Safety Bulletin

An emerging issue: 'shattered rim' wheel defects

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Safety Bulletins identify areas of concern, share information and identify positive steps to enhance safety

In the past year, there have been two significant wheel failures on freight wagons. These failures appear to be due to 'shattered rim cracking' or 'rim shelling'. While not so common in Australia, shattered rims are one of the most significant causes of rail wheel failures in North America. These recent local incidents may be indicators of a larger safety issue within the Australian rail industry.

'Shattered rim' defects

As rail wheels age, the effects of fatigue can cause a defect to develop. The defect may be caused by external damage or a manufacturing defect. A number of factors can be behind the development of a defect and its propagation such as:

- wheel rim thickness
- wheel load
- wheel/rail contact band characteristics
- residual tensile stresses to inhibit crack growth in the rim
- the size and location of the material defects in the rim – usually about 20 millimetres below the tread surface (upon approaching minimum rim thickness).

The failure mechanism is usually the result of rolling contact fatigue initiating from a sub-surface tread defect or inclusion[1].

A defect is typically found in wheels that have been in service for a long time and are approaching their 'condemning diameter'.

Exacerbating wheel defects

Rolling stock operators are hauling ever greater loads and utilising wagons more extensively, particularly in the heavy haul sector.

These ever-increasing demands and changing rail operating conditions – albeit incremental – can contribute to more wheel defects on rolling stock.

Factors that can exacerbate defects include:

- increased axle loads
- higher speeds
- greater utilisation of rolling stock
- extended maintenance and inspection periods
- introduction of improved technologies.

[1] An inclusion is an impurity in the steel included in the manufacturing process.

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Technological developments such as electronically controlled pneumatic braking (which can increase maintenance intervention periods), steering bogies (which can reduce wheel to rail contact area), micro-alloyed wheels (which are longer lasting wheels) and solid drawbar assemblies (which can increase maintenance intervention periods) can all contribute to these defects.

Some of these developments can also result in a reduced frequency for re-turning wheels to maintain a compliant profile and the need to regularly remove 'fatigued materials' from the tread surface.

Recent cases of 'shattered rim'

The two recent wheel failures involved the same heavy haul wagon type – a 120-tonne coal wagon with steering bogie.

Case 1:

On 31 May 2013, a wheel impact load detector (WILD) system identified a possible defect on a wagon of a loaded (in-service) coal train.

The train crew was alerted and stopped the train to inspect the wheel. A partial failure of the wheel tread was identified.

Further inspection revealed that the failure appeared to have originated from an inclusion below the surface.

Case 2:

On 25 August 2013, maintenance staff detected a significant wheel failure under an out-of-service and empty coal wagon. This was detected while staff were rectifying a defect on another wheel.

Indications were that the wheel failure was a shattered rim. Metallurgical testing was undertaken on behalf of the rail operator and in the presence of an external representative nominated by the ONRSR.

Freight train derailments

The rate of freight train derailments in Australia was high when compared with mainline railways in the United Kingdom as part of the *Annual Safety Report 2012 to 2013*. Across South Australia, New South Wales, Tasmania and the Northern Territory between 2010/11 and 2012/13 there were 1.27 freight train derailments per million train kilometres compared with 0.14 per million train kilometres in the UK[2].

The ONRSR is concerned with the seemingly high number of freight train derailments and through its regulatory work plan will be looking at whether rail transport operators are appropriately managing this risk.

With shattered rims identified as a potential precursor that could result in derailment, the ONRSR expects reasonable measures to be taken to reduce the direct safety risk of derailment and the consequences of fouling adjacent lines due to a shattered rim.

A broken wheel was a factor in a recent and significant train derailment in Canada which highlights the potential consequences of a shattered rim. About 150 people were evacuated from their homes when 19 cars – nine of which

[2] Source: ONRSR, *Annual Safety Report 2012 to 2013*, ONRSR, Adelaide, December 2013

were carrying crude oil and liquefied petroleum gas – and a locomotive derailed and caught fire. No one was injured, however, there was significant track damage.

Incident – Derailment of Canadian National freight train at Plaster Rock, New Brunswick

Date – 7 January 2014

Investigating agency – Transportation Safety Board (TSB) of Canada

A TSB investigation progress update states that the train crew from the 122-car train had received an alarm from a 'wayside inspection system'. The train slowed down but before it stopped the rail cars began derailing. A broken wheel on the 13th car was identified.

The progress update also states: "The broken wheel failed due to fatigue. A crack initiated at a porosity and travelled under the running surface of the wheel which caused a shattered rim."

Risk registers

With defects usually about 20 millimetres below the tread surface, visual inspections of wheel rims are not enough.

Some questions to consider are:

- Would your current maintenance and wagon inspections be effective in identifying these defects?
- Do you specifically look for defects that could lead to a shattered rim?
- Have your demands on your wagons changed in a way that might heighten the risk of a shattered rim? For example, greater usage, heavier axle loads, reducing frequency of wheel re-profiling?
- Do you enhance your wagon maintenance for those wheelsets which are approaching condemning diameter?

Some possible controls may include:

- non-destructive testing during the manufacturing phase, bearing in mind the current limitations these inspection methods have in detecting defects well below the tread surface
- trackside monitoring and detection devices. These devices, for example WILDs, which can identify flat spots or other wheel tread irregularities, may not be suitable in all operating contexts.

Australian rail operators, depending on their operating environments, may need to review and revise current risk registers in order to manage to a 'so far as is reasonably practicable' level the hazards associated with a wheel failure due to a shattered rim.

For further information contact the ONRSR on (08) 8406 1500 or operations@onrsr.com.au.