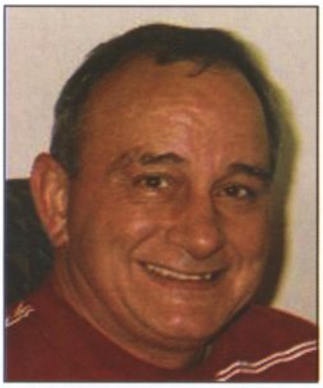
RAIL ENGINEERING INTERNATIONAL

Grinding Strategies

The Australian Way

Rail grinding strategies adopted in Australia



Dr. Stephen Marich
Principal Consultant
Speno Rail Maintenance
Australia Pty. Ltd.

For several decades, rail grinding has been applied in Australia on railway lines carrying traffic ranging from lower axle-load passenger to higher axle-load heavy-haul (Fig. 1).

The original application of rail grinding on the heavy-haul lines aimed at controlling the development of long-pitch corrugation (Fig. 2) and establishing rail profiles that would improve the wheel/rail interaction characteristics (so-called preferred profiles) and, hence, reduce the rate of rail (and wheel) wear.

The establishment of preferred rail (and wheel) profiles has also been a major objective on the more densely used passenger lines, on which trains are operated at higher speeds. However, the requirements for these lines have extended, in order to encompass:
- the control of rolling contact fatigue defects;
- the reduction of rail failure risks and rail surface irregularities, such as short-pitch corrugation (Fig. 2);
- the abatement of noise which, in more recent years, has become a major issue.

Rail grinding objectives

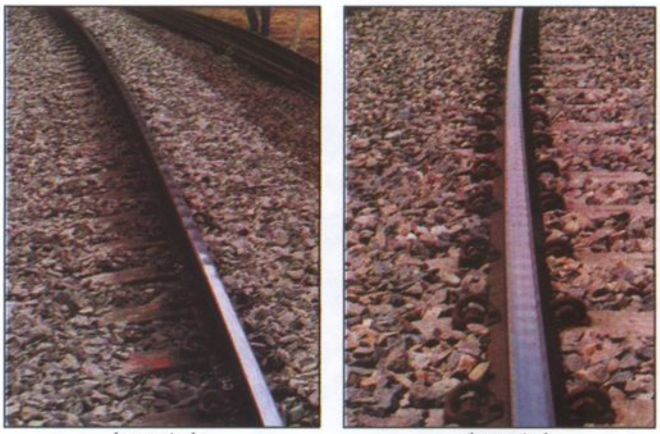
In general, rail grinding is applied in order to:
- improve, by implementing modified rail profiles, the wheel/rail interaction characteristics and, hence, reduce rail/wheel contact stresses and wear;
- correct/control rail corrugation, as well as dipped welds and joints, which, if left unattended, increase noise levels and the rate of deterioration of both track and vehicle components and, in some cases, lead to speed restrictions;
- correct/control rolling contact fatigue defects which, if left unattended, increase the risk of rail failures and, in some cases, reduce the efficiency of in-situ ultrasonic rail testing;
- correct/control other rail defects (e.g. wheel burns, squats, vertical and horizontal split heads) which, if left unattended, also increase the risk of rail failures;
- reduce the adverse influence of "rogue" wheels and bogies which, if left unattended, exacerbate the development of rail wear and defects;
- reduce noise and vibration, again by reducing vertical irregularities at welds and joints, and by controlling rail corrugation;
- moderate the adverse influence of higher axle loads, by providing improved wheel/rail contact conditions;
- reduce the sensitivity to lateral vehicle instability (hunting), again by providing improved wheel/rail contact conditions.

The grinding objectives have a major influence on the grinding strategies and procedures applied.

Rail grinding strategies

Rail grinding is a relatively expensive operation. Consequently, its application must be justified in terms of the potential economic benefits that can be achieved.

Fig. 1: Speno 48-stone rail grinding train working in the Sydney Metropolitan Region



long-pitch *short-pitch*

Fig. 2: Rail corrugation

In general, the application of rail grinding:
- increases the service life of the rail by at least 50-100%;
- considerably reduces the risk of rail failures;
- reduces the rate of deterioration of wheels, track components and track geometry;
- allows trains to be operated at higher speeds.

There are four types of rail grinding strategies that may be applied, namely:
- *corrective or defect grinding (Fig. 3),* which is primarily aimed at removing/reducing severe rail defects. This strategy usually entails relatively aggressive grinding procedures whereby a considerable amount of metal (between at least 0.5 mm and up to 4-6 mm) is removed, at relatively long intervals, generally determined by the severity of the defects.

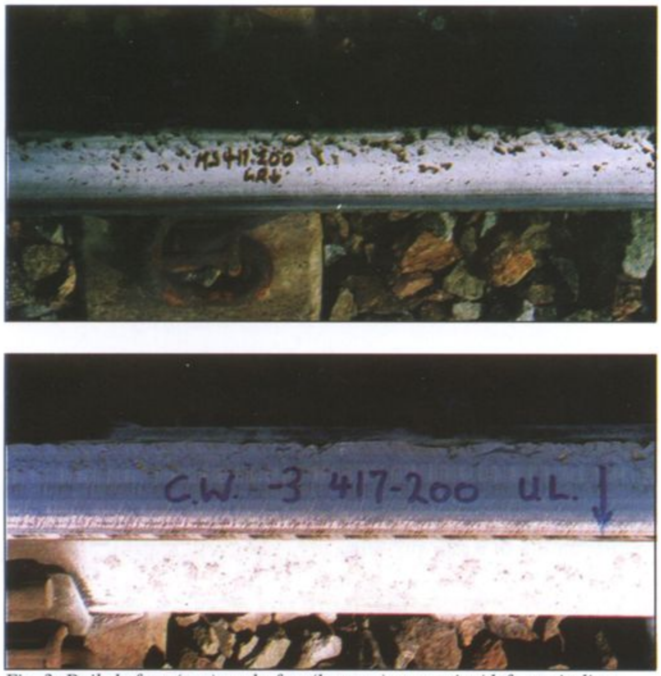


Fig. 3: Rails before (top) and after (bottom) corrective/defect grinding

Corrective or defect grinding is not very cost effective, primarily because of the large amount of metal that needs to be removed which, generally, requires the application of a large number of grinding passes and reduces the potential service life of the rail.

Nevertheless, corrective or defect grinding may be necessary in order to ensure that the rail will not fail in the short term, particularly if re-railing budgets are limited, and that the condition of the rail will not lead to speed restrictions;

— *transitional grinding (Fig. 4),* which entails a longer-term (3-6 years) strategy, aimed at changing from a corrective/defect grinding regime to a preventative or cyclic grinding regime. This may take a number of grinding cycles, particularly if the rails have not been maintained regularly. However, it is sometimes a preferred option, particularly in view of the cost effectiveness of the preventative or cyclic grinding strategy and the limited resources that may be available.

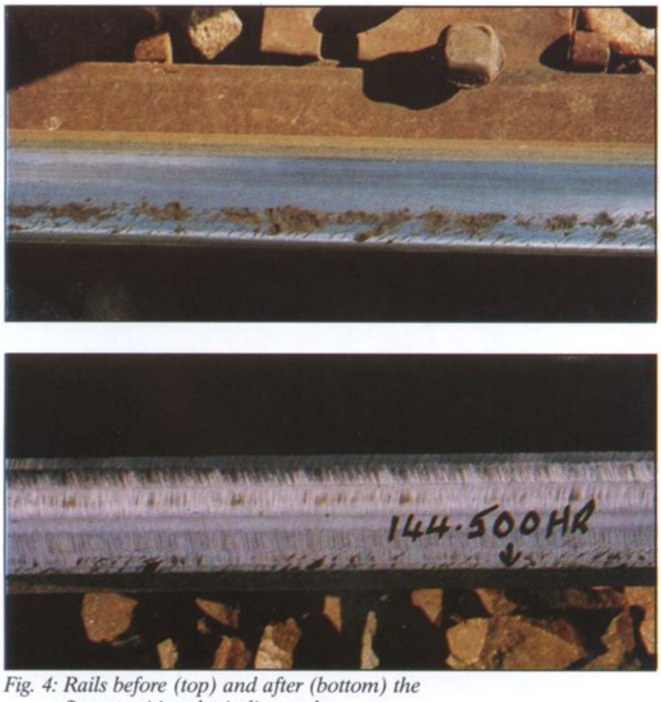


Fig. 4: Rails before (top) and after (bottom) the first transitional grinding cycle

A transitional grinding strategy may entail:

— a reduction in the severity of a specific type of defect, such as corrugation or rolling contact fatigue;

— the implementation of specific rail profiles, in order to reduce the rate of development of subsequent defects;

— the gradual implementation of preferred rail profiles.

In general, transitional grinding involves the removal of much less metal than in the case of corrective or defect grinding, for instance, between 0.3 mm and 1.0 mm, with the metal removal requirements becoming less with each grinding cycle.

Essential for a transitional grinding strategy are:

— well-defined short and long-term objectives;

— the ability to review and modify the specific strategy;

— the ability to allocate appropriate longer-term budgets;

— *preventative or cyclic grinding (Fig. 5):* once major defects have been removed by corrective/defect or transitional grinding, a preventative or cyclic grinding strategy can be implemented. This grinding strategy is primarily aimed at eliminating, or at least controlling, rail defects, as well as maintaining the surface condition and the preferred profiles of the rail. This usually entails the removal of relatively small amounts of metal (0.2-0.3 mm), with grinding being carried out at more frequent and controlled intervals.

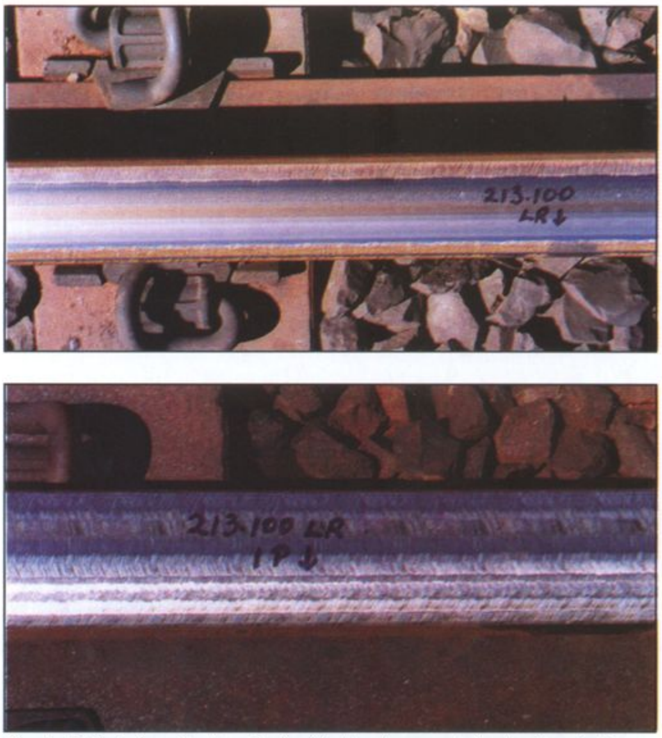


Fig. 5: Rails before (top) and after (bottom) preventative/cyclic grinding

A preventative or cyclic grinding strategy is very cost effective, particularly considering that it requires the removal of only small amounts of metal, which minimises the number of grinding passes required and maximises the service life of the rail.

The grinding cycles are system specific and depend on several factors that influence the rate of rail deterioration, such as:

— the tonnage borne;

— the main type of traffic carried and, hence, the nominal/dynamic loads applied;

— the type of rail used;

— the track characteristics, in particular track curvature, grade, rail superelevation and support conditions;

— the operating characteristics, in particular the running speed.

Track curvature (m)	Nominal period between grinding (MGT)					
	Track carrying coal traffic		Track carrying general freight traffic		Track carrying passenger traffic	
	Standard rail	Head-hardened rail	Standard rail	Head-hardened rail	Standard rail	Head-hardened rail
≤450	5	10	10	15	10	20
>450 to 650	10	20	10	25	15	25
>650 to 1000	10	20	15	25	15	30
>1000 to 4000	15	30	15	35	20	35
>4000	20	40	25	45	25	50

Preventative grinding cycles for different track curvatures, and types of traffic and rail

In the table above, a number of examples of preventative grinding cycles are given;

— *special grinding,* which entails the application of grinding in order to achieve specific objectives that usually lie outside the scope of the aforementioned three strategies. These objectives may involve:
  - — establishing special rail profiles, in order to achieve a relatively short-term increase in the service life of the rail by extending the permissible rail head wear limits. In this case, a very centralised wheel/rail contact zone, approx. 20-30 mm wide, is required. This would entail the removal of metal from both the field and gauge sides of the rail, in order to ensure that no wheel/rail contact occurs in these areas. The amount of metal that needs to be removed would, of course, depend on the wheel profile population of the passing trains;
  - — establishing special rail profiles, in order to reduce the rate of wheel hollowing. In this case, the rail profiles are changed along sections of track, in order to distribute the rail contact area across the wheel tread. In each section, the profiles implemented would still provide a wheel/rail contact zone width of 20-30 mm which, after several track kilometres, would change from the field side to the centre of the rail, and then to the gauge side;
  - — establishing a very smooth rail contact surface, in order to reduce the noise generated at the wheel/rail contact zone. Such grinding is becoming very popular on high-speed and suburban lines. It requires special grinding procedures, in order to produce a rail surface roughness of, in general, less than $12.5\ \mu m\ R_A$, but preferably less than $4\text{-}6\ \mu m\ R_A$, with a maximum rail grinding facet width of 4-6 mm. In this respect, it is of interest to note that the type of rail used is of significance, since in the lower hardness types of rail the grinding marks are rapidly removed by the wheels, while in the harder types of rail it takes much longer before they are removed.

Conclusions

As shown in this article, in Australia, there are four types of rail grinding strategies that may be adopted to meet the specific requirements of a railway line.

In order to apply the most cost-effective rail grinding strategy, the railway infrastructure owner must, first of all, be very clear about its rail grinding requirements, both in the short and the long term.

Then, the most appropriate initial grinding strategy and standards may be established, once again by the railway infrastructure owner, taking into account the available track possession times, the target profiles to be established, the associated tolerances and the grinding intervals. In this respect, a longer-term vision and supporting budgets are essential. These can be determined through interaction and discussions with the rail grinding supplier, who should then be able to determine the most cost-effective grinding procedure to be applied, which would include the defining of:
- — the number and type of grinding stones;
- — the grinding stone pressures;
- — the grinding stone patterns;
- — the grinding speed; and
- — the number of grinding passes;

that are to be applied. All of these will, of course, have a direct influence on the grinding time required to achieve the desired objectives.

Over time, and after a number of grinding cycles, it is very important to review the strategy applied and implement any modifications necessary, in order to further improve the economic benefits of rail grinding.

Reprinted from Rail Engineering International
Edition 2005 Number 1
Pages 4 - 6

SPENO INTERNATIONAL S.A.
26 Parc Château-Banquet, P.O. Box 16, CH-1211 Geneva 21, Switzerland
Tel.: +41 22 906 46 00 Fax: +41 22 906 46 01 E-mail: sc@speno.ch