UIC CODE 737-2

3rd edition, December 2004

Translation

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Measures to be taken to improve track circuit shunting sensitivity

Mesures à prendre pour améliorer la sensibilité au shuntage des circuits de voie
Maßnahmen zur Verbesserung der Nebenschlussempfindlichkeit der Gleisstromkreise

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

Leaflet to be classified in Volumes:

V - Rolling Stock
VI - Traction
VII - Way and Works

Application:

With effect from 1 December 2004
All members of the International Union of Railways

Record of updates

1st edition, January 1964	First issue
2nd edition, January 1980	Revision of Leaflet
3rd edition, December 2004	Complete overhaul of leaflet and new lay-out

The person responsible for this leaflet is named in the UIC Code

Contents

Summary

The purpose of this leaflet is to make recommendations to improve track circuit shunting sensitivity.

A summary description of track circuit functioning is given in point 1. The problem of shunting, which constitutes one of the critical points for rolling stock and track circuit compatibility, is explained in point 2.

Point 3 sets out the conditions to be met as regards the voltage to be applied to tracks to ensure, generally speaking, the correct shunting of track circuits. These conditions, already established in the previous edition of this leaflet, cover most of the situations concerning low-traffic lines which are subject to heavy pollution.

Point 4 describes a set of solutions to track circuit shunting problems when the pollution is less severe.

Point 5 looks briefly at the changing constraints associated with developments in rolling stock, running quality and traffic.

These variations are taken into account in the recommendations made in point 6 to improve track circuit shunting sensitivity according to the operating conditions of the lines and the tasks performed by the track circuit.

Point 7 makes further recommendations regarding accreditation of new rolling stock, designed to prevent in-service problems relating to track circuit shunting.

Point 8 looks at the particular case of sanding, which can cause track circuit shunting to fail if no precautions have been taken.

1 - Introduction

Generally speaking, a track circuit is an installation in which the rails offering a sufficient degree of insulation between them are used as conductors for a part of the circuit in question, the track circuit being provided with a transmitter and a receiver. In most cases, the receiver commands a relay, known as track relay, which is normally energised when no trains are passing; the presence of a train causes a "shunt" in which the two rails are short-circuited, causing the track relay to become de-energised.

2 - Problems with rail shunting

The operation of the track circuit requires that the short-circuiting of the rails by the vehicle is correct - i.e. that the shunting is good enough - to be certain that the track relay does not fail to become de-energised (in the case of Track Vacancy Proving track circuits which are dealt with in this leaflet). Nevertheless certain circumstances may prevent this condition from being fulfilled to the degree required for safety purposes. The existence of an insulating film between the wheels and the rails can, for example, prevent the occurrence of a definite short-circuit. It is possible for such a film to be caused by the oxidation of the wheels (especially when the rolling stock has not been running for a long time) or by depositing an insulating layer of composite braking particles, by oxidation of the running surface of the rails (especially on low-traffic tracks), or by depositing a layer of insulating substance on the rail (particularly as a result of sanding, braking, or leaves).

The total shunting system seen from a track point of view includes not only the impedance of the axles but also the contact impedances between the wheels and the rails, which will vary according to the rail / wheel contact.

The quality of the rail / wheel contact depends on several factors, especially the effective load applied and the surface condition of the wheel and the rail.

In the extreme case, the presence of an insulating film between two metal surfaces will only allow the current to pass after mechanical breakdown or electric disruption of this film.

3 - Shunting conditions

Studies undertaken in the past, confirmed by trials in the laboratory and on site, have helped to understand some of the phenomena involved. By introducing the notion of disruptive voltage, which is the minimum voltage necessary to pierce the insulating film, these studies have shown what conditions must be fulfilled simultaneously to ensure a correct shunt on low-traffic tracks, and therefore strongly polluted tracks, with the passage of light and short vehicles. These conditions are the following:

1. apply to the clear track a voltage higher than the disruptive voltage. This voltage can be set to a value near 80 V to cover most of the cases;

2. supply, for shunting purposes, sufficient energy to keep an electric arc voltage, the mean value of which can be set to about 2 V in most of the cases;

3. use a receiver whose drop-out threshold is higher than the electric arc voltage.

The need for a permanent high voltage between the stretches of rail on clear track would imply the use of very high power, and would present risks to staff working on the equipment or the rails.

One possible solution to resolve shunting problems resulting from the pollution of the rails lies in the use of high voltage impulse track circuits. These voltage impulses, of a peak value around one hundred volts applied during a few milliseconds, are sufficient to pierce the insulating film and still ensure the safety of staff.

However there are other solutions which can be applied:

- in addition to high voltage impulse track circuits, to cater for certain extreme cases of pollution which could be met;

- in conditions where pollution is less severe, to ensure the shunting of the track circuit while using systems with permanent voltage emission of a lower level, compatible with the safety of the staff.

4 - Solutions to improve shunting

4.1 - Solutions relating to trackside equipment

4.1.1 - High voltage impulse track circuit

As indicated in point 3 - page 4, this solution must be applied to resolve problems of shunting on strongly polluted tracks.

4.1.2 - Track relay energising delay

In cases where the problems of shunting remain very sporadic, it is possible to solve this by delaying the energising of the track relay. The value of this delay will depend on operating conditions.

4.1.3 - Track circuit actuator

This solution consists in briefly shunting the track circuit with a short circuit established by means of a passage detector (electromechanical pedal, electronic pedal, etc.) placed at the beginning of the track circuit and activated by the locomotive itself. Depending on the direction of traffic, this short circuit causes de-energising of the track relay which is held in this state by the presence of the train on the emitting part of the track circuit, or holds the track relay de-energised when the train is present on the receiving part of the track circuit.

4.2 - Solutions relating to rolling stock

4.2.1 - Track circuit shunt assister

The principle of this device is to provide a wetting current to break down the film between the rails and the wheels. This is achieved by fitting the bogies of certain rolling stock with a coil made of a single loop. This coil is energised by a high frequency alternating current and induces a voltage allowing the insulating film in the frame constituted by two axles and a portion of track situated under these axles to be broken down and the electrical connection to be retained once established.

Frequency and amperage in the coil must be sufficient to enable the induced voltage on the rail / wheel contact to be in excess of the disruptive voltage of the insulating film. Induced voltage being a function independent of the insulation of the track, it is advisable to fix the value at about 3 V to satisfy most cases.

4.2.2 - Wheel tread surface cleaning

Cleaning the wheel tread can be a possible solution. However, trials conducted by one railway turned out to be ineffective. For the time being, the best means of cleaning the tread remains the use of a a shoe braking, very abrasive by its structure, but which represents a major obstacle to the reduction of running noise.

4.3 - Other solutions

4.3.1 - Railhead cleaning

This cleaning can be carried out either by brushing, or by projection of water under pressure. The brushing method is effective only with the use of metal brushes. The application of this solution, sometimes indispensable according to circumstances, is highly cast-intensive and involves a major organisational effort.

4.3.2 - Rustproof running surface

To improve the electric quality of the rail / wheel contact, the following can be considered:

- using a rail on which the part of the head in contact with the wheel is made;
- welding a rustproof steel strip on the rail head.

Both of these solutions are expensive and are normally only applied over short distances or where the cost can be justified.

4.3.3 - Rail contact shoe mounting on vehicles

The shunting can be assured by means of shoes mounted on locomotives and applied to each rail.

4.3.4 - Sequencing of track circuits

This solution mitigates against shunting failure by restricting the clearance of a track circuit until the next track circuit is occupied. A track circuit is declared clear if and only if the following two conditions are sequentially fulfilled:

- the following track circuit becomes occupied while the track circuit in question is still in an occupied state;
- the track circuit in question is released while the following track circuit is kept occupied.

5 - New constraints resulting from changes in rolling stock and traffic

Over the last ten years, the quality of track geometry has improved, passenger rolling stock has been modernised, with a higher running quality, more and more locomotives are braked using discs only, or in combination with tread brakes, and the use of composite brake blocks is becoming more widespread in an attempt to reduce the noise generated by rail traffic. All of these developments have an adverse effect on the quality of rail / wheel contact and particularly on its electrical properties, leading to shunting failures that can call into question the use of certain types of rolling stock.

These problems are encountered most frequently on all types of rolling stock (tractive and hauled) that are not braked using cast-iron blocks.

Likewise it is possible, that the use of composite brake shoes is raising shunting failure problems. This basis require for each composite break shoe a test and a permission for using.

6 - Recommendations to improve track circuit shunting

To ensure adequate shunting of track circuits, the particular operating and environmental conditions of each track circuit or section of line must be considered. The functions associated with each track circuit must also be considered to ensure that adequate safety levels are achieved.

It is possible to split the types of situations commonly encountered into 2 main categories as below.

6.1 - Recommendations for low-traffic lines and for station areas

On low-traffic lines and in station areas where the track circuit ensures safety functions other than the spacing of trains, such as route release or route cancellation, it is recommended to use high voltage impulse track circuits with delayed track relay energising in order to avoid brief shunting failures.

If these measures are not sufficient because of a high risk of strong rail head/wheel pollution it is advisable to apply the sequencing of track circuits method described in point 4.3.4 - page 6.

6.2 - Recommendations for normal-traffic lines outside station areas

On normal-traffic lines less sensitive to rail pollution, track circuits with frequency modulated permanent low level voltage emission can be used to carry out the function of train spacing. These track circuits, easier to implement and less sensitive to return current, apply quite weak voltage levels between the rails which sometimes do not exceed a few hundred millivolts.

Because of the degradation of the quality of the rail / wheel contact and for reasons given in point 5 - page 7 particularly concerning the quality of the shunting on normal-traffic lines, certain precautions must now be taken to implement this type of track circuit.

In order to obtain a good enough shunt, a voltage of at least 3 V should be obtained at all points on the track circuit between the rails.

However, such a voltage cannot be obtained with some types of track circuits. It is therefore necessary to ensure that all types of rolling stock not fitted with cast iron shoe brakes, undergo an accreditation procedure in accordance with point 7 - page 10.

Whatever the voltage between the stretches of rail, it is recommended to delay the energising of the track relay to avoid brief shunting failures.

Furthermore, on low-traffic routes such as single cross-over tracks, it is recommended that the track circuit sequencing method be applied.

6.3 - Additional recommendations

It is recommended:

- to clean the surface of the rail in critical periods when the guarantee of correct shunting is no longer assured. Such is the case especially in autumn when leaves fall, and after a prolonged period of absence of traffic;

- to equip maintenance vehicles with rail contact cleaning shoes or with a track circuit shunt assister considering their strong tendency to shunting failure, due to light their weight but also because they generally do not have the same tread surface as commercial-traffic, especially in curves;

- to use rustproof tread surfaces for lines or portions of line periodically out of use, for example: lines assigned exclusively to freight that are not used during the weekend;

- to equip the track circuits with an actuator to force or keep them in the occupied state.

Furthermore, whatever type of track circuit is used, it is advised to delay the track relay energising to compensate for any possible sporadic shunting failures.

7 - Rolling stock accreditation

To prevent shunting failures it is recommended to test the shunting capability of new rolling stock (new trains or new operators), for accreditation purposes. These test concerns all rolling stock not using cast-iron tread brakes. The testing of rolling stock must take place on tracks where shunting conditions are least favourable.

NB : where possible, the shunting capability should already be considered in the development phase.

These tests aim to ensure that the rolling stock to be accredited is compatible with track circuit shunting in qualitative terms. The criterion for compatibility is an acceptable limit value for the residual voltage. The residual voltage is the input voltage at the receiver when the track is occupied.

If the prescribed limit is exceed, it is advisable to modify the equipment to make it capable of shunting. The solution which is generally preferred is the addition of a track circuit shunt assister or the introduction of cast-iron tread brakes in extreme cases.

8 - Particular case: sanding

In certain particular cases, sanding is used to restore suitable conditions of adhesion both during the starting up of the train as well as during normal running.

If, as a result of sanding, fairly thick layers of sand remain on the surface of the rail head, there is no hope, even with very high voltages, of ensuring the necessary quality of contact between wheel and rail for shunting purposes.

A rail-brush has been developed and on certain railways, is a permanent feature of rail inspection cars. This piece of equipment does not constitute a universal solution, but can be worthwhile in certain cases.

The general problem of sanding in relation to the operation of track circuits can be solved by a reconciling adhesion and shunting requirements, as a result of joint measures taken by the Traction and Signalling Departments. Experience has shown that it is possible, on the one hand to limit the output of the sanding devices fitted to the locomotives to 0,3 l per minute per rail, without the adhesion requirements being adversely affected, provided that the speed rises quickly enough above 2,5 km/h, and, on the other hand, to ensure an even distribution of sand on the rail head by means of basic improvements to the sanding devices and by selecting a suitable ejection speed.

In the case of higher outputs or special circumstances, such as difficult starting places (double-heading, etc.), shunting failure can occur. It is still possible to ensure the correct operation of the track circuits in these particular cases, by using nozzles of restricted output, with high voltage impulse track circuits, combined with a delayed-action system or axle counters.

9 - Conclusion

All the recommendations shown above will improve track circuit shunting quality without however giving a definitive solution to the problem of shunting, which can only effectively be solved on a case-by-case basis.

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Warning

Printed by the International Union of Railways (UIC)
16, rue Jean Rey 75015 Paris - France, December 2004
Dépôt Légal December 2004

ISBN 2-7461-0784-8 (French version)
ISBN 2-7461-0785-6 (German version)
ISBN 2-7461-0786-4 (English version)