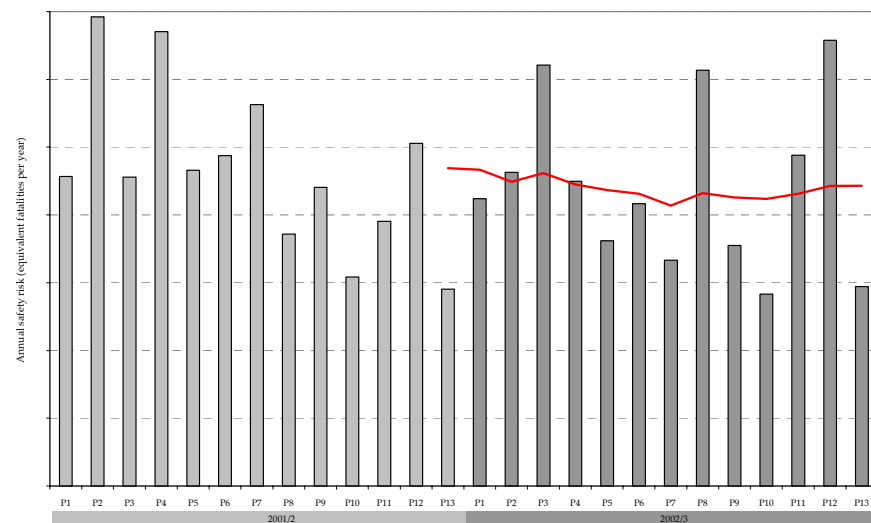


INTRODUCTION

Whilst the safety performance of a railway company can quite effectively be measured by its accident rates for relatively frequent, low consequence events, this approach cannot be used for rarer accidents which produce a greater loss such as collisions and derailments. In this case it is necessary to identify and monitor a range of incidents, known as precursor events, which might indicate that the likelihood of a major accident is changing. Such an approach is vital to understand whether initiatives are bringing benefits, or whether there are underlying and escalating problems with a company's safety management.

Sotera worked with Network Rail's Assurance & Safety Team to develop a Tool to proactively monitor Network Rail's major accident safety performance. This enables Network Rail to periodically plot its predicted safety risk and the contribution from each precursor in order to identify significant trends, and to monitor the effectiveness of safety improvement programmes. The results are presented to Network Rail's board which uses them to identify areas where safety performance could be improved and to proactively instigate improvement programmes.

SAMPLE OUTPUT



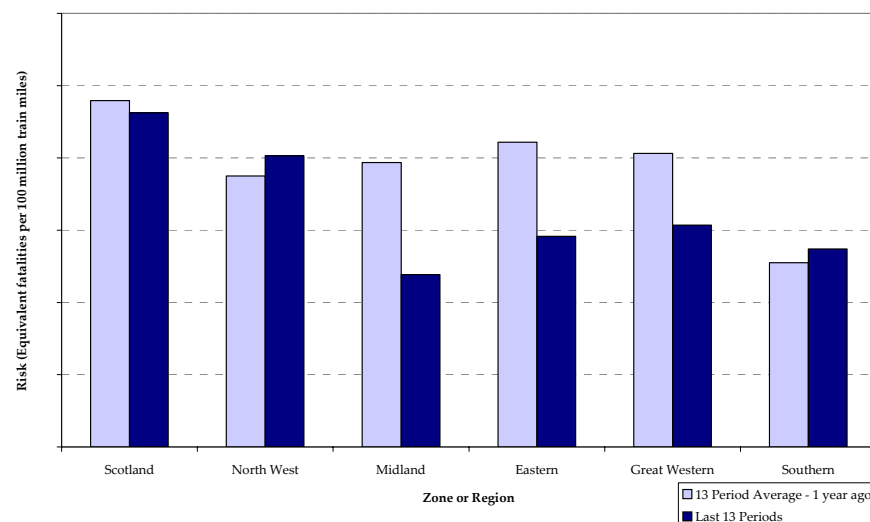
This chart shows the overall trend in safety performance, with each bar representing the predicted risk using the latest period's precursor statistics and the red line showing the annual moving average. Similar charts show the risk on a normalised basis (eg, per 100 million train miles), and the risk from individual types of accident: collision between trains, derailment, collision at level crossings, train fire, etc.

The table below shows the percentage risk contribution from each safety precursor, and gives an indication as to which precursors are improving and which are deteriorating.

DEVELOPING A SAFETY RISK PRECURSOR MONITORING TOOL FOR NETWORK RAIL

Reference	Description	Baseline Risk Contribution	Collision Between Trains	Buffer Collision	Derailment	Collision at Level Crossing	Train Fire
	Overall performance		▲	▼	▲	▼	▲
K100	Rolling stock failures	2.6%	▲		▲		▲
K001	Failed axle	0.1%			▲		
K014	Brake failure	2.0%	▲		▲		
K021	Catastrophic wheel failure	0.0%			▲		
K045	Train fire (equipment causes)	0.5%					▲
K200	Track failures	2.2%			▲		
K008	Broken rail	0.7%			▲		
K009	Buckled rail	0.2%			▲		
K012	Twisted rail	0.8%			▲		
K003	Switch and crossing failure	0.6%			▼		
K044	Gauge spread	0.0%			▼		

The following chart gives an indication of the risk breakdown by geographical area (on a normalised basis), with separate bars included to show how this has changed over the past year. This helps Network rail to focus on areas of the country which present a relatively high risk or whose risk contribution is increasing.



METHOD

The Tool is based on a detailed risk model which was developed as the first stage of this work. The risk model was based on the Safety Risk Model (SRM), developed by RSSB, but with alterations to add, or remove detail as appropriate in some areas so that the basic events better match monitorable precursor events. For example, the SRM might contain an event such as "Broken rail causes derailment", whereas the precursor risk model was developed so that it shows the number of broken rails and the proportion of broken rails which might result in a derailment.

Source data used to quantify the risk model included:

- Network Rail incident and failure databases
- RSSB incident databases
- The SRM

- Human error prediction techniques

Once the risk model was fully quantified, and the results validated against the SRM and historical data, a sensitivity analysis was carried out to derive the sensitivity of each accident to each basic event. The sensitivity analysis output is a key component of the Tool as it determines how changes in basic event frequencies affect the frequencies of accidents.

Another key element of the work was to establish what precursor events can effectively be monitored using the output from existing databases, and how these relate to basic events in the risk model. In some cases (such as broken rail), the precursors exactly match the basic events, but in others (such as signalling system wrong side failure) it was necessary to relate the basic events to slightly less specific precursors (signal failure hazard 20+ according to a ranking system used by Network Rail's signalling engineers).

MONITORING

A set of tools were developed to aid data extraction from the various incident and failure databases from which the precursor information is sourced. These convert the raw database output, carry out analysis as appropriate (eg, removing duplicate entries, separating serious events from less serious ones, deriving the area of the country, separating passenger and freight train incidents, etc) and provide the information in a form which can easily be imported into the Tool. This simplifies and standardises the data extraction process.

The Tool is implemented in Microsoft Excel, with calculation controlled by Visual Basic.

**For more information on safety monitoring tools
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