Case study:  
Developing the optimal strategy for rail grinding

Problem description:

Determining the optimal grinding strategy for re-profiling the rail to reduce vibration, cracking and train running costs.

The study sought to determine the optimal rail grinding strategy for 300m, 600m and 900m radius curved track sections. These represent very different wear rates, compounded by differential train loading (passenger numbers and train frequencies) on different sections of the lines. The current regime involves hire of the rail grinding machine and re-profiling 300m and 600m radius sections after 30 Million Gross Tons (MGT) of traffic running over them.

Results and benefits:

The study revealed the optimal strategy for proactive rail grinding should be both track radius and train loading-dependent. For 300m radius track the optimal time to regrind is every 9 MGT of traffic, for 600m radius the optimum is 17 MGT and for 900m radius track the lower wear rates shift the optimum out to 25 MGT. This selective and optimised strategy makes £15-25k/section/year net savings in total costs, risks and performance impact.

So the study revealed the optimal approach for a programme of selective sectional grinding for each route. Combined with similar studies for other routes and track loading rates, the analysis also provided the business case for procuring an in-house grinding machine.

Rail grinding is used to restore the track head profile and remove corrugations. Such grinding extends the rail life, improves the ride quality of trains and reduces noise. It also eliminates small cracks that might otherwise propagate to become rail breaks. Furthermore, the improved rail surface reduces rolling resistance to train wheels, so there are energy saving benefits also from a well-maintained track profile.

However grinding is expensive and time-consuming, requiring extensive track access during ‘engineering hours’. And the grinding process itself can create risks; for example, swarf or lubricant residues might contribute to fire risks or faulty operation of points.

Furthermore, different curvatures of track result in different wear patterns and rates, and there are single/multi-pass options for the grinding method that have different effects; so developing and proving the most cost effective strategy for rail grinding is complex.

In this organisation, rail grinding had usually been done reactively, as a response to track inspections identifying defects, drivers reporting poor rides or railway neighbours complaining of the noise. On average this was being encountered after about 30 MGT of traffic. By the time the deterioration has become so evident, the grinding also requires multiple passes to remove a significant amount of the rail head to eradicate the defects.

A more proactive approach, removing the defects in earlier stages of development, can be achieved with fewer passes of the grinder. However, the grinding is currently a purchased service from a specialist contractor, with complex and costly logistics for mobilisation and usage. So more frequent grinding would be expensive and difficult to organise.
The study we performed

This case involved a small team comprising of maintenance and operations personnel, with some consultation to procurement and customer service departments. It needed just half a day to build the ‘base case’ scenario, including the potential risk patterns for the variety of failure modes, the various defect and failure costs and consequences, the grinding costs and how these increase with the amount of damage that needs to be removed.

This was achieved using the SALVO Process storyboard for evaluating and optimising preventive maintenance, and DST Maintenance Evaluator™ to model the risks and calculate the optimal life cycle strategy.

The study, including testing for sensitivity to the many uncertain assumptions, revealed that the business case for changing the grinding intervals was robust. In fact the analysis demonstrated that it was not even worthwhile to collect ‘better’ data, since the optimal timings were unaffected across the min/max extreme ranges of credible values for deterioration rates, failure risks, event consequences etc.

Finally, the SALVO Process decision-recording stage ensured the documentation of all assumptions, scenarios explored, uncertainties, sensitivity analysis and implications for alternative strategies, providing a clear audit trail for why this rail grinding strategy is optimal.

This study used DST Maintenance Evaluator™ software to perform the complex reliability, risk and financial ‘what if?’ calculations. This tool was developed as part of the international SALVO project (www.SALVOproject.org) to support the analysis and optimisation of preventive maintenance strategies. Like other modules in the DST Asset Strategy Evaluator™ suite, the tool provides:

- A structured logic, with clear ‘storyboard’ checklist to ensure all factors are considered.
- Disciplined process to capture and quantify the knowledge of cross-disciplined teams, including their uncertainty.
- State-of-the-art analytical algorithms to evaluate the life cycle cost, risk and performance of decision options.
- Sophisticated, extremely rapid sensitivity-analysis to identify which assumptions have what effect upon the decision.
- Rapid creation and evaluation/comparison of multiple scenarios, enabling the study team to compare alternatives and explore ‘what if’ ideas - instantly.

For further information about DST Maintenance Evaluator™ and the SALVO Process please contact:

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