

Track handbook 19

G3219

Managing the critical aspects of track

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1 Purpose

The purpose of this handbook is to describe the critical aspects which need to be addressed when the track condition is approaching or has reached an unacceptable level. Addressing those aspects is in terms of:

- ◆ the intervention point at which minimum actions should be taken
- ◆ the action to be taken
- ◆ the time in which the actions should be taken
- ◆ the speed restrictions required to protect traffic.

2 Scope

This handbook covers all parts of the track structure, both plain line and junctionwork, as well as lubricators, conductor rail, fencing, cleaning, speed restriction signs, structures, tunnel walkways and obstructions.

3 Introduction

This handbook is one of a series intended to help those responsible for managing the track asset achieve standards and meet LU corporate objectives.

The handbook offers:

- ◆ practical advice on track activities
- ◆ guidance on choices and alternatives
- ◆ 'dos and don'ts' for use on site
- ◆ technical data and illustrations
- ◆ material to use in staff training.

Before you first use this handbook, you should familiarise yourself with its contents. These are set out on the following page under the heading 'What this handbook covers'.

You will find in this handbook notes and comments based on the day to day experience of staff, outlining methods they have found successful in particular conditions as well as points not be overlooked in carrying out the work.

At the end of each section there is a list of sources of further information. **In the event of any conflict between this handbook and LU standards, the latter shall prevail.**

4 Critical aspects



Effective maintenance of the track may be defined as maintenance that provides the longest lasting improvements for the least cost effort and interruption to traffic. Achieving this result is dependent on:

- ◆ regularly inspecting the track
- ◆ noting and recording its condition
- ◆ anticipating when repairs or replacements are required
- ◆ providing the necessary resources and planning, and undertaking remedial works before the track degenerates to a state in which it needs urgent remedial action.

4.1 Introduction

In order to reduce the risk of incidents or failure to an acceptable limit, there are certain critical parts of the track which must be regularly inspected for defects. If defects are identified, appropriate remedial and follow-up action has to be taken.

A "**critical part**" can be defined as a piece of equipment, machinery or structure which, if it fails, is likely to cause major loss to people, property or the service.

Critical parts are a primary element of critical aspects which also cover critical conditions and minimum actions.

Critical aspects are divided into:

- 1) critical aspects that lead to loss to people, and
- 2) critical aspects that lead to loss to property and the service.

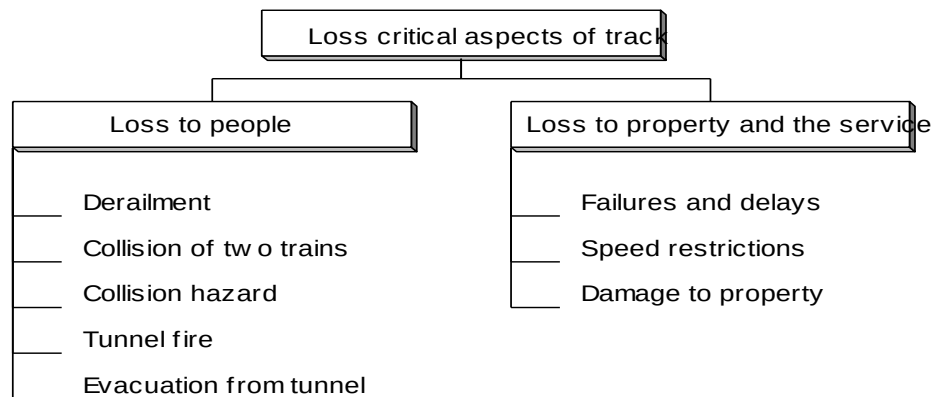


Fig. 1 Loss-critical aspects of track

Avoiding loss to people is the highest priority and is the focus of this handbook.

4.2 Critical parts associated with loss to people

To identify the critical parts associated with loss to people, fault tree analysis has been used and the results are shown in section 21. This identifies LU's highest risk exposure and the events which could lead to loss to people.



The critical parts associated with "loss to people" incidents are as follows:

- | | |
|---|--|
| ◆ plain line running rail | ◆ running rail joint misalignment |
| ◆ check rail (including cover checks) | ◆ track-mounted lubricators |
| ◆ track stability/support | ◆ track twist |
| ◆ stock and switch rails | ◆ track gauge |
| ◆ lead rail | ◆ fencing |
| ◆ closure rail | ◆ cleaning |
| ◆ crossing nose | ◆ terminal protection |
| ◆ wing rail | ◆ maintenance works - only in relation to objects and track etc. |
| ◆ negative/positive splay | ◆ walkways - only in tunnels |
| ◆ slipper run | ◆ object on the track |
| ◆ conductor rail | ◆ speed restriction signs |
| ◆ conductor rail ramps | ◆ structures |
| ◆ conductor rail joints | ◆ vegetation |
| ◆ fishplates (including at blockjoints) | |



This handbook outlines the critical aspects which must be addressed when the track condition has reached or is approaching an unacceptable level. The handbook defines:

- ◆ the intervention point at which minimum actions should be taken
- ◆ the action to be taken
- ◆ the time in which the actions should be taken
- ◆ the speed restrictions required to protect traffic.

The intervention levels which have been set are based on defects occurring in isolation from other track-related defects. Where multiple defects occur at a single location, the risks should be assessed and a higher priority given to the work as necessary.

The location of defects should also be considered. Derailments occur more frequently on curves (particularly sharp curves), on transitions and near junctionwork and these locations need to be given priority.

Priority should also be given to locations where the risk of loss of life or injury is greatest should a derailment occur, such as at bridges and bridge approaches, approaching tunnel mouths, on high embankments and places of restricted structural clearance.

The levels specified in this handbook do not necessarily reflect the level at which an incident or failure would occur. They reflect a level at which the risk of such an incident or failure is unacceptably high.

The minimum conditions and actions have been derived using collective experience, engineering judgement and extracts from existing standards. They are the requirements to which managers are expected to work. They may be amended at a later date in the light of application or subsequent quantified risk assessment, or both.

5 Plain line running rail



The critical aspects of the maintenance of plain line running rail are:

- ◆ rail head sidecut;
- ◆ vertical wear of rails;
- ◆ broken and defective rails.



Minimum actions for these critical conditions are set out in table 1, at the end of this section.

5.1 Rail head sidecut

5.1.1 What causes sidecut and why is it critical?

Sidecut normally occurs on the high or outside rail of curves where the speed of trains causes the wheel flange to make contact and wear the gauge face of the rail. It can be accelerated by:

- ◆ a lack of cant due to poor design, installation or maintenance
- ◆ irregular cant or alignment which can set up sidecut in patches
- ◆ trains overspeeding on curves
- ◆ lack of rail lubrication.

"Hunting", the tendency for train wheels to bear on one rail and then the other caused by the tapered shape of the wheels, can cause cyclic or intermittent sidecut on level straight track.

Rail wear patterns and rates of wear vary considerably due to frequency of traffic, loading, types of rolling stock, wheel profiles, site formation conditions, track geometry, condition of the track components supporting the rail and joining it to adjacent rails, and climatic conditions.

When running rails wear, their strength is reduced and they become more likely to deform or break, risking a derailment.

A sidecut rail is illustrated in plate 1.

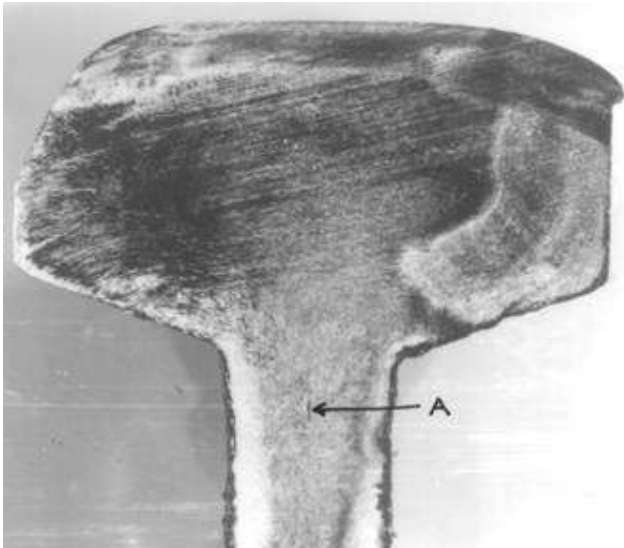


Plate 1 Rail head sidecut on the left and lipping on the right of this cross-section of a bullhead rail

Arrow 'A' shows very minor piping in the web.

5.1.2 How is sidecut measured?

Sidecut may be measured using either the combined running rail and stock rail gauge (Fig. 2 indicates the use of this gauge on bull head rail) or other approved devices.

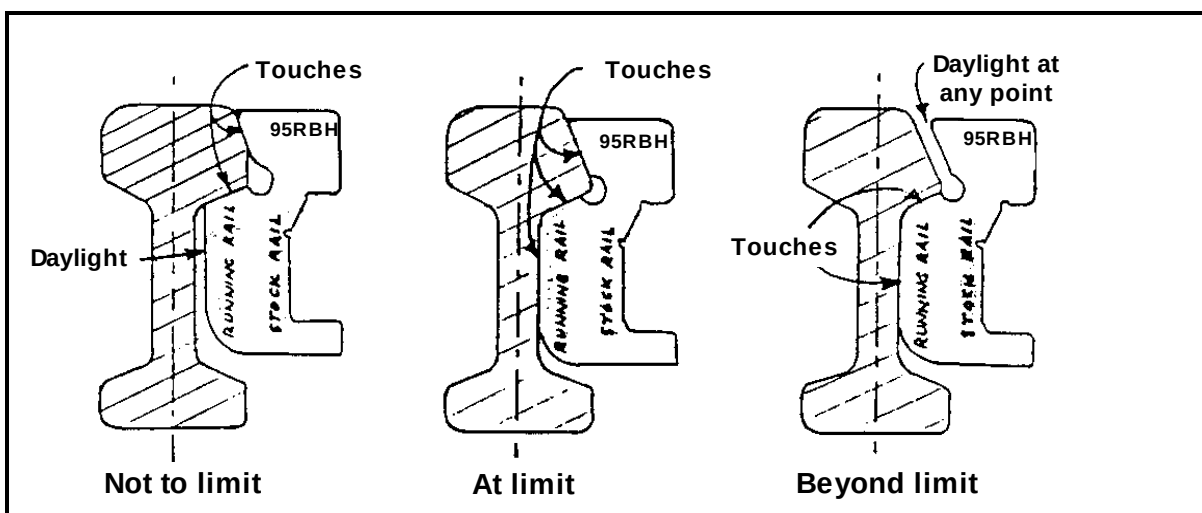
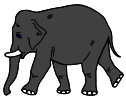


Fig. 2 Measurement of running rail sidecut. This gauge is a "Go/No Go" gauge. If it indicates excess wear the rail should be changed as indicated in table 1.



REMEMBER!

- ◆ Depending on the type of sidecut gauge used, different gauges may be required for flat bottom and bullhead rails, but they are used in a similar manner.

The LU gauges are basic measuring devices and the following points must be considered when using them.

- ◆ The angle of sidecut or a concave sidecut pattern may permit daylight to be seen even when the rail head is not worn to its limit and does not need to be replaced.
- ◆ Lipping at the bottom edge of the rail head may prevent the gauge making proper contact with the rail.
- ◆ Step or feeler gauges should be used to obtain accurate measurements.

Measurements should be taken at locations visually assessed as having the most severe sidecut at least every six months to assess rate of wear and at no more than 100m intervals. There should be a minimum of 8 measurements taken per curve as sidecut may vary.

5.1.3 How is sidecut controlled?

Sidecut on rails in curved track can be controlled by ensuring that the rails are properly lubricated.

Section Track Managers (STMs) need to monitor sidecut closely so that the turning or transposing (where these are permitted) or replacement of rails takes place before the permissible limits of wear are exceeded.

The measurements should be taken at the same point each time so that the rate of sidecut can be estimated and a prediction made of the remaining life of the rail. In order to ensure that the same point is used each time, the rail should be painted at the measuring location and the kilometreage recorded.

More frequent measurements may be required as the sidecut nears the limit depending on the rate of wear and the past history of the site.

5.1.4 When should the rail be replaced?

When the sidecut reaches the permissible limit. Consideration should be given to replacing the low rail at the same time if it is flattened (mushroomed) or vertical wear is approaching the limits specified in table 1.

Replacement of the rail needs to be foreseen at least two years in advance so that it can be submitted for inclusion in the track renewals programme.

5.1.5 What special precautions need to be taken when replacing a defective sidecut rail in a running line?

Care needs to be taken to ensure that there is no step in either direction on completion of the works. There are several ways this can be done:

- ◆ by installing a rail with similar sidecut to the existing rail at the point of installation;
- ◆ by cutting out the appropriate length of defective rail and then
 - cutting the rail at a point where the sidecut is minimal or non-existent
 - pulling the rail to close the gap
 - welding in a section of new rail at the newly created gap.
- ◆ by installing a new rail and grinding it throughout its full length to a similar sidecut profile. Care needs to be taken to ensure the correct angle profile is maintained for the full length.

This condition is explained in more detail in section 8 on rail joints.

5.2 Vertical wear of rails



There are two causes of vertical wear: (i) train movements which affect the head of the rail and (ii) rail movement in the chair or baseplate which affects the foot of the rail. The rate of vertical wear varies depending upon the type and frequency of traffic, the loading, the wheel profiles, the site conditions and the track geometry.

5.2.1 Why is vertical wear important?

Vertical wear is important for the following reasons.

- ◆ it reduces the strength of the rail and makes it prone to deforming or breaking.
- ◆ when the head wears down the clearance between the tip of the wheel flange and the fishplate is reduced. In extreme cases this can make the wheel flange ride on the top of the fishplate, causing wear and damage to both.
- ◆ wear on the foot of the rail (chair or baseplate gall) can create stress concentrations, causing a rail to break.

5.2.2 What other factors cause vertical rail wear?

The other main factors are:

- ◆ mechanical wear caused by the contact stresses induced in the rail head by trains and friction between the running surface of the rail and the wheel tread (particularly at locations where trains brake and accelerate).
- ◆ rail head corrugations on the running surface of the rail along the wheel/rail contact band. Corrugations are detectable by increased wheel noise or "roaring". See plate 2. In extreme cases, the vibration induced into the rail can cause premature failure of track components. Corrugations can only be removed by rail grinding or planing.
- ◆ mushrooming (lipping) of the railhead. See plates 3 and 4. This normally occurs on the low rail of curves, on switch and stock rails and on crossing noses. It is caused by plastic deformation of the rail head and can develop into extensive "lipping" on both sides of the rail. If the lipping breaks off near insulated joints it can "short out" the track circuits and disrupt the signalling system.
- ◆ chair or baseplate gall which is abrasion of the bottom of the foot of the rail caused by the relatively soft rail steel moving in the harder cast iron chair or baseplate. Extreme and accelerated gall often occurs in conditions of rapid and regular change from wet to dry and in permanently damp atmospheres.



Plate 2 Rail head short wavelength corrugation. The light-coloured areas indicate high spots on the rail surface.

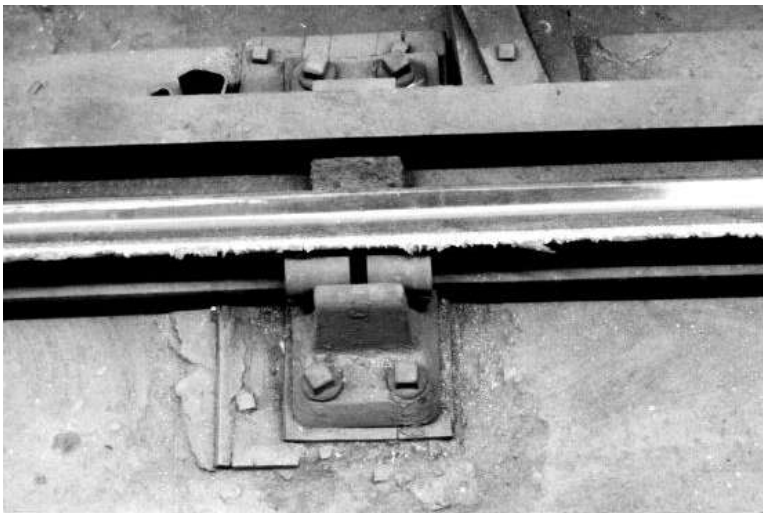


Plate 3 Mushrooming (lipping) of the rail head normally occurs on the low running rail on curves, on crossing noses and on switch and stock rails.



Plate 4 Mushrooming should be removed by grinding otherwise it can lead to cracks developing in the head of the rail. Broken-off strips of steel can also cause signalling short circuits.

5.2.3 How is vertical wear measured?

Vertical head wear is best measured using callipers and a steel rule. The extent of the wear is the height of a new rail minus the measured rail height.

Chair or baseplate gall is calculated by measuring the rail height (with callipers) adjacent to a sleeper and then at the chair or baseplate. The extent of the gall is the difference between these measurements. It will be necessary to move the chair or baseplate to measure gall.



New 56E1 flat bottom rail has a nominal height of 159mm. New 95RBH rail has a nominal height of 145mm.

5.2.4 What are the permissible limits of vertical wear?

The Safety Standard limit on headwear, outside fishplate limits and where only LU trains operate, is 19mm. Within fishplates limits, and where Train Operating Companies' trains also operate, the limit is 14mm. However, these limits are reduced where sidecut is present (see S1159).

In addition to the above limits, the Safety Standard limit for chair or baseplate gall is 2mm.

5.2.5 How is vertical wear controlled?

Like sidecut, vertical head wear and chair or baseplate gall needs to be monitored closely.

As vertical head wear approaches 3mm from the limit and chair or baseplate gall exceeds 1mm, measurements need to be taken at least every 6 months at no more than 400m intervals depending upon the site history.

Since the rate of wear will vary considerably depending upon the site, measurements should be taken at the same location each time so that the rate of wear can be established and the remaining rail life predicted.

The rail needs to be replaced when the limit is reached. This needs to be foreseen at least 2 years in advance so that it can be submitted for inclusion in the track renewals programme.

5.3 Broken and defective rails



A **broken rail** is defined as "a running rail which, before removal from the track, is fractured through its full cross section or has a piece broken out of it which renders it unserviceable".

A **defective rail** is defined as "a running rail, unbroken, but which will require premature removal from the track for any reason except when the removal is due to rail head sidewear or corrugation".

5.3.1 How are broken rails normally found?

Broken rails are normally located by patrolmen, reports of "unusual noises" from drivers, ultrasonic inspections and signal failures caused by the loss of track circuits. A clean break through the rail (plate 5) can arise from an internal defect or surface flaw; but plate 6 shows an example of breakage originating from bolt holes and plate 7 shows how a part of the rail head can become detached.

5.3.2 How are defective rails normally found?

They are normally found by:

- ◆ visual inspection of rails and rail joints which should be done by track patrolling staff, STMs during their regular inspections and staff doing maintenance works such as removing, greasing and replacing fishplated joints. Cracks in the rail head, foot or web can be detected visually as can damage to the rail head such as "squats" or "wheel burns" (plates 8 and 9)
- ◆ ultrasonic inspection. If the defect is inside the rail it may not be externally visible. It is necessary to use ultrasonic equipment to locate the defect before it causes a failure.

5.3.3 What action is to be taken on the detection of a broken or defective rail?

The first and immediate action to be taken on the detection of a broken or defective running rail must be to protect traffic. The type and level of protection is dependent upon the potential for the break or defect to cause a derailment. The factors which affect this are:

- ◆ the location of the break or defect
- ◆ the manner in which the rail has broken or the severity of the defect.

5.3.4 How is the traffic to be protected when a broken rail is found?

Traffic must be protected immediately by:

- ◆ stopping traffic or
- ◆ imposing a speed restriction (see S1158) or
- ◆ fitting broken rail ramps, emergency clamped fishplates or temporary bolted joints in association with the speed restriction.

To determine which of the above is required, an inspection needs to be made to see if the rail is broken through or if a section is missing. The location of the break in relation to any rail joint, weld, chair or baseplate is also important in determining the action to be taken. The action to take is set out in S1158.

5.3.5 How is traffic to be protected when defective rails are found?

The action to be taken depends upon the nature, size and location of the defect. The action to take when defective rails are detected is set out in S1158.

5.3.6 Is a flame-cut rail considered a defective rail?

A flame-cut rail is only "defective" if trains are being run over it. A rail may be flame cut (subject to limitations in tunnel locations) for the purpose of making alumino-thermic welds, as long as the weld is made before resumption of traffic.



Where to find more information on what to do when broken or defective rails are found

S1158 Track – Inspection and maintenance

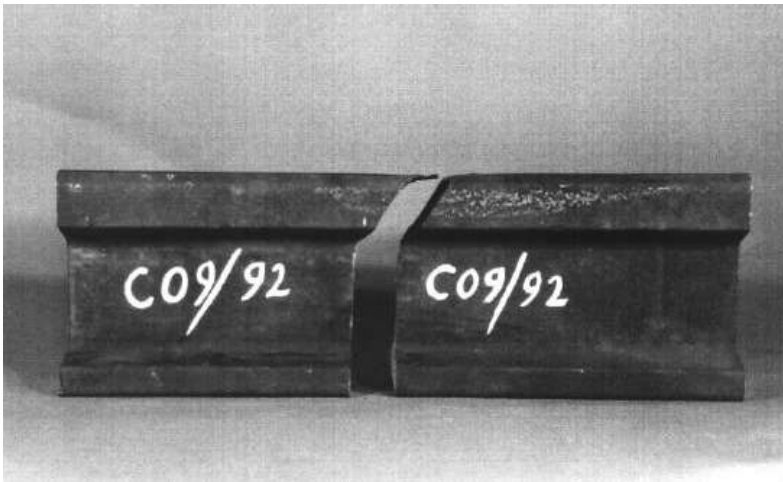


Plate 5 A complete fracture which started as a crack in the rail head originating from an internal defect.

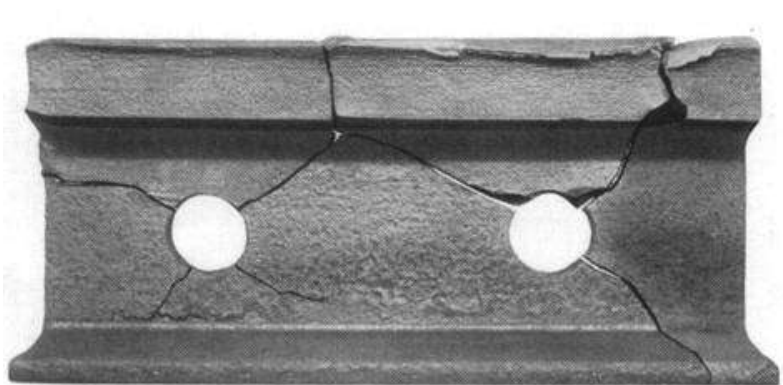


Plate 6 This rail has broken into a number of segments through the bolt holes. The break has been caused by cracks which started at the deformed bolt holes.

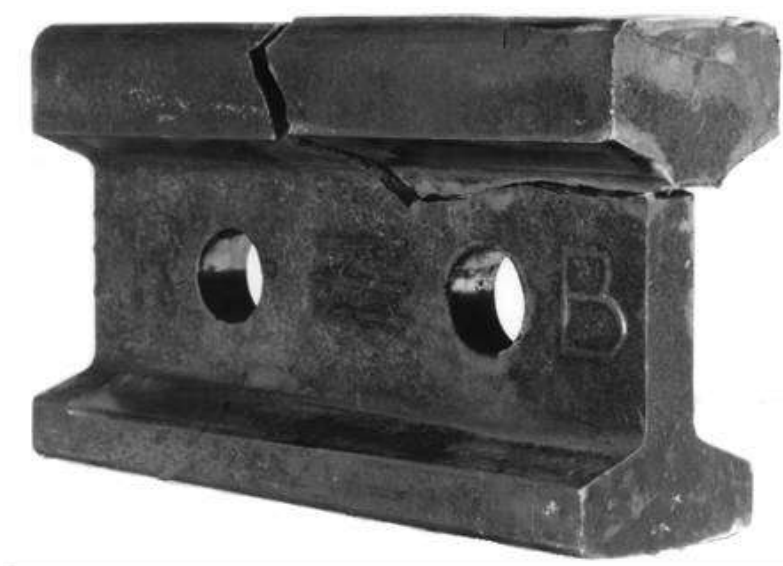


Plate 7 This crack has started in the upper fillet radius and has caused the head to become detached.



Plate 8 A wheelburn which has been plated

Wheelburns prevent the rail from being ultrasonically tested; they need to be removed as they can eventually cause further damage to the rail.

Wheelburns normally occur in pairs (one on each rail) in a pattern reflecting the position of the powered axles of the vehicles.

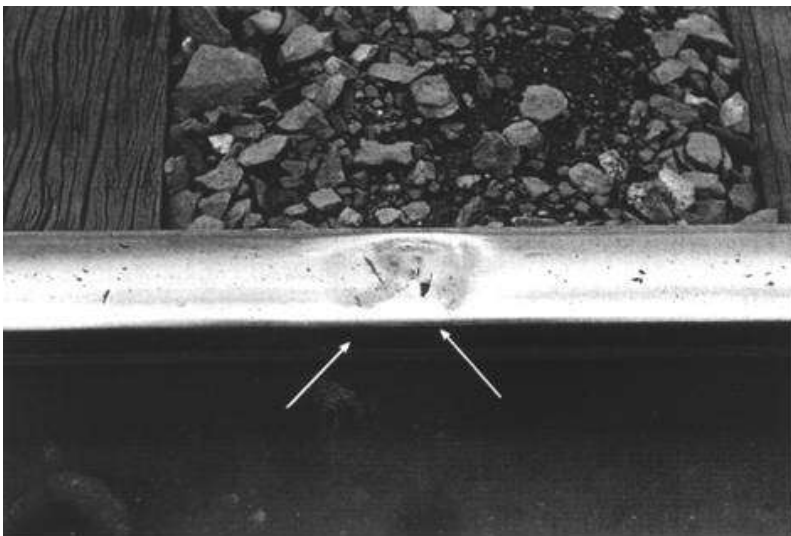


Plate 9 Example of a squat defect on the rail running surface, showing a depression and widening of the running band

Table 1: Critical aspect: Plain line running rail				
Critical condition	Inspection		Minimum action	
	Check to be made	Sub-standard condition found	Immediate	Follow-up
Running rail head sidecut	Check with combined running rail and stock rail gauge	Gauge indicates wear over limit (11mm, or less if vertical wear is present)	Monitor for deterioration	Arrange replacement of rail within 7 days
Vertical wear of running rail	Measure rail height or chair or baseplate gill	a) Measurements indicate wear over 18mm where only LU trains operate or 12mm where TOC trains operate b) gill exceeds 2mm	a) Monitor for deterioration b) Monitor for deterioration	a) Arrange replacement of rail within 6 months b) Change within 6 months
Broken running rail	Check for missing portion of rail section or crack across rail head	Portion of rail missing. Rail cracked through full section	Either stop traffic, impose a 5 mph or 20 mph speed restriction, fit broken rail ramps, emergency clamped fish plates or temporary bolted joints. based on the type of break. See attachment 3	Renew within 36 hours
Defective running rail	Check for cracks in the rail head, foot and web, or for damaged rail head	Visible crack not through full rail section. Wheelburn or squats	As detailed in attachment 4 based on type of defect and location	Repair or remove defect within defined time scales in attachment 4
Ultrasonic signals indicate defective running rail	Ultrasonic test for non-visible defects	See S1158 for other than visible defects		
Flame cut rail ends or fishbolt holes	Check for flame cut rail ends or fishbolt holes	Any part of a rail end or fishbolt hole flame cut	Fit emergency clamped fishplates or temporary bolted joints and impose a 20 mph speed restriction	Replace rails within 7 days
THIS TABLE MUST BE READ IN CONJUNCTION WITH STANDARDS S1158 AND S1159				

6 Check rails in plain line track



Check rails are a requirement of HM Inspectorate of Railways on running lines where the curve radius is 200m or less. The check rail must be continuous and must extend at least 5m beyond any adjacent transition curve so that it terminates in either a straight section or a curve of radius greater than 200m. If the checked curve abuts another sub-200m curve of opposite hand, the check rails overlap at the point of contraflexure. Check rails should not finish within 5m of a running rail joint.



Minimum actions for critical conditions are set out in table 4 at the end of this section.

6.1 Why are check rails provided in plain line track?

Check rails limit the lateral outward movement of wheels on curves and so reduce the force exerted by the outside wheels of the train on the high or outer rail. This has the benefit of reducing wheel wear and sidecut on the high rail and wear on track components. Another benefit is that the risk of flange-climb on the outer rail is minimised. However, these beneficial effects depend on the check rail being in the correct location with respect to the running rails.

6.2 Where should the check rail be positioned in relation to the low rail?

6.2.1 Flangeway gap and track gauge

The distance between the check rail and the low running rail (the flangeway gap) should be:

- ◆ 44mm where the design track gauge is 1432mm
- ◆ 47mm where the design track gauge is 1435mm
- ◆ 50mm where the design track gauge is 1438mm, etc

The nominal design gauge in plain line is shown in table 2.

The Maintenance Limit tolerance on track gauge is +22, -7 and the Safety Standard tolerance is +27mm, -10mm. However, the tolerances on the flangeway are +5, -3 and +6, -4 respectively. Track gauge in checked areas should therefore be maintained to tighter tolerances in order that the “check gauge”, nominally 1388mm on LU, is not unduly compromised.

Table 2: Nominal rail gauge for running lines and sidings, mm

Track type	FB tube track	FB ballasted track	BH track
Radius $\geq 400\text{m}$	1432	1435	1432
400m, > radius $\geq 200\text{m}$	1435	1435	1435
200m, > radius $\geq 160\text{m}$	1438	1438	1438
160m > radius $\geq 130\text{m}$	1441	1441	1438
130m > radius $\geq 100\text{m}$	1444	1444	1438
100m > radius $\geq 80\text{m}$	1447	1447	1438
80m > radius $\geq 70\text{m}$	1450	1450	1438
radius < 70m	1453	1453	1438

6.2.2 How do I measure the check rail gauge?

It should be measured using a linen tape. The check rail gauge is shown in fig. 3 and should be between 1385mm and 1393mm (Maintenance Limit).

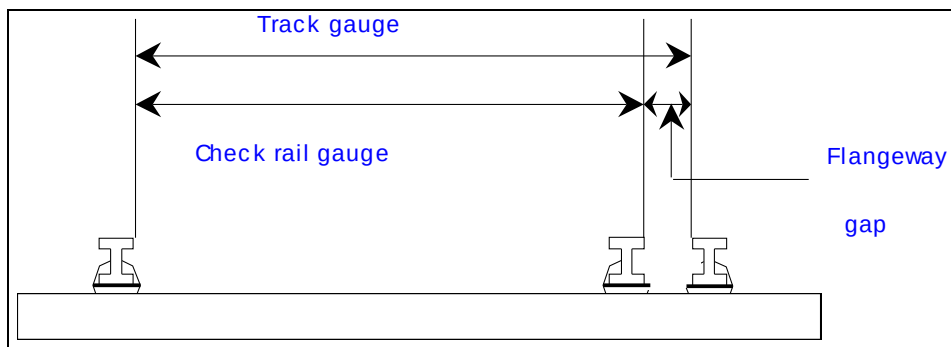


Fig. 3
Measurement of check rail gauge.



The condition is becoming critical (i.e. Safety Standard) if the check rail gauge is outside the range 1384mm to 1394mm.

6.2.3 What should I do if the check rail gauge is not within tolerance?

If the measurement is outside this range, see if the correct check rail bolts and blocks are in position and tight. If these are in order and the check rail gauge is still not within tolerance, it means that either the rails need regauging or the check or running rail or both is worn and should be replaced.

6.2.4 What is the maximum distance the top surface of the check rail should be above the running surface of the low rail?

The check rail height should be a maximum of 25mm. STMs need to monitor the difference in height as this will change due to vertical wear on the low running rail which will need to be replaced when the permitted tolerance is reached.

6.3 Defective check rails and fastenings

6.3.1 What do I do if the check rail fastenings are missing?

The keys or clips which attach the check rail to the chair or baseplate need to be replaced immediately if they are missing. This is particularly important where three or more consecutive clips or keys are missing, since this will allow the check rail to move, increasing the risk of a derailment.

In extreme cases, the sideways force on a bullhead check rail can crush the keys holding the rail in place. Particular attention needs to be given to this condition during patrolling inspections, making sure that any damaged keys are replaced.

6.3.2 What has to be done to protect traffic if a broken, cracked or flame-cut check rail is found?

If a check rail is broken through or has a piece broken out of the check face it is possible for a wheel to ride up a protruding step, if present, and cause a derailment. To protect traffic the minimum actions set out in table 4 need to be taken when a broken or cracked check rail is detected.

As with running rails, flame cutting of check rails is not permitted as it may lead to premature failure. The actions to be taken when flame cut check rails are found are specified in table 4.

Table 4: Critical aspect: Check rail

Critical condition	Inspection		Minimum action	
	Check to be made	sub-standard condition found	Immediate	Follow-up
Check rail gauge	Measure check rail gauge	Check rail gauge not within tolerance range of 1385mm to 1393mm.	Inspect every 48 hours for deterioration	Rectify within 4 weeks, with attention if necessary to track gauge
Flangeway gap	Measure flangeway gap	Flangeway gap not within a +5mm, -3mm of the required dimensions; 44mm, 47mm or 50mm etc as specified	Monitor for deterioration	Rectify within 4 weeks, with attention if necessary to track gauge
Height of head of check rail above head of low rail	Measure height difference	Height difference exceeds 25mm	Inspect weekly for deterioration	Change low running rail within 14 days
Missing keys or clips	Check for missing keys or clips	Keys or clips missing	If 3 or more keys or clips missing in a row replace urgently	None
Broken check rail	Check for missing portion of rail section, cracks across rail head or cracks through the full rail section	Portion of check rail missing and continuity of check face broken	Impose 20mph speed restriction	Replace within 36 hours
		Portion of rail missing and continuity of check face unbroken	Inspect on each patrol for discontinuity of check face	Replace within 7 days
		Cracked through full rail section	Ensure check face is continuous and secured Impose 20 mph speed restriction and fishplate	Replace within 36 hours
Cracked check rail	Check for cracks in head, web or foot	Visible crack, not through full section	Inspect on each patrol Fishplate if in doubt	Replace within 14 days
Flame cut check rail	Check for flame cut rails	Any part of a check rail is flame cut	Inspect on each patrol Fishplate if in doubt	Replace within 14 days

7 Rail lubrication



The high or outer rail on curves, and the check rail (where used), are lubricated to control rail and wheel wear and to reduce noise levels caused by the contact of the wheel flange on the rail.



Minimum actions for critical conditions are set out in table 5 at the end of this section.

7.1 How is the rail lubricated?

Lubricant can be applied to the rail by either train-mounted or track-mounted devices. This handbook focuses on the latter.

A track-mounted lubricator of a Portec type is shown in plate 10. The grease is picked up by the wheel flange from the lubricator spreader bar and placed on the gauge corner and gauge face of the rail. Williams oil boxes are also used to a lesser extent to lubricate rails.

Grease is also placed on the face of check rails using rail lubricators. This reduces the friction between the back of the rail wheel and the check rail contact face and helps to reduce noise and wear.



Plate 10 Portec rail lubricator

Note the contamination of the rail surface with lubricant. The acceptable amount of lubricant on the running surface of the rail is within 3mm. If it extends beyond this it should be cleaned off and the lubricator discharge rate checked and reduced as necessary.

7.2 What about the attachment of the lubricator to the track?

The attachment of the lubricator to the track needs to be checked during regular inspections by patrolmen and STMs as a loose lubricator could move, obstructing the track and risking a derailment.

7.3 Maintaining the lubrication

7.3.1 How do I know if a rail lubricator is working correctly?

The signs are:

- ◆ evidence of a thin layer of grease on the gauge face or corner of the running rail indicates correct application. This layer may not be readily visible but will dirty a rag if wiped along the rail
- ◆ the gauge face should be smooth and the gauge corner polished.

Indications that the rail is not being correctly lubricated include:

- ◆ excessive noise (squealing) as trains go around curves
- ◆ recent signs of metal particles (snowing) beside the rail. Care needs to be taken when assessing this condition, however, as the snowing may have been caused by a previously rectified problem.

With the exception of snowing, these conditions are critical since they may cause considerable discomfort to customers and neighbours or greatly accelerated rail wear.

Check the spreader bar to make sure that sufficient grease is being delivered. A deficiency may indicate an incorrect pump setting or a pump failure.

When planning preventative works, remember that the operation of the lubricator may not be the cause of the problem. Changing vehicles or the profile of their wheels, track maintenance works such as regauging or rail replacement or any other action which changes the wheel/rail interface, can produce similar conditions.

7.3.2 What should I do if the lubricator is not working correctly?

Check that there is grease or oil (as appropriate) in the reservoir. If this is not the problem, arrangements should be made to have the lubricator checked to ensure that it is correctly adjusted. If there are signs of rapid rail wear or excess noise, consideration should be given to hand greasing the rails.

7.3.3 How do I hand grease the rails?

A thin film of grease should be applied to the gauge face of the rail for two sleeper bays every 15 sleepers. The head of the rail must be kept free of grease across the crown (at least 20mm each side of the centre of the running surface) of the rail. Any grease that is accidentally applied to the crown of the rail should be removed.

7.3.4 What happens if lubricant from rail lubricators or other grease or oil gets on the crown of the rail?

Grease or oil on the crown of the running rail reduces the braking efficiency of trains by reducing the friction between the train wheels and the rails.

Grease or oil in rear of a signal could cause a train to overrun the signal, increasing the potential for a collision. The loss of friction could also cause the wheels to lock up under braking or spin when power is applied, causing wheel flats and wheel burns in the rail.

7.3.5 Are lubricators the only source of grease or oil on the crown of the rail?

Lubricators are the most common source. Other sources include spillage during maintenance works, discharge from trains or track maintenance machinery or vandalism.

7.3.6 How is the grease or oil removed?

Grease or oil on the crown of the running rail needs to be removed as soon as it is detected. This would normally be done by wiping the rail with a clean rag, although bad spills may require the use of solvents. The latter should only be used following approval from the Track Manager and in accordance with COSHH regulations.



Where to find more information on the maintenance of rail lubricators

S1158 Track – Inspection and maintenance
S1159 Track – Dimensions and tolerances
G3201 Track handbook 1 – Maintenance of plain line

Table 5: Critical aspect: Rail lubrication

Critical condition	Inspection		Minimum action	
	Check to be made	Sub-standard condition found	Immediate	Follow-up
Signs of rapid rail wear Excess wheel/rail contact noise	Check reservoir level, pump and plunger settings, whether air locks present, worn or incorrectly adjusted spreader plates	Insufficient lubricant present	Hand grease if rail wear or noise extreme	Adjust or repair lubricator within 36 hours
Lubricant on crown of running rail	Check of pump settings	Lubricant on crown of rail	Clean rail head of lubricant Speed restrict to 10mph if not possible	Adjust or repair lubricator within 36 hours
Rail lubricator not fixed to track	Check of lubricator attachment	Lubricator not fixed to track	Clear obstruction	Tighten or replace components within 36 hours

8 Plated rail joints



Plated rail joints, with their discontinuity in the running rail surface, are a potential weak link in the track. The high dynamic forces generated by the train wheels as they pass from one rail to the next cause rapid deterioration of joint components and track geometry if the joints are not properly maintained.

The most critical aspects of rail joints are:

- ◆ broken or cracked fishplates and broken, loose or missing fishbolts
- ◆ horizontal alignment at joints
- ◆ vertical alignment at joints
- ◆ special requirements at insulated joints
- ◆ sleeper spacing

This section should be read in conjunction with section 9 on track fastenings and support.



The minimum actions for critical conditions are set out in tables 7 to 9 at the end of this section.

8.1 Inspection

In the course of regular inspections by patrolmen and STMs, and during maintenance works such as removing, greasing and replacing fishplates, fishplates need to be checked visually for breaks and cracks which could develop into failures, and fishbolts for breaks, damage and looseness.

Broken fishplates may also be found by listening for excessive noise (clatter) as trains pass over them. A simple way of detecting loose fishbolts is to tap them with a hammer or kick them with your boot.

Particularly thorough inspections need to be made at the following locations:

- ◆ junction fishplates between bull head and flat bottom rail and at liftplates, since the change in rail section places additional load on the fishplates
- ◆ poorly supported joint sleepers causing the joint to "pump"
- ◆ kinked joints on sharp curves
- ◆ shimmed joints
- ◆ any combination of the above.

8.2 Action when broken or cracked fishplates are found

Where a single cracked or broken fishplate is detected, it should be kept under observation during regular track patrols and the complete joint assembly should be replaced within 24 hours (72 hours in cat D track).

Potentially the most critical fault which can occur at a rail joint is when both fishplates break, allowing the rail ends to pull apart. If this occurs, the action is to replace the complete joint assembly within 24 hours, with a 5mph speed restriction until this is done.

Broken fishplates with their fishbolts must be replaced with new. The site should also be fettled as there it is normally a maintenance or site defect which causes the fishplate to break. The cracked or broken plates and the old bolts must be removed from the site to prevent any re-use. Consideration should always be given to eliminating the fishplated joint altogether, replacing it with a weld if permitted by standards. This is especially important in the case of composite (junction, 56E1 to 95BH) joints, in which the fishplates are particularly prone to failure; replacement should if possible be by using forged transition rails.

Plate 11 shows a broken fishplate.

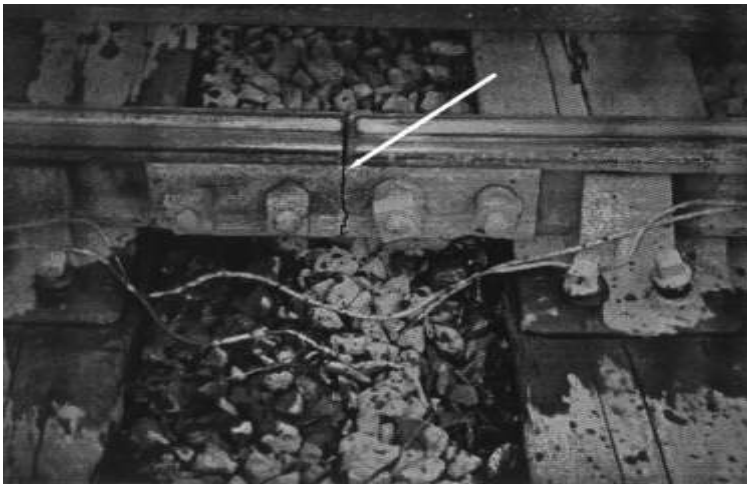


Plate 1 Fishplate showing the location of a typical break

Fishplates normally break at the centre, as shown here, or at the bolt holes. The condition of the ballast and the leaning screwspike suggest that the support conditions for the joint are unsatisfactory.

8.3 Action when loose, damaged or broken fishbolts are found

Where loose or damaged fishbolts are found they should be tightened or replaced as necessary.

Where a single broken fishbolt is found the rail joint should be kept under observation during regular patrols and the fishbolt replaced.

The track condition is critical if both fishbolts are missing or broken from one rail end as this will permit the rail ends to pull apart. The action to be taken depends on the width of the gap between the rail ends and is shown in table 9.

Regardless of the action taken above, all fishbolts at the joint must be replaced with new within 36 hours.

8.4 Joint alignment

8.4.1 What is critical about the horizontal alignment at rail joints?

If a horizontal step occurs at a joint with a facing step on the running on end, a ramp is presented to an approaching wheel flange. If this step is 5mm or more it is possible for the wheel to ride up the ramp and cause a derailment (fig. 4).

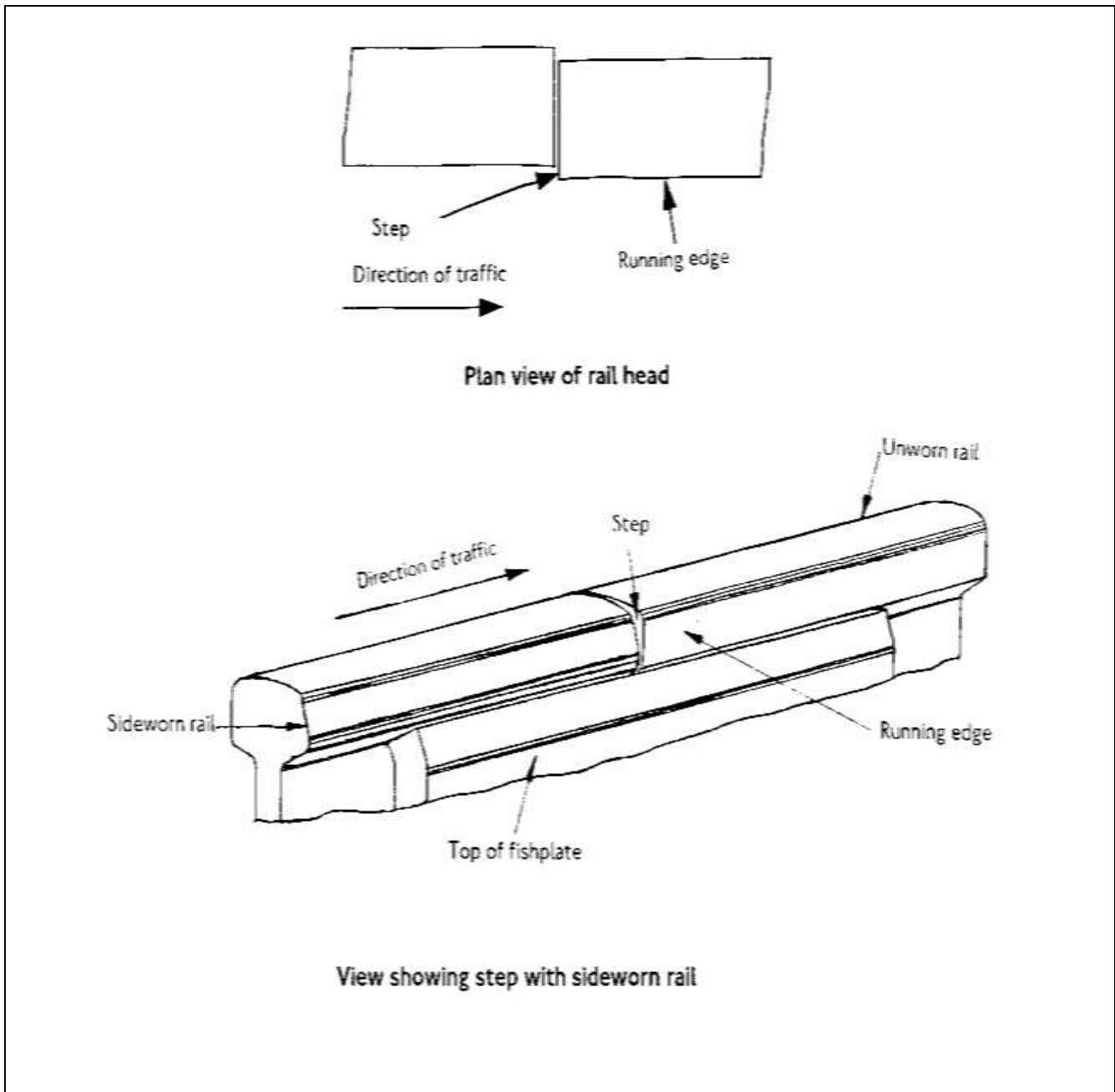


Fig. 4 Rail head and sideworn rail

8.4.2 Where is this horizontal step most likely to occur?

At locations:

- ◆ where the fishbolts are missing, loose or defective
- ◆ where a change of rail section occurs
- ◆ on the outer rail of curves
- ◆ where a new rail has been laid on the outer rail of a curve without regard to the side cut in the existing adjacent rail.

STMs and track patrolmen need to note any joints out of true alignment and arrange repair as necessary.

8.4.3 What actions are necessary to protect traffic where there is a horizontal step of 5mm or more at a rail joint?

The following action should be taken:

- ◆ a speed restriction should be imposed
- ◆ minimum repair should be made by tightening or adjusting fishbolts or grinding back the gauge corner of the foul rail to a smooth profile to allow restricted running with a less severe speed restriction, then
- ◆ the joints should be repaired permanently.

8.4.4 What is critical about vertical alignment at joints?

Rail dip and rail-end batter are critical as they lead to:

- ◆ further damage to the rail and track components such as fishplates, fishbolts, sleepers, chairs and baseplates
- ◆ broken fishplates, fishbolts and rails
- ◆ joints pumping
- ◆ degradation of the ballast
- ◆ track twists
- ◆ rough riding.

Examples of lipped and damaged rail ends are shown in plates 12, 13 and 14.



Left Plate 12 Lipped rail joint

Note the reduction in expansion gap at the running edge.



Right Plate 13 Lipping broken off

The result of this is a damaged rail end.



Plate 14 Rail end with severe crushing of the running surface

Lipping has occurred over the sides as well as the end of the rail. The depression in the rail head will lead to extra impact forces on the rail and the joint.

8.4.4 How do rail dip and rail-end batter occur?

The tendency for a dip in a rail to form at a rail joint is caused by:

- ◆ wear between the rail fishing surface and the fishplate which, when combined with sleeper settlement causes the rail to bend downward
- ◆ plastic deformation on the running surface of the rail, usually on the running on end, within 200mm of the rail end. This condition is made more severe by the lipping and chipping of the rail ends. It is known as rail-end batter.