be matched to the spring on the other side of the same wheelset and shall not vary by more than ± 2mm from the painted spring height of the retained spring, or it should have the same grade number stamped on the buckle.

Only ribbed, grooved and dimpled springs may be used as a replacement if this was the type of spring originally fitted. However, it is permissible to fit a matched ribbed, grooved and dimpled spring as a replacement on an axle originally fitted with two riveted springs.

Whenever wagons are lifted at maintenance events springs shall be tested for deflection at maximum working load as indicated on appropriate spring drawing in conjunction with the tolerances shown on Drawing No. F-A0-8487. Testing may be omitted if there is an indication on the wagon that it was lifted (and the springs tested) within the previous 6 months.

If the free height of any spring is found to exceed 9.5mm below nominal, or if a spring is in any other way defective then both springs on that wheelset shall be matched i.e. the free height shall be within 2mm.

7. GENERAL NOTES ON LAMINATED SPRINGS

The year the spring is fitted to the wagon shall be indicated by two 25mm high figures painted in white on the buckle (e.g. 03 would denote 2003).

When manufacturing new laminated springs to existing drawings it is the responsibility of the owners to ensure that they are working to the latest issue of any drawing.

Spring stop size and clearances should be calculated using proforma G-PB-1, G-PM-1, G-PB-2 and G-PM-2 of B.R. Publications P.9. A copy of this document will be made available upon request to the Senior Standards Engineer, PWRA Management Group.

Cases have been found in service where the rib on the bottom plate of the spring is fouling the buckle housing on the axlebox top. This prevents the spring buckle from seating on the axlebox correctly. This situation occurs where there is no centre drain groove in the buckle housing. The recommended modification to overcome this problem (for vehicles in service) is to cut a centre drain groove in the buckle housing leg to give clearance for the rib.

There are also cases where the spring buckle does not seat correctly on the axlebox top even after the centre drain groove has been made. This occurs if the bottom spring plate rests on the buckle housing lip. Steel shims placed under the spring buckle to give a clearance between the bottom spring plate and buckle housing lip alleviates this problem. When fitting shims it shall be ensured that equal thickness shims are fitted to each axlebox on the same wheelset in order to maintain equal spring loading.

Axleboxes with same buckle housing lip depth shall be fitted either side of the same wheelset. Shims shall not be fitted if the resulting depth between the spring buckle and the buckle housing lip is less than 9.5mm.

Drawing No. F-A0-2365 shows the centre drain groove and the fitting of shims for the various types of axleboxes.

The design of axleboxes shall incorporate a suitable drain groove, and depth of buckle housing lip to ensure there is clearance between the spring bottom plate and the housing lip when the spring buckle is seated on the axlebox top.

8. SCOPE

This instruction applies to all PWRA vehicles that operate on Network Rail Controlled Infrastructure.

9. IMPLEMENTATION

This document shall be implemented immediately.

In the event of any query arising, or clarification required, please contact:

Senior Standards Engineer
PWRA Management Group
Room 225 Derwent House
rtc Business Park
London Road
Derby
DE24 8UP