MANAGEMENT OF CYCLIC TOP

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Note

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Contents

SUBJECT	PAGE
1 Scope	2
2 Background	2
3 What is Cyclic Top?	3
4 Why Does it Develop?	5
5 Detection by Track Recording Vehicles	6
6 Finding the L2 on Site	8
7 Detection by Other Methods	9
8 Manual Treatment Methods	10
9 Mechanised Treatment Methods	11
10 Trend Monitoring	12
11 References	13

1 Scope

This booklet has been produced for the guidance of track staff at all levels. It is intended to give general information on the causes, identification and repair of cyclic top.

2 Background

Cyclic top can be a cause or contribute to derailments. Typically between three and six derailments are attributed to a cyclic top cause per year in the UK. In the course of a year's track recording 40, 000 defects are detected which are serious enough to warrant urgent treatment.

As a defect type cyclic top deserves special attention because of the particular difficulties it presents in detection and treatment.

Photograph - The result of a cyclic top derailment.

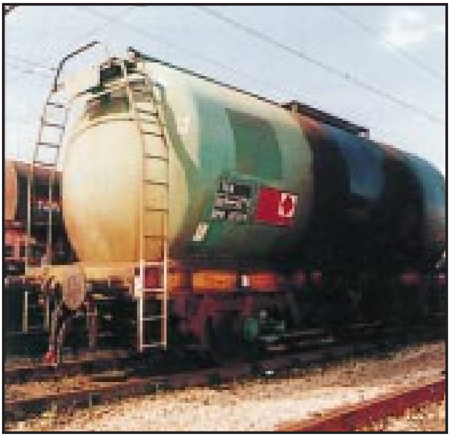
Maintenance contractors' aim is to eliminate the risk presented by cyclic top with the overall objective of further improving the safety and quality of Britain's railway network.

3 What is Cyclic Top?

Cyclic top is a series of dips or vertical irregularities, in one or both rails.

When trains pass over these dips wagons can experience a bouncing motion which in severe cases causes the wheels to leave the rails.

This bouncing frequency is particularly severe in some types of freight wagon which have susceptible suspension. These include IVA and TTA as shown in the photographs below. The possibility of a permanent ban or permanent speed restriction on this stock has been rejected because of the number of such wagons and because many of them are from continental Europe.



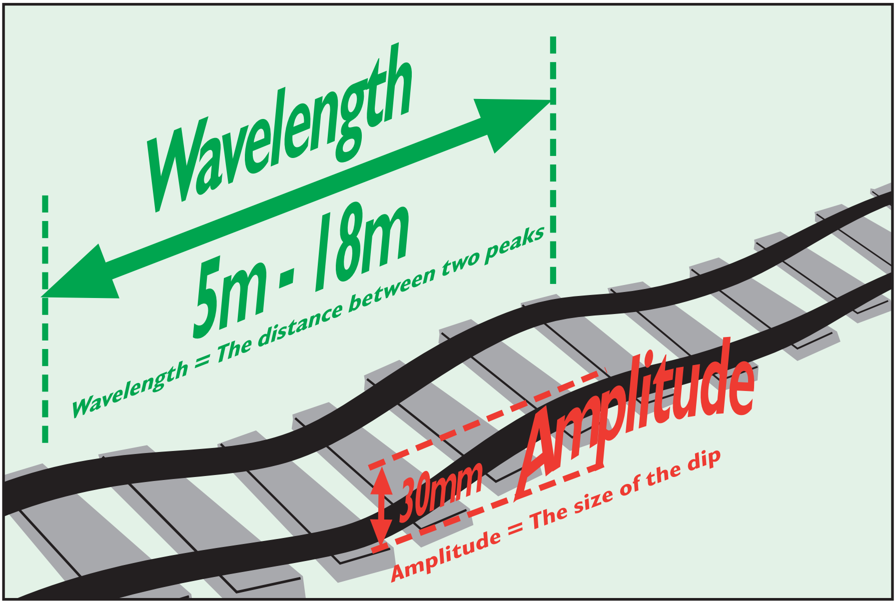
Photograph - An IVA Wagon

These types of vehicles are susceptible to derailment caused by cyclic top.

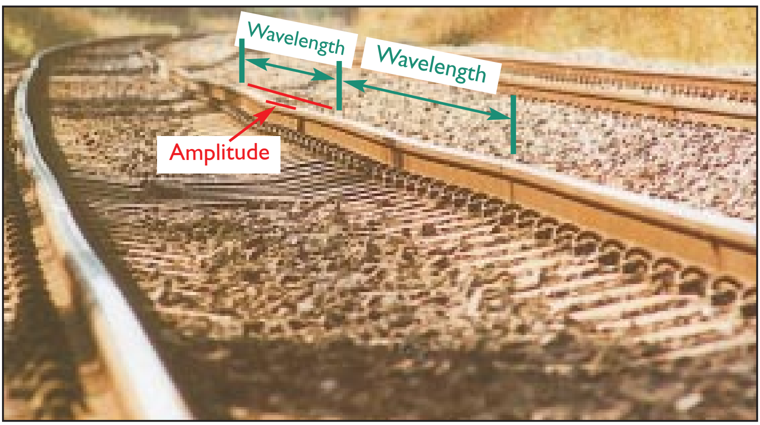
The problem is not exclusive to these types of vehicle.

Photograph - A TTA Wagon

A particular problem has been shown to occur when the dips are at intervals (wavelength) of between 5 and 18 metres (7 to 28 sleepers). To pose a serious risk of derailment two or more evenly spaced dips (amplitude) are thought to be required. For this reason jointed track is very susceptible to cyclic top faults. The dips may not be immediately obvious because of voiding under sleepers. Train speed is also a factor. It is unlikely that cyclic top derailments will occur at 30mph or less. Fortunately nearly all track with a speed higher than 30mph is track recorded and the location and magnitude of cyclic top identified.



Wavelength and amplitude of cyclic top faults



Photograph of cyclic top site

4 Why Does it Develop?

The problem occurs in both jointed track and CWR and is caused by a number of track conditions.

Below are some of the faults which trigger cyclic top:

- dipped joints
- dipped welds
- switch & crossing faults
- weak formation
- dipped insulated block joints (IBJ's)
- poor track geometry
- differential settlement in structures, underbridges and level crossings

Rail lengths of 5 to 18 metres may present an increased risk of cyclic top especially when joints are worn or dipped. Cyclic top causes wagons to bounce on their suspension. This can introduce heavier loading on the track half way along a 60ft rail. This behaviour of the suspension occurs without the wheels losing contact with the rails. Over a period of time these heavier loads can cause a dip at the half-length even though no joint is present.

Even after joints have been removed by introducing CWR the problem can persist owing to ballast memory. This occurs, despite packing or tamping as dips reappear due to differential compaction of the ballast layer.

Joints which have been welded with poor vertical alignment may also cause cyclic top.

A bouncing motion may be triggered at any dip or bump in the track, caused by triggers listed above. The effect tends to be worse where there is a predominant traffic type travelling at the same speed.

At these locations a single dip or bump may repeat further on as the pattern of uneven wheel loading continues.

Vehicles which are unevenly loaded may contribute to the effects of cyclic top.

In some cases it may not be possible to identify the cause with normal methods of visual inspection.

5 Detection by Track Recording Vehicles

Track Recording Vehicles (TRV's) analyse and record the features of track geometry including cyclic top. Once a cycle pattern has been recognised, and the allowable parameter exceeded, a fault is recorded as an exceedence. Cyclic top faults are recorded on all routes with a line speed of 30mph or higher.

These exceedences are known as Level 2 faults (L2s). L2s require particular attention within a given amount of time. A list of L2s is produced on the recording unit and passed to the maintenance team for action. An example is shown on the next page

Note: The rectifying team must sign off and date each L2 and indicate what has been done. **There must be:**

- **A SIGNATURE**
- **DATE**
- **DESCRIPTION OF WORK DONE**

If the fault is not rectified it must not be signed off. If no fault is found this should be reported to the area track engineer.

If tamping or other remedial work is planned, the date and nature of work should be shown, sign off **<u>should not be done</u>** until work is complete. (Sign off to be completed by competent person in charge of the remedial work).

Refer to RT/CE/S/104 or your company minimum action sheet for details of the repair timescales and Emergency Speed Restrictions which may apply.

MINIMUM ACTION ON DETECTION OF CYCLIC TOP

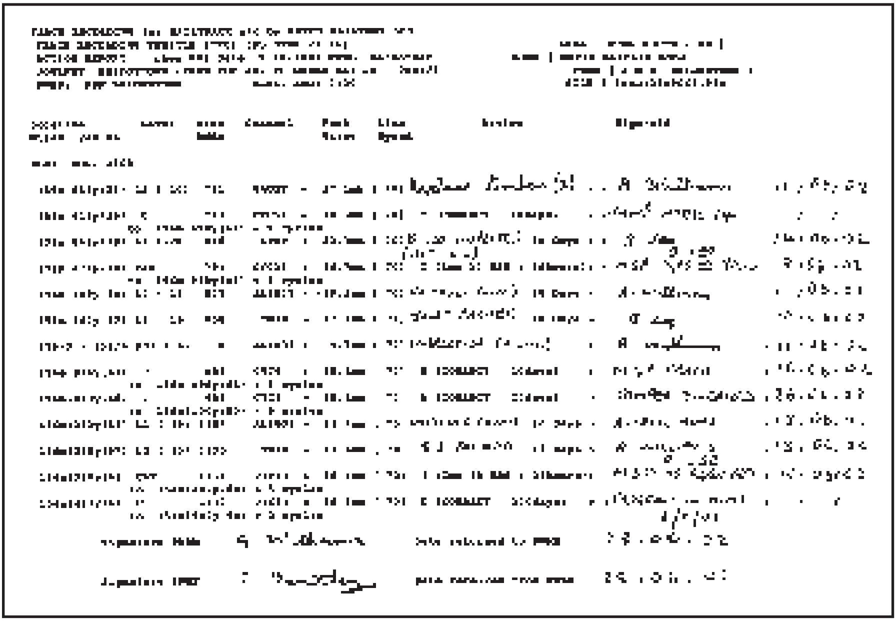
EXCEEDENCE	ACTION
Level 2 top exceedence = 20mm	Correct within 10days
Level 2 alignment exceedence = 50mph, 15mm; <50mph, 30mm	Correct within 10 days
Cyclic top (Immediate) exceedence = 30mm one rail or = 50mm both rails	Immediate 30mph ESR and correct within 36 hours (See Note 2)
Cyclic top (Category A) exceedence = 26mm one rail or = 47mm both rails	Immediate 30mph ESR and correct within 10 days (See Note 2)
Cyclic top (Category B) exceedence = 23mm one rail or = 43mm both rails	30mph ESR within 36 hours and correct within 20 days (See Note 2)
Cyclic top (Category C) exceedence = 20mm one rail or = 40mm both rails	Correct within 60 days
Cyclic top (Category D) exceedence = 18mm one rail or = 38mm both rails	Correct within 120 days
Level 2 alignment exceedence or twist worse than 1 in 125 at the same location as a Cyclic top fault within any of the above categories	Immediate 30mph ESR and correct within 36 hours Dependent on category (See Note 2)

<u>Notes:</u>

1. These actions assume no significant associated irregularities. If other irregularities exist the action may need to be more stringent. In particular, the timescales for twists between 1 in 91 and 1 in 200 should be shortened on canted curves below 200m radius.
2. 30mph ESR for cyclic top related exceedences must be applied to all freight vehicles including Freightliners.
3. Ensure that the reference is made to the latest issue of RT/CE/S/104 for changes in this table.

4. The TRV records and reports on other irregularities such as twist and alignment. These may have a combined effect on the priority of the exceedence. The TRV take account of these other defects automatically.

EXAMPLE OF THE IMMEDIATE ACTION REPORT



DEFINITIONS FROM THE IMMEDIATE ACTION REPORT

- **Start and End:** Define the location of the cyclic irregularities.
- **Distance from AWS:** Distance in metres to the preceding AWS magnet (a negative value indicates distance to the next AWS magnet).
- **Rail:** LT = Left RT = Right BO = Both
- **Peak:** Amplitude of the cumulative cycle value.
- **Action Category:** 36 hours, 10 days, 20 days, 60 days, 120 days.
- **Risk Type:** C = Cyclic C&A = Cyclic and Alignment
  C&T = Cyclic and Twist
  C&A&T Cyclic and Alignment and Twist
- **Linespeed and Line Reference:** Produced from data files onboard the TRV.
- **Cyclic Filter:** that exceeded the threshold
- **Action Categories:**

(Imm 30 ESR :36hrs)	Impose 30 ESR immediately. Repair within 36 hours
(Imm 30 ESR :10days)	Impose 30 ESR immediately. Repair within 10 days
(36h 30 ESR :20days)	Impose 30 ESR within 36 hours. Repair within 20 days.
(Correct :60days)	Correct within 60 days
(Correct :120days)	Correct within 120 days

6 Finding the L2 On Site

Once the track recording vehicle has identified a cyclic top L2, blue paint is automatically dropped in the 4ft of the track to mark the location. The blue paint is dropped 22metres to 25metres beyond the end of the cyclic top site.
When investigating the cause of the L2, you start at the blue paint or reported mileage and work back towards on-coming traffic. The cyclic paint drop should not be confused with other automatic paint drops, for example the UTU train drops blue paint near the rail foot.

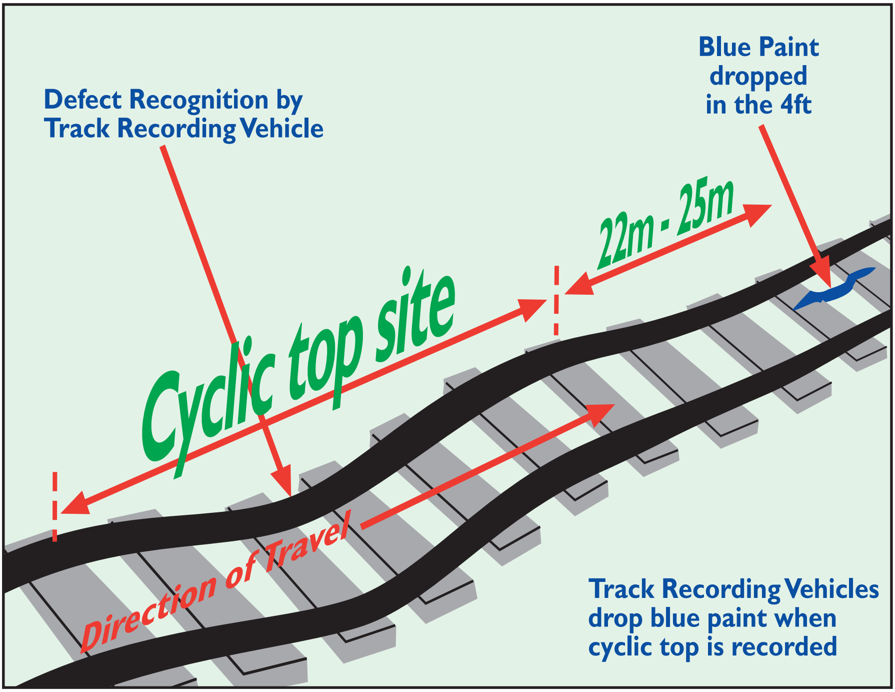


Diagram - to show where blue paint is dropped

The causes of the cyclic top may be located at a greater distance than 22 - 25 metres back from the blue paint. This is because the cyclic top would build up over several cycles.

The TRV data includes the locations of AWS magnets which can be used as an aid to locating cyclic top sites.

7 Detection by Other Methods

Visual inspection plays a vital role in the management of cyclic top. In many places track recording vehicles are programmed only once a year. Cyclic top faults can arise between TRV runs.

Inspection personnel should look out for a series of high points and dips in the running rail. These may be more easily seen when kneeling to sight along the rail head or from the opposite cess.

Dynamic movement (voiding of the track during the passage of a train) adds to the effect of cyclic top. It may be difficult to spot dynamic faults visually. The TRV will measure the dynamic effect. These voids can be measured by the use of void meters.

A clue to look out for is any evidence of voiding. This may be observed under a passing train or by the presence of lighter coloured ballast next to the voided sleeper.

Photograph - Lighter coloured ballast on the sleeper ends indicates voiding.

Particular attention should be paid to features which can trigger a bouncing motion in trains such as S&C, underbridges and wetbeds etc.

Inspection personnel should be familiar with locations where cyclic top problems have arisen previously.

8 Manual Treatment Methods

All treatment methods are aimed at lifting the dips to create a smooth top.
Some treatments require more resources than others and some are more durable than others.

Method	Costs	Durability
Handheld Stoneblowing	takes time and preparation	very good durability
Measured shovel packing	takes time and preparation	very good durability
"Kango" Packing or similar	quick and easy	moderate/poor durability
Joint (Weld) straightening and shimming etc. (where appropriate)	takes time and preparation	good durability when used with one of the above techniques

The choice of treatment method depends on how many faults are present, how urgent they are and how much resource can be assigned. **It is important to identify the basic fault (dipped weld etc) and correct that to achieve a permanent solution.**

In general it is better practice to use one of the most durable techniques as the sites will need to be revisited less often.

Sites which are "kango" packed may need to be revisited within days. This treatment may not be cost effective in the longer term.

It may be that only complete ballast and rail renewal will remove cyclic top completely. This would be ascertained by site inspection.

9 Mechanised Treatment Methods

Both tamping and stoneblowing are effective methods of eliminating cyclic top faults subject to site conditions.

Tamping is most effective when a lift of 40mm or more is used.

Ideally a variable overlift system (such as Design Overlift) should be employed. These systems are computer controlled and apply extra lifts in anticipation of the likely settlement under traffic (eg. ALC or ATTA).

For tamping to be helpful the ballast must be substantially clean. Contamination (with sand, clay, coal-dust etc) impairs the drainage and friction of the ballast and leads to rapid deterioration.

Tamping and Stoneblowing both require reasonably secure fastenings and sound sleepers to be effective.

10 Trend Monitoring

Permanent Way Engineers will observe the pattern of L2 faults from one run to the next. This is done in two ways:

1. Overall numbers of L2s on a particular route are monitored to ensure that the trend is either stable or improving.

2. Locations where defects recur on each run are monitored as a way of establishing the root cause and whether the previous treatments have been effective.

3. Numbers of L2s on a particular length are taken into account when renewals proposals are considered.

11 References

Further reading may be found in the following publications:

Railtrack
Track Maintenance Requirements
Railtrack Line Specification, RT/CE/S/104

Railtrack
Track Inspection Requirements
Railtrack Line Specification, RT/CE/S/103

Railtrack
Track Geometry Management of Recording and of Immediate and Urgent Actions
Railtrack Line Procedure, RT/CE/P/038

British Railway Track - Volume 4
Plain Line Maintenance

Permanent Way Institution
British Railway Track
6th Edition 1993