

HOT WEATHER

GUIDELINES FOR

PERMANENT WAY



Produced by Civil Engineering Conference
For use by all railway civil engineering staff

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Hot Weather Guidelines for Permanent Way

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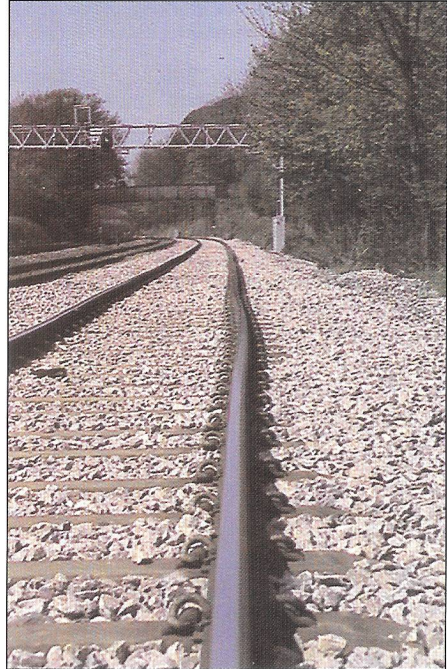
Introduction

The onset of hot weather brings with it the risk of track buckling; this will not be solely due to the high temperature but also because of at least one other defect in track condition. Ideally all such defects should be eliminated before the hot weather season starts; if not, then the appropriate precautions must be taken to safeguard traffic.

Metals expand and contract as the temperature changes. If a length of steel rail is rigidly clamped at both ends and then heated, the metal expands and is put under compression until the force becomes too great and the rail bends or buckles sideways. Rails are rarely straight and therefore when they have compressive forces applied they are already "kinked" and even more susceptible to buckling. Conversely at very low temperatures the steel contracts and ultimately could break in tension.

We prevent buckling in CWR by using plenty of ballast on the sleeper ends and a suitable Stress Free Temperature (SFT) in the rails. The SFT range might be called the average rail temperature measured throughout the year and we use a 21 to 27C range. It ensures that rails are not excessively in compression in very hot weather, or are not excessively in tension in cold weather. Originally CWR also used heavy concrete sleepers to resist buckling; however with suitable precautions most forms of sleeper can now be used.

We reduce the risk of buckling in jointed track by having gaps between rail ends to allow for expansion as its rails get warmer.



A buckle in crimped ended steel sleepered track, not stressed before hot weather

Many factors affect the temperature of the rail in hot weather when it is normal for the rail to be much hotter than the air temperature.

Whilst we normally associate hot weather with the risk of buckling, other problems can occur when the temperature rises. Lipped insulated joints can bridge across, switch blades can expand and nuts make contact. At switch diamond knuckles the rodding may make contact and stop operation completely.

Track Buckling

A track buckle is fully defined in Railtrack Line Standard RT/CE/S/011 CWR and the same definition applies for jointed track.

Summarised one can say that any track deformation in hot weather which requires emergency remedial work, an emergency speed restriction or emergency closure of the line is a buckle and must be reported. Remedial work will involve cutting or adjusting the rails or slueing the track.

A buckle is not reportable if it is in a siding or occurs when work is being undertaken within a Rule Book Section T III possession. Where a hot weather TSR has been imposed and a buckle does not occur then this is not reportable.

Whilst we normally think of a buckle as being a horizontal misalignment a vertical misalignment can occur, in other words the

track lifts up in the air. This can happen where the track is light in weight, e.g. timber sleepers and 95 lb BH rail or when there is a vertical hump such as at the summit of two gradients.

On occasions P Way staff are called to a suspected buckle in hot weather which is in fact a simple misalignment that has been there for some time, but unfortunately it is only in hot weather when other staff notice such things. One way of telling is by looking at the sleeper ends. If one end has ballast tight against it and perhaps a small heap, and the other end has a vertical gap, this will be a buckle since the movement has been sudden (Fig. 1). If however there is no such vertical gap it will probably not be a buckle since the ballast has had time to move against the end of the sleeper by vibration (Fig.2).

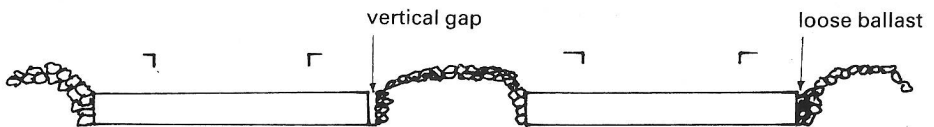


Fig.1. Buckle

Fig.2. Misalignment

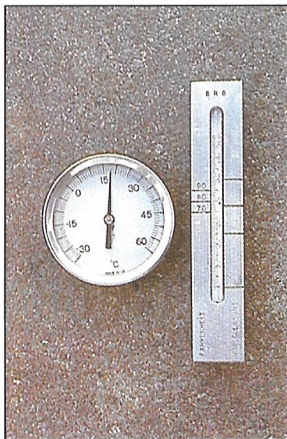
Temperatures

a) Forecasts

Each Contractor should have a system of obtaining and passing on hot weather forecasts to each Section so that appropriate precautions can be taken when necessary.

It must be remembered that special precautions apply in very high temperatures, as detailed in RT/CE/S/011.

Rail temperatures can be up to 18C higher than the air temperatures.



Dial and Mercury Thermometers

b) Thermometers

There are three basic types.

- i) dial type: they can be easily damaged and should be regularly compared against a master thermometer. They usually have a magnetic back which holds them against the steel rail.
- ii) mercury type: these are made of glass and contain mercury, they should be handled with great care since exposed mercury is a health hazard, see COSHH documentation or similar.
- iii) electronic: these have a probe which is pressed against the rail and give an immediate digital readout.

All thermometers should be checked against a master thermometer which is known to be accurate, prior to hot weather and at monthly intervals when in regular use.

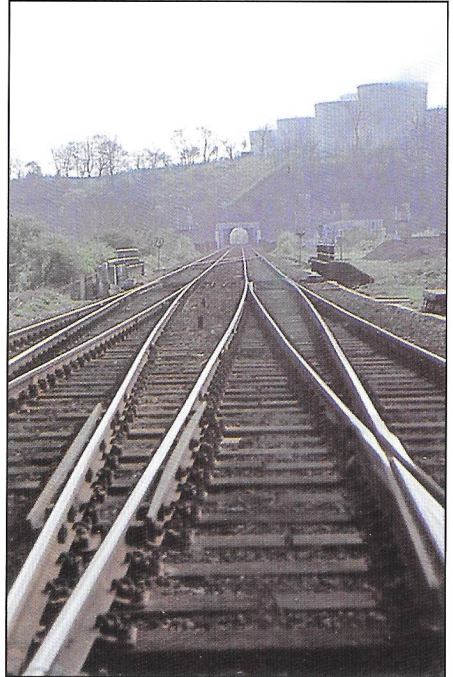
A thermometer should be placed in contact with the rail web or foot but out of direct sunlight to avoid false readings. A dial or mercury thermometer should be left in contact with the rail for at least ten minutes to allow it to reach the ambient temperature.

Wherever possible more than one thermometer should be used so that an average value can be assessed for greater accuracy.

Particular Risk Features

Certain physical conditions can increase the risk of a buckle:

- a) the further south in the country generally the higher the maximum temperatures are likely to be.
- b) a north-south cutting, since the rails will be exposed for the whole day to the sun during its traverse from east to west, and will often be sheltered from the wind.
- c) rails totally in the open and not shaded at any time by trees, buildings, walls, etc.
- d) any embankment with known slip or settlement problems where the risk of lateral movement is increased.
- e) wet beds (see 6.1 d).
- f) mining or mineral extraction which causes subsidence (see 6.1 r).
- g) a short length of plain line between fixed points such as S & C.
- h) certain weak fastening types.



A typical site where extra care is required. Short lengths of plain line between S & C, a bridge forming a fixed point and a tunnel.

Risk Times for Buckling

The normal greatest risk time for buckling is in late spring or early summer when the temperature variation between night and day suddenly becomes very much greater than previously and the day temperatures become much higher. When high temperatures gradually build up over a period of weeks the risk appears less, (Fig.3) as if the rail stress equalises itself without buckling, whereas if the high temperatures suddenly occur (Fig.4) then the track cannot take the sudden changes and buckles occur at the weakest places.

Buckles have been known to occur all year round.

During the day the most common time for buckling is in the afternoon, usually after 13.30hrs., the air temperature will have built up and the rail will have been exposed all day to the sun. Whilst the track may be apparently stable under its own weight the dynamic lateral and vertical forces induced by a loco or a train may be sufficient to initiate a buckle.

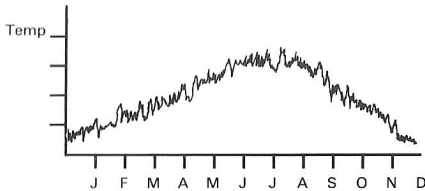


Fig.3. Steady rise in temperature, minimum buckle risk.

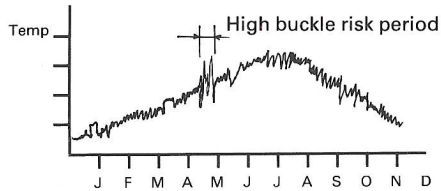


Fig.4. Sudden large increase in temperature, between night and day, high buckle risk.

Causes of Track Buckles

6.1 GENERAL

a) BALLAST SHORTAGE

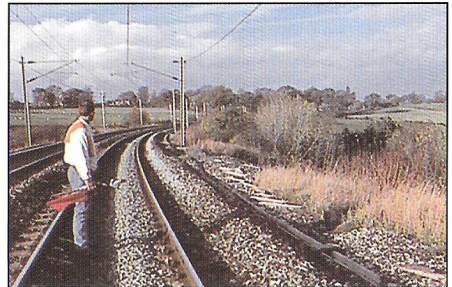
If there is inadequate ballast to resist the lateral forces then the track will obviously move bodily when excessive compressive forces occur in the rails.



The sleeper ends are exposed, so there is inadequate horizontal shoulder ballast, nor is it piled 125mm high.

Track maintenance itself can actually cause this problem, a tamper whilst doing an excellent job for the top and line compresses the ballast and can leave the cribs short of ballast to the required levels. Digging out wet beds and then replacing with cleaned ballast may again leave the beds short, since the dirt has been thrown away.

On heavily canted track unloading of ballast can be a problem since it tends to fall to the low side of the track and a regulator or men with shovels are needed to place it in the correct place.



The fresh ballast that has been unloaded is all on the low side of the curve.

It should also be remembered that some regulators do not produce the correct ballast shoulder profile for CWR.

At the ends of bridges and at points of access onto the track the shoulder is often trodden down to a sub standard condition and is another trigger point for a buckle.

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Machines travelling along the track to a site and with one wheel or track on the shoulder will often seriously flatten the shoulder to a sub standard condition.

Ballast profiles are defined in RT/CE/S/102 Track Construction Standards for both CWR and jointed track. RT/CE/S/104 requires that these profiles are maintained.

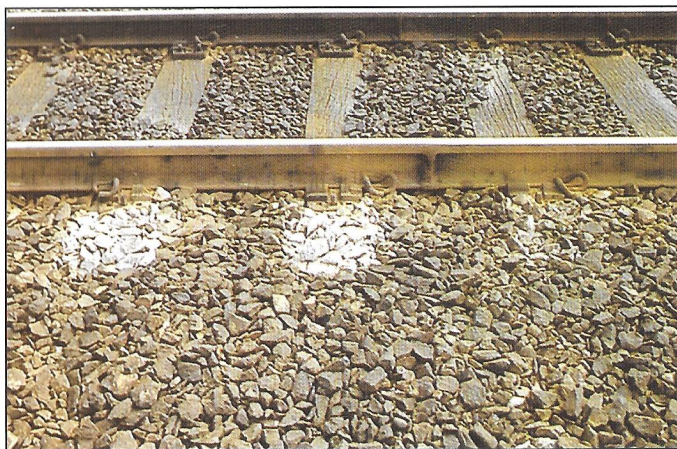
b) BALLAST DISTURBANCE

Any form of disturbance to the ballast will loosen it and therefore reduce its resistance. Tamping and lining, relaying, reballasting, resleepering, digging out wet beds, lifting (whether manual or mechanical) or even packing will all cause disturbance.

Consolidation of the ballast after such work with a DTS, passing a ballast train backwards and forwards or even kangos with packing plates will help consolidate the ballast and increase the resistance. The DTS has much the greatest effect and details of the reduced hot weather precautions following the use of the DTS unit can be found in RT/CE/S/011.

c) VOIDS

Any void means that there is little if any contact between the bottom of the sleeper and the ballast. This will greatly reduce the frictional resistance to lateral movement.

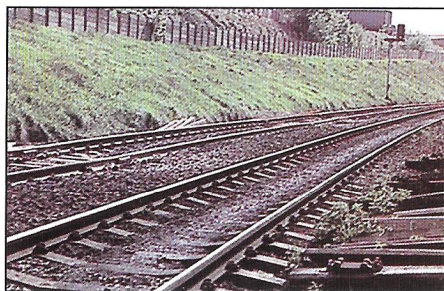


The white rounded ballast shows that voiding has been taking place for some time.

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d) WET BEDS

Wet beds can reduce friction even more than voids. In winter the slurry will be a liquid, in a hot summer the slurry bakes to a hard material and may not even be in contact with the sleeper at all.



The joints in the far track are wet. The near track is oily and little shoulder ballast is apparent on the low side, which could be a problem in cold weather.

e) POOR BALLAST CONDITIONS

As well as wet beds poor friction can occur if the ballast has an excess of fines in it. This may be caused by ash contamination, especially under old jointed track or even some CWR sites when the track was "laid on top" during various accelerated relaying programmes. The angularity of good stone ballast helps it interlock and gives greater friction in contact with the surfaces of the sleeper.

If the ballast under the sleepers is wet or fouled with a soft material such as marl or clay, this will again seriously reduce the friction.



The white dust on top of the sleepers suggests that there is a problem with the material in the ballast beneath.

f) SHORT ENDED SLEEPERS

Short ended sleepers may occur at catchpits in the 6ft or other restricted sites. These are lighter than the adjacent sleepers and therefore have reduced frictional resistance. They may not have the correct ballast shoulder at their short end.

g) **POORLY SPACED OR OUT OF SQUARE SLEEPERS**

Poorly spaced sleepers may provide inadequate or variable resistance, out of square sleepers will cause tight gauge which in turn will give high lateral forces from passing wheels.



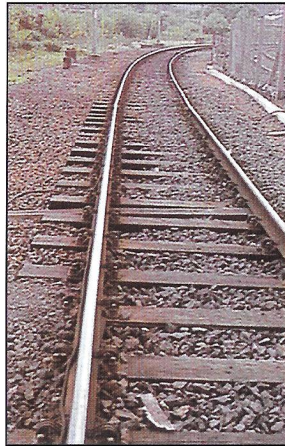
The sleepers are out of square, fastenings are missing and the insulated joint, appears to be breaking up.

h) **MIXED SLEEPERS**

A short length of wood sleepers in a length of concrete, such as over a shallow subway will have a reduced weight and frictional resistance.

i) **MISALIGNMENTS**

Any misalignment provides a trigger point for a buckle to start.



The left hand joint is misaligned and the right hand one is dipped.

j) **UNDER TRACK CABLES OR PIPES**

S & T cables are usually enclosed in orange pipes, but other cables and pipes can all reduce the ballast in the crib and reduce resistance to buckling.

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k) BRIDGES

Long timber bridges often have some looseness in their construction which increases with their age.

Bridge parapets on underbridges, abutments on overbridges or direct fastenings on a bridge deck all form fixed points which can limit the amount of lateral movement of the track and the likely points of buckling are just clear of them, where there is also the likelihood of a ballast shortage at the shoulder.

**l) TRAP AND CATCH POINTS
LEVEL CROSSINGS**

Again these form fixed points.

m) TUNNEL MOUTHS

The temperature difference between the open air track and that inside the tunnel can be very different and poses an additional risk, especially if there is a change of material.

n) OLD TRACK

The older the track the looser its fastenings will be and the poorer the ballast condition, so the greater the risk.

o) SWITCHES AND CROSSINGS

Any S & C forms a fixed point and therefore the plain line adjacent to the switch or the crossing is likely to move first under excessive compressive loads in the rails.

For buckles in S & C itself see item 6.4

p) VARIABLE GAUGE

Tight gauge is similar to out of square sleepers, but for different reasons, in that it gives a much greater lateral force from wheel sets and can initiate a buckle.

q) INSULATED JOINTS

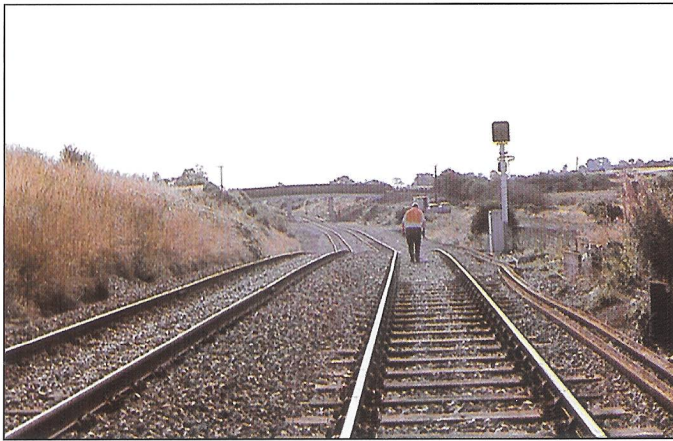
Insulated joints form a discontinuity in the rail and hence a possible trigger point. 4 hole shop manufactured glued joints and 6 hole joints are stiffer than dry ones and therefore more resistant to buckling.

r) MINING OR MINERAL EXTRACTION

Mining and mineral extraction can cause subsidence of the track as well as drawing it sideways, since it can be variable, sudden and substantial. Special local instructions should be laid down for such sites. CWR stresses can be monitored with Rail Force Transducers if necessary.

s) UNSTABLE EMBANKMENTS

Unstable embankments can lead to dips or horizontal misalignment which act as trigger points. Alternatively where the track has to be lifted and packed regularly to maintain top and line, this may lead to ballast shortage.



With coal settlement such as this the joints need careful attention to ensure the gaps between rails remain satisfactory.

Causes of Track Buckles (cont.)

6.2 JOINTED TRACK

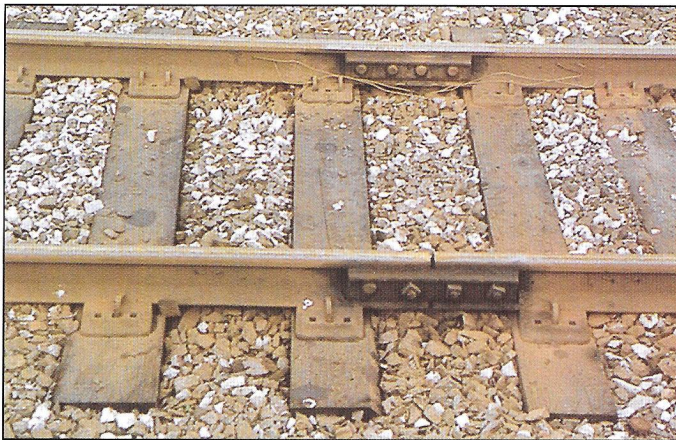
a) INCORRECT EXPANSION GAPS

If joints are closed or small in cold or cool weather then expansion at the rail ends will be limited when the temperature rises and once there is no gap then the rails will build up a compressive stress which may produce a buckle.

b) FROZEN OR SEIZED FISHPLATES

If fishplates are not free to move (i.e. the fishplates are frozen or seized) then the thermal expansion cannot take place and consecutive joints will be unable to expand longitudinally. This will cause the build up of high compressive forces which can lead to a buckle.

If a single isolated tight joint is present in cold weather or a single isolated open joint in hot weather (over 38C) then the fishplates are probably frozen. If a number of consecutive joints are open or tight in the "wrong" weather then there is a creep problem.



The rail has crept so that the fishplates are onto the left hand baseplate. The near rail has a gap the far one does not, suggesting that one fishplate is frozen.

c) POOR FASTENING CONDITION

If the fastenings are not in good condition, because of corrosion or they are loose then the rails will not be held properly and the risk of movement and hence buckling is greater.

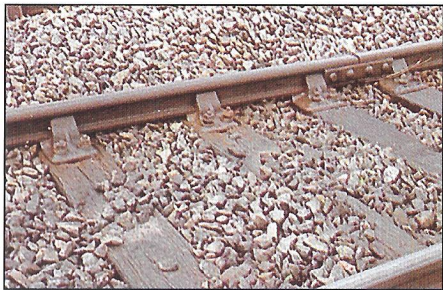
i) Rail to chair fastenings.

There are basically three types of keys for BH, wooden or steel keys or the Panlock. It should be noted that Panlock provides the least resistance of the three to creep and under no circumstances should they be used in lengths with known creep problems nor in BH CWR.

Steel keys suffer from corrosion and can also become crippled through repeated driving. In recent years some wooden keys have been made to poor tolerances; they also have a tendency to dry out and shrink in hot weather, reducing their grip.

ii) Chair to wooden sleeper fastening. This is normally by a chair/baseplate (coach) screw or a throughbolt. A chair screw must be fitted with a ferrule; it should not stand more than 6mm proud of the housing nor should it be squashed flat when the screw is driven down by mechanical means.

Throughbolts are difficult to maintain unless they have been regularly greased/oiled at the nut end and kept tight. There is usually wear in the bottom of the sleeper and what should be a square depression to hold the bolt head breaks up and when an attempt is made to tighten the nut the whole bolt rotates.

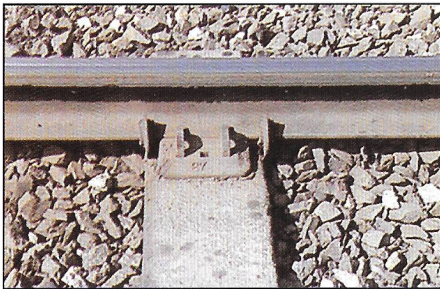


The throughbolts are standing well above the chair housings and the wear in the middle of the two left hand sleepers suggests voiding for a long time.

For details of Pandrol, SHC, Mills and BJB fastenings see 6.3b

d) ANCHORS

Anchors are designed to prevent railcreep, but also increase rail stability if correctly fitted. However if they are loose or not against the sleeper or baseplate then longitudinal resistance can be reduced. An anchor on one rail that is loose will permit that sleeper to go out of square and cause gauge variations, see below.



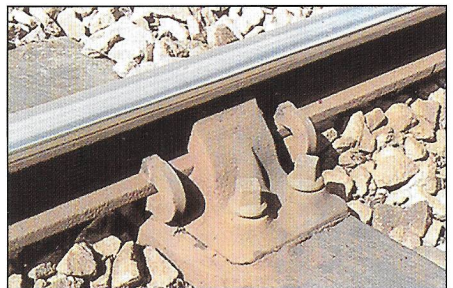
Anchors properly fitted.

e) GAUGE VARIATIONS

Variation in gauge is usually caused by loose fastenings, it will also accentuate the lateral forces from the vehicles and hence the risk initiating a buckle.

Typical gauge variation problems occur in BH track with worn, damaged or corroded keys, wear or corrosion in the chair jaws, worn or corroded chair screws and rotten wood in the sleepers. In FB track on wooden sleepers then again screws in the wood may be not holding or the various fastenings may be worn, damaged or corroded. On concrete sleepers similar problems can occur when the concrete becomes eroded in the bolt holes of through bolted chairs.

Gauge problems may have arisen when spot resleepering has been carried out, and the sleepers installed were tighter than the old ones causing tight spots. It is also possible that drilling for the fastenings in new sleepers may not be exact. A different type of sleeper and chair/baseplate in amongst others can also cause gauge variation problems.

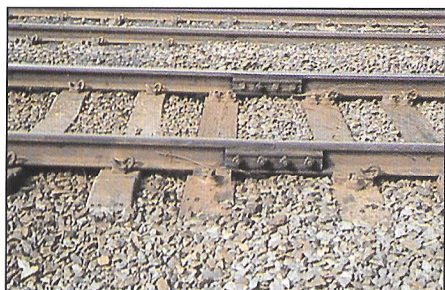


Anchors properly fitted.

.....

**f) CHANGE OF RAIL AND/
OR SLEEPER TYPE**

Where BH abuts FB track or concrete sleepers abut wood, or different types of sleepers of the same material, then there is a difference in weights and a variation in friction.



A change from concrete to wood sleepers.

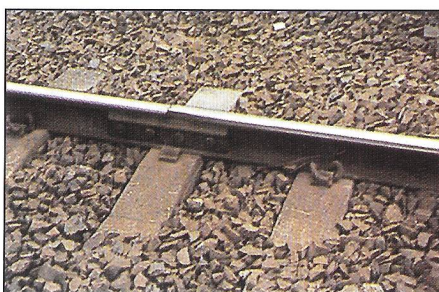


A composite weld at the change from flat bottom to bullhead rail.

g) CREEP LOCATIONS

Where creep is known to occur a special watch should be kept in hot weather in case movement

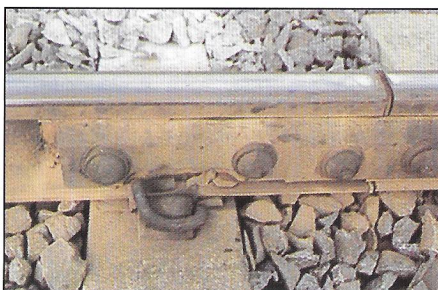
occurs and the already tight joints go into compression. Where a creep site has been anchored then a check must be made that the anchors are holding satisfactorily.



Creep is so bad that the joint is on top of the sleeper.

h) INSULATED JOINTS

These are probably no weaker than any ordinary joint though 4 hole shop manufactured glued joints and 6 hole joints will normally be stronger



This six hole insulated joint is showing signs of glue failure and movement, the gap between the Tee piece and the right hand rail suggests it is also pulling apart.

Causes of Track Buckles (cont.)

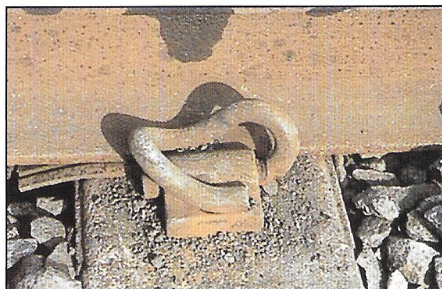
6.3 CWR TRACK (normal, with concrete sleepers and FB rail)

a) INCORRECT RAIL STRESS

This is one of the most common causes of buckling in CWR. A site may not have been restressed following clipping down at a temperature outside the permitted Stress Free Temperature range of 21-27°C. Alternatively it may have lost stress through movement towards the inside of a curve in cold weather, or a rail defect may have been removed and the stress not reinstated when the new rail was welded in. Lifting and/or slueing may have been undertaken outside the limits in RT/CE/S/011, leading to loss of rail stress.

possible looseness and reduction in toe load. A Pan clip once overdriven may be distorted and again have reduced toe load. Similarly, clips inserted into the wrong housings will be ineffective.

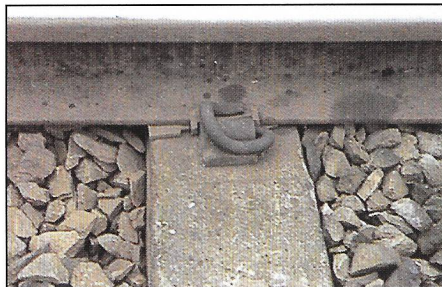
A device is available to check the toe load of Pandrol clips, where serious doubt exists.



The pad is half out and the sleeper has rotated.

b) POOR FASTENINGS CONDITION

- i) Pandrol. Care must be taken to ensure that the clips are properly driven, insulators and pads are of the correct type and in good condition and properly in place. A twisted insulator or misplaced pad will cause



The H pad is not properly seated around the housing.

-
- ii) SHC. Similar remarks as for Pandrols. Care should be taken that the clip does not wear too deeply into the insulator, a common occurrence, which gives reduced toe loading. Two further problems that are starting to occur are cracking of the concrete vertically against the outermost hoop, then horizontally along the prestressing wires to the end of the sleeper so that a block of concrete breaks out. The second problem is cracking of the concrete in the rail seat.



A maintenance screw has been fitted to this BJB fastening, but the gauge plate is on top of the rail foot, so the gauge is suspect.

- iii) Mills. The clips often become loose in the housing through wear and rusting. A nylon toe shoe for insertion under the top of the clip has been designed but does not appear to be in common use.
- iv) BJB, RN, NABLA. These have now become a serious maintenance problem in many places. The beechwood insert in the concrete has rotted away and the coach screw has little if any hold and the whole fastening becomes loose, this seriously reduces if not totally eliminates the toe load and can cause significant gauge variation. Pandrol housings can be glued in to replace the original BJB screw.
- v) There may be other types of fastenings (e.g. RNB) in existing CWR which are not now used where similar problems occur resulting in loss of toe load or lateral restraint.

c) INSULATED JOINTS

These are discontinuities in the rail and hence a weakness which can act as a trigger for a buckle. They must therefore be kept in good condition, any loose bolts, worn liners or glue failure will reduce their strength.

Any 4 holed dry insulated joint has a higher buckle risk than glued one, since it is not as rigid.

Six hole glued insulated joints have in the past been fitted in incorrect locations, so that clips cannot be fitted. Sites where the sleeper spacing is incorrect, will cause a weak spot.

d) POOR ALIGNMENT AT WELDS

This could act as a trigger point for a buckle.

Causes of Track Buckles (cont.)

6.4 'S & C'

Until the issue of the revised Handbook 11 in 1993, the method of stressing into S & C was the subject of much debate and various methods had been tried or it was ignored altogether. Some Areas even used a lead as an anchor regardless of its dimensions.

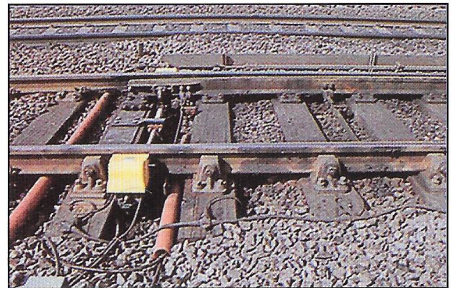
Where there is plain line CWR adjacent to the toes of switches of a suitably strengthened lead the actual stressing zone is from the CWR into and up to the heel blocks. Similarly the plain line CWR at the back of a crossing must be stressed to the crossing itself.

Handbook 11 (1993) showed and RT/CE/S/011 now shows where adjustment switches are mandatory and optional and it must be appreciated that there is a difference between the anchor length and the stress transition length. Sites not meeting the new requirements should be subject to careful consideration as to the installation of new adjustment switches and carefully watched in hot weather.

Appropriate precautions and actions are required if it is known that stressing of the plain line into either a switch or the back of a crossing has not been done in accordance with the RT/CE/S/011.

Any length of rail greater than 37m is considered as CWR and has to be dealt with as such. It is therefore possible in long switches that the rails between the crossing and the heel blocks of the switch come into this category and should be correctly stressed.

The toes of switches have had both the stock and switch rails machined and reduced in section, there are point rods, cables and other S & T equipment in the beds which means less ballast, all leading to less resistance to buckling. In certain places ballast trays are being used; these are channel shaped steel plates secured to the timbers which form a trough to permit cables, etc. to be kept clear of the ballast and against which ballast is supposed to be packed.



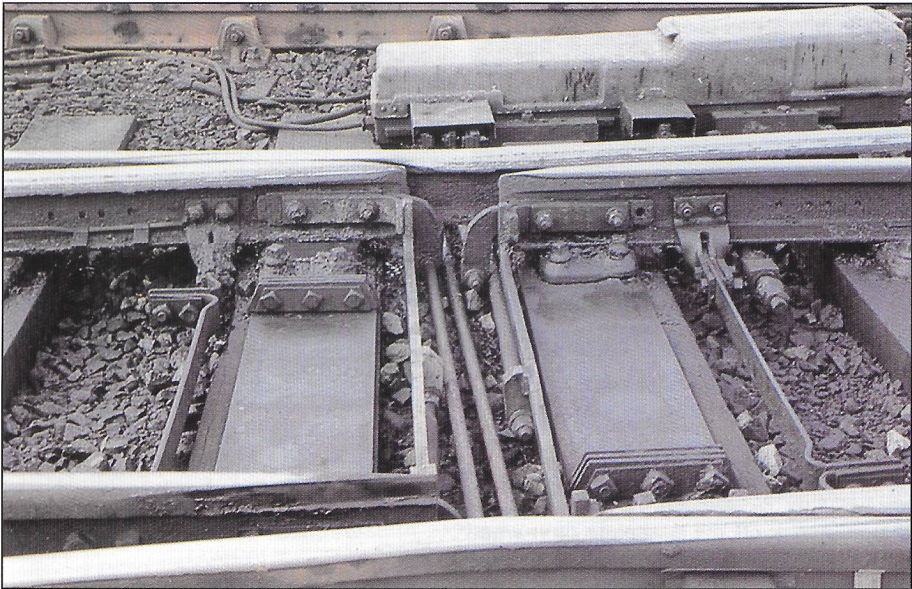
Rodding, orange pipe and stretcher bar all reduce the ballast in the beds at the toe of the switches.

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Whilst RT/CE/S/011 now defines the procedures for stressing when crossings or switches were charged in existing layouts this is a risk area, since in the past some areas did not stress into the adjacent CWR.

Switch diamonds are a continual cause of problems in hot weather, the switches expand and the S & T rodding at the toes can actually make contact and it may not be

possible to reverse the switches or detection may be lost. Even greater problems can arise if manganese rails are present since these have a 50% greater expansion than normal grade rail. Hot weather problems in switch diamonds are difficult to cure, but it may be worth considering installation of adjustment switches.



Severe wear at the toes of a switch diamond and the many point rods

Adjustment Switches

These allow for the expansion at the end of the CWR, in the Stress Transfer Zone.

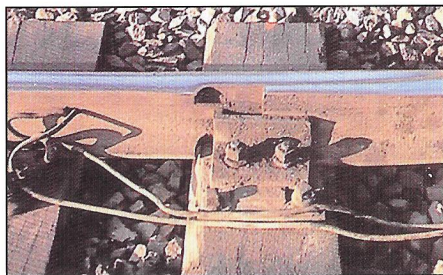
The clamps and the overlapping rails should be kept lightly oiled to permit thermal movement at any time of the year. The screws fastening the baseplates to the timbers must be kept tight. Where plastic "cheeses" are present these must be watched for wear, especially in the bolt pockets with T bolt fastenings.



Some voiding of this adjustment switch is apparent from the white dust on the sleepers and baseplates.

Care must be taken to ensure the full width of the rail foot rests on a baseplate, if not then there is the risk of the reduced section of the rail breaking. Alternatively if the full rail section comes off the baseplate then when the rail expands again it may catch on the base plate and force the sleeper out of square.

Full details are shown in RT/CE/S/011.



Both these adjustment switches require urgent attention.

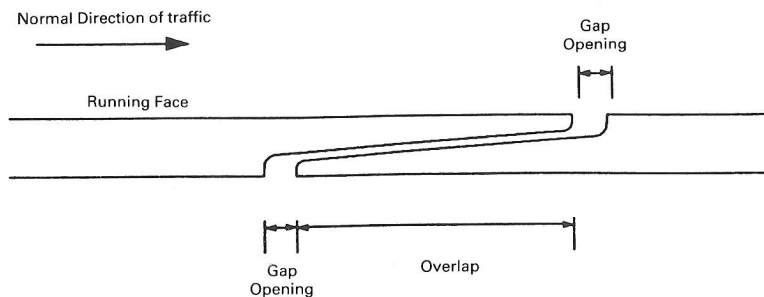
If there are straps in the four foot they must be screwed down 'tightly to stabilise the adjustment switch timbers.

Settings must be checked on a regular basis, and action taken where gaps become too wide (especially in summer) or too tight (especially in winter). Where resetting is required regularly, the underlying causes should be investigated. This may be indications of rail movement in the CWR indicating a potential loss of stress, or in jointed track indicators of rail creep.

Settings and dimensions for adjustment switches are shown below.

The old practice of "summer" and "winter" rails adjacent to adjustment switches is not recommended. This was where creep problems in the jointed track closed up the switches in hot weather but left them wide open in winter. The first pair of rails behind the adjustment switches were changed as necessary by using rails of different lengths.

Whilst this minimised the work required to reset the adjustment switch gaps and overlaps, unfortunately it did not cure the underlying cause of the creep.



Rail temperature	Overlap of switch rails	Gap opening
-4 to 2C	635mm	125mm
2 to 7C	641mm	119mm
7 to 13C	648mm	112mm
13 to 18C	654mm	106mm
18 to 27C	660mm	100mm

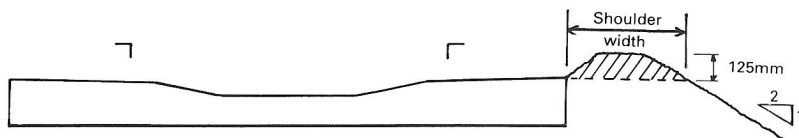
Work To Be Undertaken Prior To Hot Weather

8.1 GENERAL

NB Each year each Permanent Way Production Engineer should plan to execute the following work prior to 1st May:

- a) Make good ballast shortages.

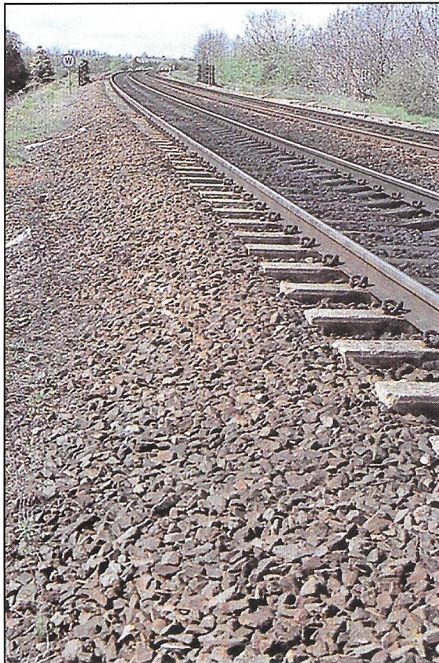
For normal CWR and jointed track the following is required



MATERIALS	SLEEPERS	STRAIGHT OR CURVED	SHOULDER
CWR	concrete/wood	straight or curves 2000m radius	375mm
CWR	concrete/wood	curved	450mm
IRJs, catchpoints, adjustment switches			450mm
For all the above situations the ballast should be heaped 125mm high above the top of the sleeper end			
jointed	wood/concrete	straight/curved	300mm
For the above the ballast should be level with the top of the end of the sleeper but where extra lateral resistance is required CWR shoulders may be provided			

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- b) Dig out wet beds and make good. Leaving wet beds dug out and open in warm or hot weather so that they can dry out is prohibited as well as being very risky.
 - c) Tighten or replace fastenings as necessary.

- d) Ensure all insulated joints are in good condition and free from lipping.
- e) Team Brief staff on precautions to be taken in hot weather and in exceptionally hot weather conditions.



This ballast shoulder is deficient.

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Work To Be Undertaken Prior To Hot Weather

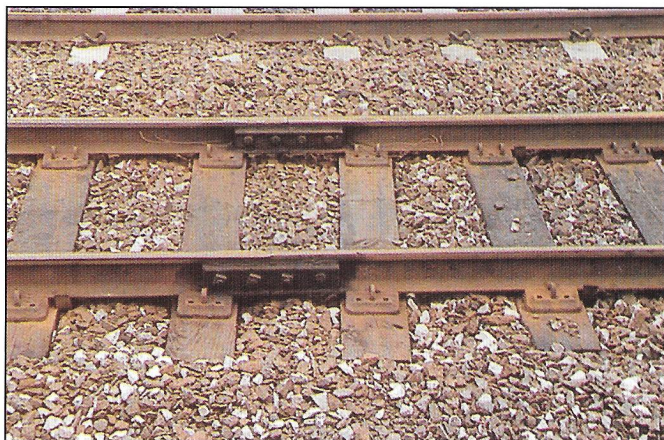
8.2 JOINTED TRACK

- a) Complete all necessary rail adjusting.

The expansion gaps required are detailed below

RAIL TEMPERATURE	WEATHER DESCRIPTION	GAPS FOR 60FT RAILS	GAPS FOR 120FT RAILS
Below 10C	cold	10mm	10mm
10C to < 24C	cold to warm	6mm	6mm
24C to < 38C	warm to hot	3mm	3mm
over 38C	very hot	zero	zero

- b) Fit rail anchors, where necessary.
- c) Complete fish plate and bolt lubrication.



These fishplates have been lubricated, but the creep has not been rectified.

Work To Be Undertaken Prior To Hot Weather (cont.)

8.3 CWR (CONCRETE SLEEPERS)

NB The items listed below reinforce those in RT/CE/S/011 and in no way supersede nor alter its requirements.

- a) Ensure that rails are correctly stressed.
- b) Ensure that adjustment switches are set to the correct dimensions.

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Work To Be Undertaken Prior To Hot Weather (cont.)

8.4 S & C

- a) Check that all bolts (stock rail, heel block, stress transfer, insulated, tight and normal ones) are in place and have been correctly torqued tightened.
- b) Ensure that following any replacement of switches or crossings, correct restressing has been carried out into the adjacent CWR, where applicable.
- c) Ensure that switch toe dimensions are correct, especially in switch diamonds. This is particularly important if the switches are of rolled manganese, which has a coefficient of expansion 50% greater than normal grade steel.



The dimensions for the switch toes can be found in RT/CE/S/104 Track Maintenance Requirements.

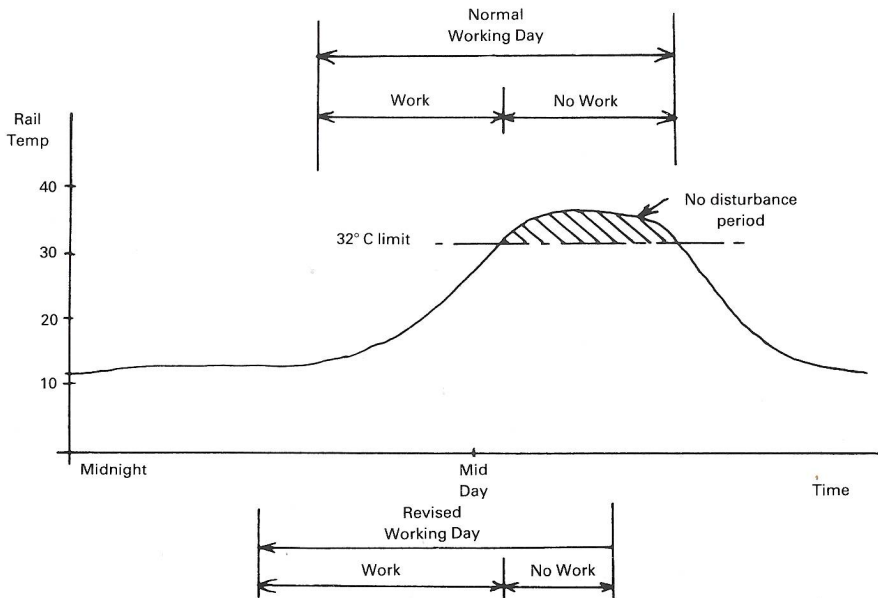
Working During Hot Weather

Some recent summers have been very hot and long. In such hot weather there should be only minimal disturbance to rails, fastenings and ballast but on occasions it will be necessary to undertake maintenance work to safeguard traffic.

RT/CE/S/011 defines the conditions for disturbance of CWR in hot weather and similar limitations apply for jointed track.

In many cases it is worth starting early in the morning and completing the essential work before temperatures become too high.

When there is a forecast of hot weather the person controlling the work shall put one or more thermometers on the rail at the start of work. The temperature must then be periodically observed to ensure that work is stopped, the ballast profile re-instated and if possible consolidated before 32°C is reached. The person will also need to take appropriate precautions for that site. Precautions for that site on the following days will then apply as laid down in RT/CE/S/011.



Precautions To Be Applied in Hot Weather

10.1 Critical Rail Temperature

Where it has not been possible to complete all pre-hot weather work before 1st May, there is a significant deficiency in resistance to buckling, or a disturbance occurs during hot weather, hot weather precautions must be applied to the affected length of track.

Each local office must have a system in place which allows Critical Rail Temperatures (CRTs) to be calculated for each site. RT/CE/S/011 details how each CRT is calculated for CWR:

It is based on:

- the stress free temperature
- how the track is disturbed
- the track construction and curvature

RT/CE/S/011 also defines the different types of CRT and how long these CRTs shall apply for.

For jointed track or other types of disturbances (eg. Unstable embankments) Permanent Way Engineers shall use their professional judgement in calculating CRT values.

10.2 Watchman

When the rail temperature is expected to reach the CRT(W) (as defined in RT/CE/S/011), a watchman must be appointed for a site or set of nearby sites.

A person engaged as a watchman should be competent to know what is being sought and how to take action if conditions become serious, in accordance with the Safety Critical Work Regulations. It is not necessary for the Watchman to be trained nor appointed as a patrolman, neither is it expected that he would walk a patrol length, but will need only to observe a suspect site or sites.

The watchman must have at least a thermometer, a red and yellow flag and six detonators. He must put a thermometer on the rail as soon as he arrives on site and remain there, normally until the rail temperature has dropped below CRT(W) and is not likely to rise again that day.

It should be remembered that the Watchman may be likely to exceed normal working hours and is at risk from sunburn and thirst; appropriate precautions should be taken.

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Whilst the watchman has a flag and detonators to stop trains, communication with the nearest signalling centre must be available, preferably by telephone. Should this not be possible then an alternative quick method of communication must be laid down.

The watchman has a difficult task, since buckles often occur as a train passes; however he should look and listen for signs of movement e.g. gaps occurring at the sleeper ends. If there is movement, then traffic must be protected according to the Rule Book Section B (part iii) and the PWSM notified.

If jointed track is being inspected then a watch must be kept on the expansion gaps; at a rail temperature over 38°C then there should not be any open ones. If there are any open joints then slackening of the fishbolts and hitting the rail in the web should allow the rail to move and the joint to close.

The Watchman shall take and record temperature readings at regular intervals at each site being monitored.

10.3 When CRT(30/60) is Reached

When and if the rail temperature reaches the CRT(30/60) then the Watchman shall impose an emergency speed restriction (ESR) of 30/60mph. The ESR shall remain until the rail temperature drops to the CRT (30/60) and continues to fall.

10.4 When CRT(20) is Reached

When and if the rail temperature reaches the CRT(20) then the Watchman shall impose an ESR of 20mph. The ESR shall remain until the rail temperature drops to the CRT (20) and continues to fall.

Records To Be maintained

11.1 General

The following records are to be maintained by Contractors,

- a) All stressed lengths of CWR and associated stressing records.
- b) A list of all lengths of CWR having a SFT less than 21°C, these are 'cold' or 'red' spots susceptible to buckling if the temperature is high.
- c) All CWR having an SFT greater than 27°C, these sites should only be a problem during cold weather.
- d) A list of all sites where the ballast profile is not in accordance with the specification.
- e) A list of all sites that have been subject to ballast disturbance, eg. after tamping and lining, after wet bed remedial work, etc. or which still have a restriction imposed.
- f) A list of all jointed track with known tight joints, ballast shortages or creep problems.

And from the above information:

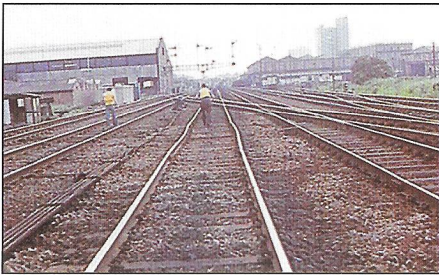
- g)
 - A list of sites where CRTs apply
 - Why they apply and
 - What the CRT values are.

The CRT lists must be updated each time there is a change (often daily). PWSSMs must be in possession of a current CRT list at all times along with:

- h) An action plan for covering hot weather precautions.
- i) A list of staff available for hot weather patrolling.
- j) Details of the weather forecast for that day and the next two days.

When A Buckle Occurs

If a buckle occurs then the first and immediate priority is to protect traffic in accordance with the Rule Book and advise the local signalling centre. Once the line is protected, contact must be made with Control, the PWSM and/or local P. Way Production Engineer, who will initiate any further action.



A buckle where creep in jointed track has come up against a 'short' rail and a fixed point, the S & C.

Dependent on the rail temperature, the time of day and the extent of the buckle then it may be possible to pass traffic at a reduced speed. Before this is done clearances must be checked to any structure, the OLE if present, and/or any adjacent line(s).

Alternatively it may be possible to slue the track outward to a smooth curve to permit traffic to pass, again at reduced speed, after clearances have been checked.

The buckle must be kept under continuous observation in case it gets worse as the temperature rises or if the temperature starts falling and there is inward but uneven movement.

Measurements of the deformation must be taken and the cause of the buckle established to enable the Track Buckling Report Form to be completed and a decision to be taken on permanent remedial action.

Once the rail temperature has dropped below the CRT(W) or 32°C (whichever is lower) and it is certain that it will remain there then it will be necessary to restore the original alignment and rectify the cause of the buckle.

Remedial action may simply involve slueing the track back to its original alignment when the temperature has cooled and restoring the ballast shoulder.

In CWR the rails may have to be cut, slued and rewelded. Care must be taken here since the SFT could be in excess of 27°C and further restressing will be necessary before the onset of cold weather.

In jointed track it will be necessary to pull back to adjust the expansion gaps, it may also be necessary to cut out a piece of rail.

Once remedial work has been carried out it should be remembered that the site has been disturbed and appropriate precautions must be planned and maintained until the ballast has been consolidated.

Reporting Of A Buckle

Any buckle must be reported to the Area Office as soon as possible and in accordance with local instructions.

RT/CE/S/104, Track Maintenance Requirements requires that when a buckle occurs the Contractor shall provide two reports to Railtrack:

- 1) An immediate report (eg. by telephone, fax or micromail) to be made by the end of the next working day, following the buckle occurring, containing details of:
 - Date
 - Time
 - Zone
 - Route
 - Line
 - Mileage

- 2) A Track Buckle report form based on that in Appendix A which shall be sent within 5 working days of the buckle occurring.

Such details shall be sent to:

- a) Local Railtrack Track Engineer, and
- b) Railtracks Professional Head of Track, Railtrack House, Euston

Other posts may need to be advised as required by local instructions.

Lateral End Resistance Plates (LERPs)

Lateral end resistance plates are recommended in certain locations to improve lateral resistance of sleepers or timbers. For details see RT/CE/S/011. A number of points need to be considered and allowed for prior to installation and during any lifting of the track where they are fitted.

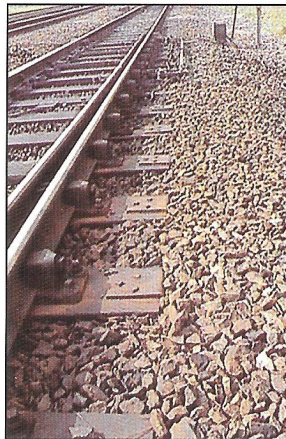
If fitting to concrete sleepers or bearers then care must be taken to ensure that any drilling of the concrete does not damage or get too close to any stressing wire or reinforcement.

The bolts used to fasten the LERP should preferably not be of the expanding type to minimise the risk of cracking the concrete if overtightened.

Before fitting LERPS the track must be to the exact alignment required.

When LERPs are installed the ballast will be disturbed and so it must be consolidated into place to avoid the first few trains moving the sleeper or timber through the disturbed and loose ballast, thereby totally defeating the object of the work.

Whenever tamping is to be undertaken on track fitted with LERPs then consideration must be given to removing and replacing them, since it is possible that any lift could also cause lateral movement. This risk obviously increases as the cant becomes greater.



Lateral end resistance plates on the timber ends used to retain the alignment at the switches.

15 & 16

Long Welded Rails (LWR)

- a) The maximum length of rail that can be installed is 120ft, except for:
 - i) CWR
 - ii) in long tunnels where the temperature is known to remain constant. Here 180ft rails are permitted.
- b) Whilst the creation of 180ft rails was stopped some time ago it appears that some still remain. These should be cut into 90fts with fishplated joints wherever possible.

CWR or LWR Placed Lineside

New and serviceable CWR or LWR is often placed lineside in preparation for, or as a result of rerailing work. For numerous reasons it can be a hazard and consequently the length of time it is left lineside should be minimised.

Unrestrained CWR or LWR placed lineside suffers thermal stress like any other rail but will usually undergo expansion and contraction to a greater extent than rail placed in the track. Consequently the risk of movement of the rail must be considered.

Recommended guidelines are:

- a) Where possible place the rail in the cess as far as practicable away from the nearest running line. Rail placed in the four foot or six foot will normally present a greater risk to traffic.
- b) Make sure both ends of any rail are free to expand and contract. This is easily achieved by placing a suitable object (timber block) under the rail a short distance from its end (say 500mm).
- c) Support the rail to ensure it freely passes over any cable or equipment.
- d) Consider restraining the rail locally with straps or similar in areas where movement can not be tolerated.
- e) Ensure the CWR is inspected in accordance with normal track inspection frequencies.
- f) Arrange for watchmen to be posted where it is felt that hot weather may cause a significant risk of the rail movement at a given site.

Conductor Rails

Conductor rails are normally laid in 440yd. lengths. The last fifteen insulator pots at each end of the rail must rest on greased steel packings, to permit movement.

To ensure that the conductor rail is kept in a "stationary" position anchors must be provided, at or within 50yds. of the centre of the rail. One anchor is required for the first 150yds of rail and a further anchor for each additional 100yds.

The anchored insulator pots should be mounted on adjacent sleepers and the sleeper clips (cleats) must be tightly fastened to ensure that the clip does not tip during hot weather.

Where aluminium conductor rail is fitted then it is only produced in 360m lengths and expansion gaps are designed into the rail by the maker at each fishplated joint. No grease is required at the insulator pots and only one insulator pot is anchored at the centre of each length of rail.

Conductor rails are allowed to expand and contract from the anchored position. However, high temperatures can lead to damage not only to the conductor rail itself but also to the associated conductor rail equipment. Note that when insulators fail the conductor rail can take up a position which is high, low or wide to gauge. Failures are more likely to occur on long rails with tight curves.

Therefore during sustained periods of high temperature or when there is a large variation between night and day temperatures the following checks should be carried out on a weekly basis or more frequently if circumstances demand it:

- a) The position of conductor rail should be gauged including ramp ends and side ramps.
- b) Anchor insulators and clips should be in their correct position. If the anchor is defective or not installed the rail can creep.
- c) Other insulators should be examined for their condition and security of fixings.
- d) Cables attached to the conductor should not be tight. If the cables are tight this can lead to lug damage and tipping of the conductor rail.
- e) The conductor should be able to move freely between the ears of the insulator.
- f) The ramp end insulators should properly support the ramp. There must not be excessive overhang. Check the expansion gaps in the conductor rail are adequate.
- g) The ramp end should not dig into the ballast.
- h) The temperatures of conductor rail joints, bonds and cable lugs shall be checked and recorded using remote infra-red thermometers. They are more prone to failure in hot weather.

Further checks that should be carried out with aluminium composite rail include:

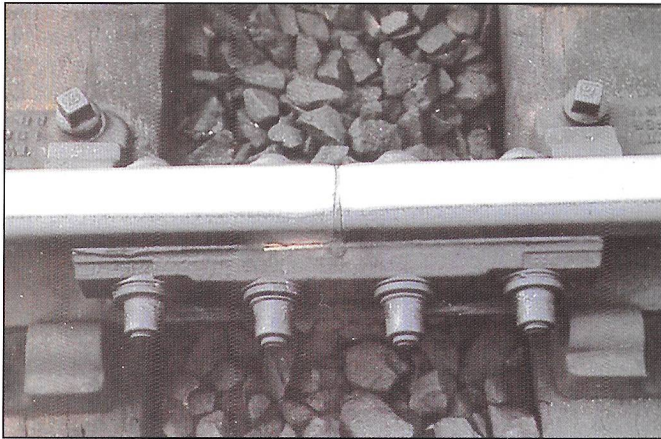
- i) Looking for fractured insulators. These can allow the conductor rail to move upwards and could foul the collector shoe.
- j) Ensuring the insulator / conductor rail spacing clamp allows the conductor rail to pass freely through.
- k) Looking for any separation of stainless steel from the aluminium.

Insulated Joints

The expansion of rails in hot weather can cause poor insulated joints to bridge across and drop the track circuit.

A careful watch must be kept on the end post (or tee piece) condition as well as any lipping of the rail ends. If the end post is in poor condition it may crush permitting the rails to move closer together as the compressive force in the rails becomes greater. If lipping is present then bridging across the joint may occur.

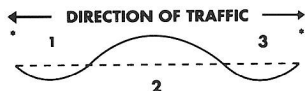
Any lipping at rail ends can be removed by careful use of a hacksaw or other approved saw, remembering to clean off any resulting filings from the joint.



Lipping on the rail head is close to bridging across.

6 INCIDENT

6.1 Extent:



* DELETE WHERE NOT REQUIRED

- 1 = Extent: millimetres over metres
 2 = Extent: millimetres over metres
 3 = Extent: millimetres over metres

Vertical distortion: 0 = none, 1 = 1 to 50mm, 2 = 51 to 100mm, 3 more than 100mm ☐

6.2 Ballast dimensions:



- W = millimetres
 X = millimetres
 Y = millimetres
 Z = millimetres

7 SKETCH

Make a sketch showing:

- Outline track detail, indicating side A and side B as shown in 6.2 (above)
- Direction of traffic
- Rail joints, insulated joints, adjustment switches, etc
- Location
- Site and relative extent of buckle
- Any other relevant detail

8 CORRECTIVE ACTION TAKEN

Give details of protection and corrective action taken, (plus any other notes and comments):

9 DEFINITION OF A TRACK BUCKLE

The extent of deformation of track constituting a reportable buckle is that which necessitates **emergency remedial work** under cover of either a precautionary speed restriction or closure of the line. the emergency remedial work may consist of:

- Adjusting rails
- Cutting rails
- Slueing the track

The following circumstances do not constitute a reportable buckle:

- A misalignment that occurs during work whilst it is under a possession of a line
- The imposition of a precautionary speed restriction, where no track deformation actually occurs
- A misalignment in a siding

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