UIC CODE 715-2

2nd edition, August 2003

Translation

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Recommendations for management of rails

Recommandations pour la gestion des rails
Empfehlungen zur Bewirtschaftung der Schienen

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

Leaflet to be classified in Volume:

VII - Way and Works

Application:

With effect from 1 January 1990
All members of the International Union of Railways

Record of updates

1st edition, January 1990	First issue
2nd edition, August 2003	Retyped in FrameMaker Important: The points in this leaflet have been renumbered in the new edition. Point 1 becomes Summary. The first digit of each point has been decreased by one (i.e. 2 becomes 1, 3 becomes 2, and so on). Please take account of this when using cross-references from other leaflets.

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

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Summary

Rails account for a large proportion (from 30% - 50%) of the cost of new infrastructure. Management of this asset, its maintenance and renewal costs play a key role in the optimisation of track maintenance costs.

Rails are also the track components which are directly subject to stresses and undergo direct wear by rolling stock. They are subjected to loads and dynamic forces, which they transfer to the infrastructure through sleepers and ballast, possibly amplified by the effect of surface defects in the rails. Consequently, there are two aspects to optimisation of rail maintenance:

- optimisation of the useful life on a given site depending on the loads carried and speeds, also bearing in mind the effect on track maintenance of other components such as sleepers and ballast,

- optimisation of maintenance operations relating to surface condition in order to reduce corrective work on sleepers and on track geometry, and to minimise overall expenditure for maintenance of superstructure, infrastructure and bridges.

These different factors are clearly interdependent.

The service life of a rail depends especially on the loads sustained and the speeds operated on the different lines; consequently, it is highly desirable that the railways use the classification of *UIC Leaflet 714*, which is highly representative of actual traffic on the lines.

Furthermore, since rail maintenance policy depends on changes in the condition of materials and, in particular, changes in internal and surface defects, it is recommended that a system of monitoring statistics of rail breaks and damage be introduced in order to be able to assess the residual value of materials at any given time.

1 - Optimisation of the useful life of rails

1.1 - Choice of rail

Two aspects must be considered:

- the grade and structure of the steel used,
- the rail profile.

1.1.1 - Grade and structure of steel

Concerning the use of rails made of hard-grade and extra-hard grade steel, reference should be made to *UIC Leaflet 721* (see Bibliography - page 9).

It is recommended that rails of grade-900 steel manufactured by the oxygen process, if possible by continuous casting, be used.

1.1.2 - Rail profile

In the interest of simplification and uniformity, the UIC has recommended the use of standard profiles, which are intended to replace all national and regional profiles currently in use.

These are in particular:

- UIC 54,
- UIC 60.

For reasons mainly connected with fatigue strength, it is recommended that the UIC-60 profile be used on heavily-loaded lines and on high-speed lines.

1.2 - In-situ rail inspection

Ultrasonic rail inspection is a technical and economic necessity.

Manual inspection is the most costly method and should be confined to short stretches of track and specific locations.

In contrast, rail inspection using vehicles, preferably railway-owned, is the least costly method, if the number of kilometres to be inspected annually is sufficiently high.

If less than 5 000 km are inspected per annum, it is preferable to outsource the work to a private contractor or a neighbouring railway.

It is recommended to:

1. Inspect all mainline track on a Railway periodically.

   Periodic inspection:

   - to detect and eliminate rail defects likely to cause fracture at an early stage. As a result, the number of rail failures on a given line can be minimised, preventing especially the occurrence of multiple fractures. This objective can be achieved by optimisation of inspection frequency;
   - makes it possible to ensure track availability at the level required by the operator;
   - avoids the costs incurred due to safety measures restricting traffic when a rail break occurs.

2. Introduce inspection cycles based both on tonnage hauled on the track and statistical monitoring of internal defects recorded during previous inspection runs.

   These cycles are determined from a mean tonnage of 12 million tonnes between two inspections in accordance with the recommendations of *ORE Report D 88*[1] (see Bibliography - page 9).

3. Start inspections of new rails after at least 100 million tonnes of traffic, bearing in mind respective guarantee periods and conditions of use.

1.3 - Lubrication

Lubrication is designed to control lateral rail wear and is particularly essential on tight curves.

Out of all existing systems, it is recommended that locomotive-borne wheel-flange lubricators be used in the majority of cases.

1.4 - Grinding

Grinding eliminates rail and weld surface defects, short and medium-wave corrugation and restores the rail profile in-situ. Ultimately it produces savings in replacing rails, fastenings and sleepers, makes it possible to reduce levelling operations substantially as well as alleviating stresses imposed on the infrastructure and on bridges.

Grinding is recommended in urban areas to eliminate acoustic and vibratory annoyance associated with corrugation wear.

On the whole, it is accepted by all railways that, if action is required, it is preferable to remove rail corrugation completely and some railways go as far as applying finishing passes, once defects have been completely eliminated.

However, if this is not possible for various reasons other than technical ones, the depth of rail corrugation should be less than or equal to 0,01 mm, if this depth is seen not to have a significant effect on the quality of the track and its components.

Initial passes should remove between 0,02 and 0,05 mm of steel from the peaks, and final passes 0,01 mm.

1. ORE became ERRI (European Rail Research Institute) in January 1992.

1.5 - Rail repair

It is necessary to be aware of the various rail repair methods and their cost so that a policy of optimal rail utilisation can be established from the dual standpoint of:

- cost effectiveness,
- the quality of services required by the operators.

Assuming the value of a new basic rail with UIC 60 profile to be 1, the following average values apply for:

-	straightening dipped welds	:	0,1
-	rail renewal in-situ over long lengths (residual values 0,1 to 0,5)	:	2,4
-	rail replacement due to a defect	:	3,4
-	build-up welding of surface defect	:	0,2
-	repair by 48 mm wide-gap weld (to avoid insertion of closure rail)	:	0,4

2 - Rail renewal - Rail reconditioning

2.1 - Rail renewal

From a maintenance standpoint, there are two main reasons for renewing rails in long lengths:

- excessive wear,
- excessive maintenance costs.

2.1.1 - Rail wear

The railways must ensure that their criteria for withdrawal due to wear, especially lateral wear (side wear), are compatible with modern rolling stock.

2.1.2 - Withdrawal for economic reasons

It is often decided to renew all the track components simultaneously: rails, sleepers, ballast, fastenings. However, the emergence of materials with long service life, such as reinforced concrete sleepers, raises the question of the economics of this type of operation.

For example, it may be worthwhile only to renew the rails at midservice life of the concrete sleepers.

Which solution is chosen depends on an assessment of the actual condition of the components and after an economic study that takes into account the impact of the work site on traffic on the line, which in turn depends on the degree of mechanisation of the work site.

The following table gives an indication of comparative costs for the different possible solutions:

Type of work	**Complete renewal**	**New rail renewal**	**Serviceable rail renewal**	**Ballast renewal**	**Sleeper renewal**
Relative cost	1	0,3 - 0,5	0,3 - 0,4	0,3 - 0,7	0,4 - 0,65

Costs can be reduced by making sensible and justifiable re-use of components removed.

2.2 - Rail reconditioning

Rail reconditioning gives rails a second life and makes it possible for them to be re-used, either to replace individual defective rails in the track or to renew long lengths of rail on secondary lines.

Both options should be considered in order to optimise resource management.

Three methods can be used to recondition rails:

- by in-situ grinding,
- by in-situ planing,
- by reconditioning in workshops.

This last method is the most commonly used by the various railways and gives the best end results in that it generates a residual value for removed rails of between 25 and 50% of the value of new rails.

It involves the following main operations:

- prior classification (in situ or in workshop),
- ultrasonic inspection,
- press-straightening in the horizontal and vertical planes,
- removal of damaged ends or ends with holes, of internal defects detected during ultrasonic tests and of thermic or electric welds,
- reprofiling by planing, use of milling cutters and profiled grinding wheels,
- re-welding into basic-length rails or continuous welded rail,
- re-drilling of normal rails where required.

NB : A comparative table of the advantages and disadvantages of the various methods of rail reconditioning is appended.

2.3 - In-situ welding

This method enables continuous welded rails to be made from short length rails, whenever this is economically justified, and will therefore be of advantage in subsequent track maintenance work due to the elimination of joints.

From the experience of several railways, the cost involved amounts to between 10% and 20% of the cost of rail renewal.

Rails may be welded:

- electrically, or
- by thermit welding.

The method chosen should depend on an economic analysis which takes into account welding costs and subsequent savings.

Appendix A - Table comparing the three reconditioning methods

Reconditioning in workshops		Reconditioning in situ by planing		Reconditioning in situ by grinding	
1	Removal of rail required.	1	No removal of rail required.	1	No removal of rail required.
2	Method independent of operating conditions.	2	Method requires track closure.	2	Method requires track closure.
3	Method independent of rail laying conditions; work methods depend on the type of machine.	3	Track stability and level must be good. Joints must be well tamped. Before passage of the machine all obstacles impeding the progress of the machine must be removed. Longitudinal connections welded to the rail must be removed.	3	Track stability and level must be good. Joints must be well tamped. Before passage of the machine all obstacles impeding the progress of the machine must be removed.
4	Method practically independent of weather conditions.	4	In damp weather the coefficient of friction between rail and machine decreases so that the power of the machine during planing must be reduced. it is then advisable to limit planing to one rail at a time.	4	Method practically independent of weather conditions with rare exceptions (snow; risk of fire in dry seasons).
5	It is easy to cut out defective sections detected by ultrasonic inspection.	5	The elimination of defects detected by ultrasonic inspection is more costly.	5	The elimination of defects detected by ultrasonic inspection is more costly.
6	In most existing workshops long welded rails must be cut into basic rail lengths. In the new workshops it is possible to reprofile rails in great lengths (limit set by workshop size).	6	Planing of welded rails possible over great lengths.	6	Grinding of welded rails possible over long lengths.
7	Swarf removal not difficult.	7	Swarf drops on the track and must be collected by magnetic drum. The magnetic power of the drums must be limited so as to prevent disturbance of track circuits. The ballast must be properly levelled at sleeper level.	7	Swarf removal not difficult.
8	Wheel-slip traces can be corrected by: - cutting out defective rail sections; - milling with provision of transitions at both ends.	8	Prior grinding of wheel-slip traces + build-up welding to prevent damage to machine tools.	8	Wheel-slip traces can be corrected by build-up welding.

Reconditioning in workshops		Reconditioning in situ by planing		Reconditioning in situ by grinding	
9	Workshop capacity depends on the working speed of the reprofiling machine, i.e. 6 m/min for reprofiling the running edge and 4 m/min for reprofiling the whole rail head. Annual capacity based on 8-hour shift: Reprofiling of running edge: 500 km of rails. Overall reprofiling: 350 km of rails.	9	The average work progress in 8 hours work is 300 m finished track or about 60 km per year and machine. Progress in other applications: 1. reprofiling of running edge alone: 160 - 300 m/h, 2. reprofiling of whole rail head: 80 m/h, 3. reprofiling of whole rail head with simultaneous planing of 4 mm: 40 m/h. Annual capacity based on 8-hour shift: Reprofiling of running edge: 300 km of rails. Overall reprofiling: 150 km of rails.	9	Average work speed with 8 hours, use is 3 000 m finished track.

Bibliography

1. UIC leaflets

International Union of Railways
Leaflet 714: Classification of lines for the purpose of track maintenance, 3rd edition of 1.1.89

Leaflet 721: Recommendations for the use of hard quality and extra hard quality rails, 1st edition of 1.1.80

2. Minutes of meetings

International Union of Railways
"Way and Works" Committee (Question 7 G 23 - Optimisation of the economics of rails), June 1989

3. ERRI reports

ERRI
D88/RP1: Standard rail failure statistics, 1.4.65

D88/RP2: Study on the dynamics of rail defects, 1.10.65

D88/RP3: Guarantee of rails according to tonnage carried, 1.10.65

D88/RP4: Measurements in the track of the size of internal transverse rail failures - Studies of the SNCB concerning the dynamics of failures in the rail-ends, 1.10.66

D88/RP5: Standard rail failure statistics 1965 - Rail fractures causing derailments - Final Report, 1.4.68

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Printed by the International Union of Railways (UIC)
16, rue Jean Rey 75015 Paris - France, August 2003
Dépôt Légal August 2003

ISBN 2-7461-0560-8 (French version)
ISBN 2-7461-0561-6 (German version)
ISBN 2-7461-0562-4 (English version)