Australian Government
Australian Transport Safety Bureau

# Derailment of SCT Logistics freight train 2PM9

near Koolyanobbing, Western Australia on 27 October 2020

**ATSB Transport Safety Report**
Rail Occurrence Investigation (Short)
RO-2020-018
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**Addendum**

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# Safety summary

## What happened

On 27 October 2020, train 2PM9, operated by SCT Logistics, departed Perth, Western Australia for Melbourne, Victoria. Near Koolyanobbing, Western Australia, a wheel fractured and disintegrated on the 58th vehicle on the consist, wagon ARFY2253s, resulting in a derailment. The derailed wagon and those trailing separated from the train, but no other wagons derailed. There were no injuries.

## What the ATSB found

Detailed material examination identified that a transverse fatigue crack initiated in the vicinity of a spalling defect in the wheel tread prior to the incident journey. The crack propagated into the rim and flange of the wheel. On the day of the incident, a skidding event at the fatigue crack likely induced rapid brittle cracking in the wheel. This resulted in its fragmentation and subsequent derailment.

In the 12 months prior to the occurrence, ARFY2253s experienced various issues with brakes and overheated wheels, although it is not clear whether any of these issues contributed to the derailment.

The failed wheel was recently reprofiled, but the maintenance provider's work instruction did not require non-destructive examination beyond a visual inspection to identify any remaining defects.

## What has been done as a result

The operator and maintenance provider have developed a process for monitoring wagons that experience repeated issues, such as with braking. Inspection procedures for thermal cracks and overheated wheels have been refined, and non-destructive testing is being investigated for use in certain wheel inspections.

## Safety message

Skids and hotspots may be repairable on wheels in otherwise good condition, however, they can induce wheel failure if cracks are present, as in this case. Diligent inspections and non-destructive testing can be useful for detecting and monitoring wheel cracks, which is particularly important as these cracks approach the wheel wear condemning limit.

# The investigation

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope investigation was conducted in order to produce a short investigation report, and allow for greater industry awareness of findings that affect safety and potential learning opportunities.

## The occurrence

On the morning of 27 October 2020, train 2PM9, operated by SCT Logistics, departed Perth, Western Australia for Melbourne, Victoria. The train was 1,658 metres long, and consisted of 2 locomotives hauling 68 wagons, with a trailing load of 3,690 tonnes. At 0816 Western Standard Time,[1] the train was approaching a restricted speed zone and the driver applied the automatic brakes. At 0841, while approaching Koolyanobbing, the trailing left wheel on wagon ARFY2253s fragmented, and two large pieces of the wheel were ejected. ARFY2253s was the 58th wagon in the consist. The wagon's braking system used a WF2 triple valve, and the wagon was unloaded with a tare mass of 30.84 tonnes. The train continued without incident, and the driver applied the dynamic brake in preparation for an upcoming turn. At 0843, approximately 3.5 km beyond the initial wheel fragmentation, a third piece of the wheel was ejected, and the wagon derailed (Figure 1).

**Figure 1: The derailed wheelset on ARFY2253s**

Source: SCT Logistics

At this point, the crew observed dust towards the rear of the train, and applied both the dynamic and automatic brakes until the train came to rest at 0846. Upon inspection it was found that ARFY2253s and the trailing ten wagons had separated from the train. No other wagons derailed. Track damage was observed over a distance of 2.4 km between the wagon derailment and its stopping point.

## Context

### *Wheel fracture examination*

The derailed wheelset and the ejected wheel pieces were recovered from the site by Gemco Rail (Gemco), SCT Logistics' primary maintenance provider. Gemco contracted independent

[1] Western Standard Time (WST): Coordinated Universal Time (UTC) + 8 hours.

consultants Bureau Veritas to conduct a metallurgical examination of the derailed wheelset in order to determine that nature of the failure, and any aspects that may have contributed.

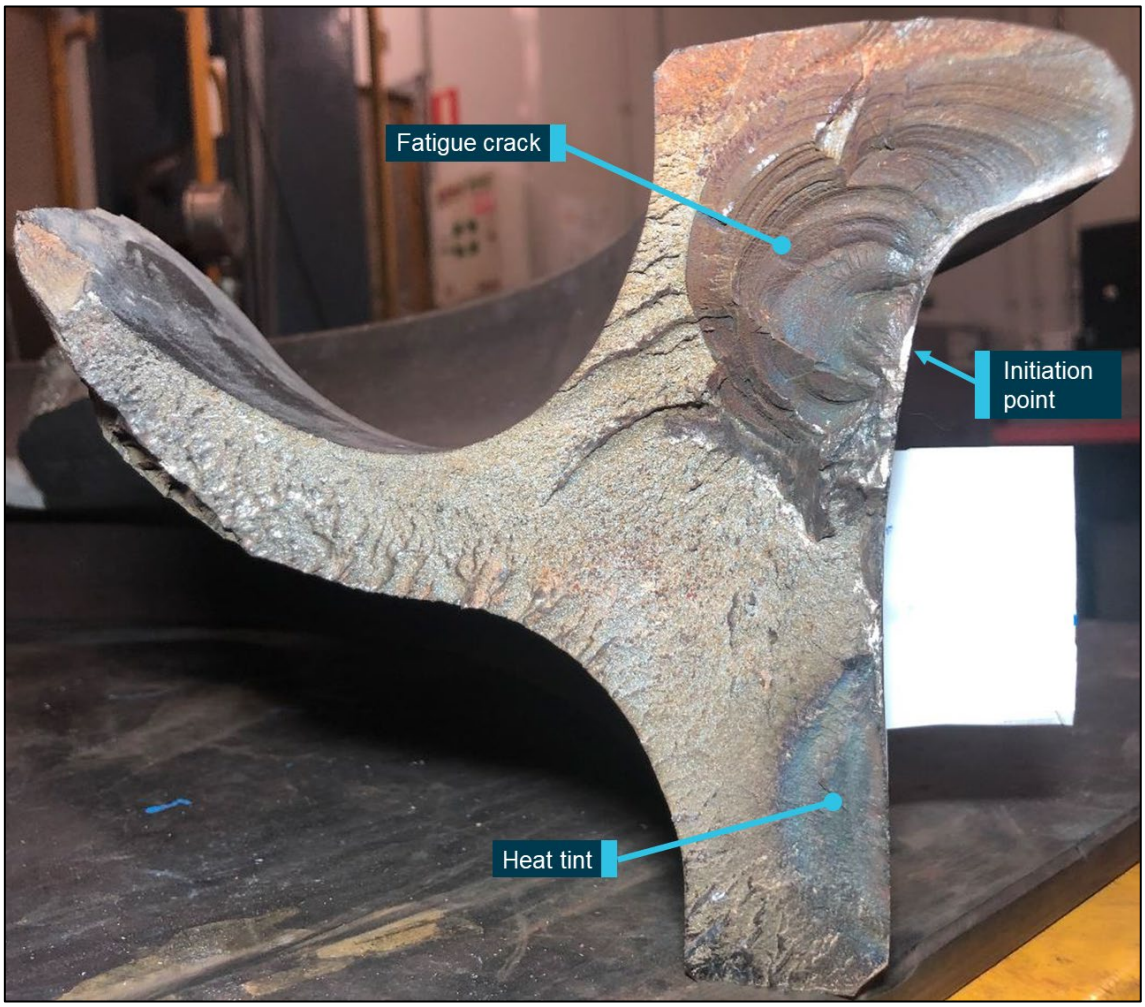
Figure 2 shows the recovered fragments of the rim, labelled 1-3, and the three fractures that separated the different pieces, labelled A-C. Fragments 1 and 2 were the first to be ejected from the wheel during the incident journey, with fragment 3 ejected after the brakes were applied.

**Figure 2: Reassembled wheel fragments (left) and wheel hub (right)**


Source: Bureau Veritas, annotated by ATSB

The Bureau Veritas analysis identified a fatigue crack at the surface of the wheel, within fracture A (Figure 3). The fatigue crack presented as a darkened region on the fracture surface, with distinct beachmarks indicating crack propagation into the wheel rim and flange from the initiation point on the surface. The fatigue appeared to have propagated through approximately 40 per cent of the wheel rim's cross section. Bureau Veritas made no comment on the age of the fatigue crack.

**Figure 3: Fracture A on fragment 1 of the wheel**




Source: Bureau Veritas, modified by ATSB

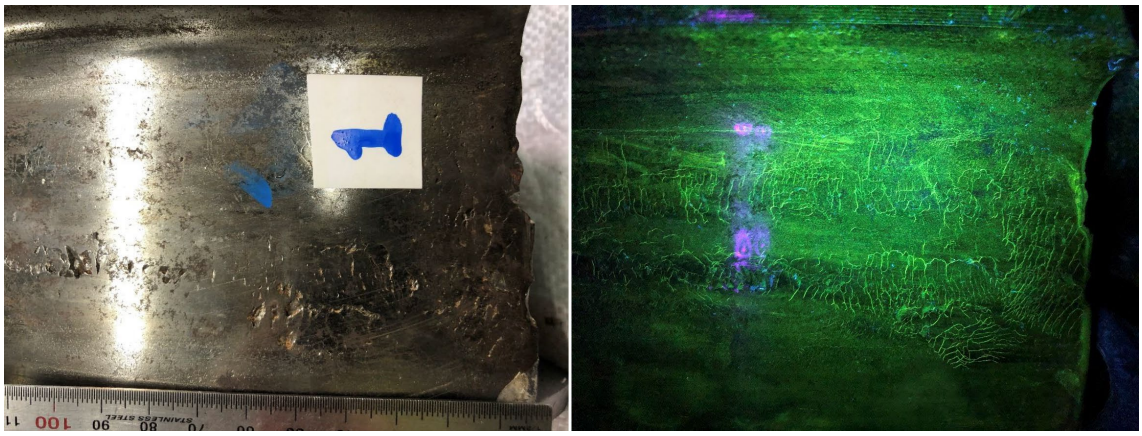
The Bureau Veritas report concluded that the wheel failure originated from this fatigue crack. At some point, the fracture mode changed from fatigue to brittle cracking, indicated by the colour and surface texture change between the fatigue crack and the rest of the wheel cross section. The brittle cracking progressed towards the wheel hub. It then propagated circumferentially around the wheel, branching out to the wheel surface, resulting in the ejection of the three wheel fragments.

A heat tint mark was also present on the fracture surface. Heat tinting such as this is indicative of oxidation, a result of freshly exposed steel that is subjected to heat and oxygen. The Bureau Veritas examination also identified skid marks on the wheel surface near fracture A.

In addition to skid marks, the wheel surface near the fatigue crack had multiple spalls and gouges (see Figure 4). Fluorescent magnetic particle inspection also revealed multiple transverse and longitudinal cracks around these surface defects. Several cracks were found that extended below the wear condemning limit[2] of the wheel rim.

[2] The wear condemning limit marks the maximum allowable wear in a wheel before it must be replaced.

**Figure 4: Wheel surface adjacent to fracture A**



*The left image shows the various spalling and gouging observed on the wheel surface. The right image shows numerous surface cracks under fluorescent magnetic particle inspection.*
Source: Bureau Veritas, modified by ATSB

Hardness testing was performed on several sections of the wheel. The heat-affected regions showed some surface hardening outside of the specification for Class B[3] forged steel wheels such as these, although this would be expected in the event of a skid. Some areas within the wheels were slightly under the minimum specified hardness, but the report did not find this to have contributed in any way to the wheel failure, and since these regions were below the wear condemning limit, this was permitted by the wheel specification.

## *Wheel maintenance and inspections*

In the 12 months before the derailment, wagon ARFY2253s experienced a variety of issues requiring maintenance, including brake defects and uneven wheel wear. Wheelsets were replaced twice as a result. The most recent wheelset change was 4 months before the derailment, when the incident wheelset 92709 was installed on the wagon due to overheated wheels.

Prior to installation on the wagon, wheelset 92709 was re-profiled. The rim thickness was reduced to 34 mm from 44 mm to remove hollowing and spalls that were observed on the wheel tread. Gemco's wheel reprofiling work instruction was based on the Association of American Railroads Specifications Manual. Regarding the removal of defects such as spalling and shelling, Gemco required a visual examination following wheel reprofiling, but neither document required any non-destructive testing, such as fluorescent magnetic particle inspection.

The Australian Standard for wheel maintenance current at the time of writing (AS 7514:2018) referred to the Rail Industry Safety and Standards Board's *Code of Practice – Wheel Defects*. Regarding the reprofiling of spalled wheels, it stated:

> Rectify spalling or shelling by machining to a sufficient depth (3 mm minimum) to completely eliminate it, and carry out crack detection after machining.

Crack detection was not explicitly defined in the document, but it included visual inspection, magnetic particle inspection and dye penetrant inspection as examples.

Following the installation of wheelset 92709, dragging brakes were reported on the wagon on two occasions. The wheels were inspected on the second occasion and no defects were noted.

## *SCT Logistics investigation*

As a result of the derailment, SCT Logistics contracted an independent investigator to determine any potential factors that led to the derailment. In the resulting investigation report it was noted that a wheel flat was present at fracture A, and the flat's worn edges indicated that it may have

[3] Class B is a specification defined by the Association of American Railroads. Wheel hardness and ductility varies with class. Class B wheels are softer than Class C wheels, with a higher fracture toughness.

occurred some time ago, on a previous journey. The report examined readings from wayside detectors on the day of the derailment and from previous journeys, but found no evidence of a wheel flat being detected.

The independent investigator's report found that the fatigue crack at fracture A resulted in the wagon's derailment. It determined that the crack originated from a spall on the wheel's surface. The report also stated that the brittle fracture of the wheel was likely initiated by the braking event prior to entering the restricted speed zone during the incident journey.

The report stated that wagon and bogie maintenance were '…considered to be a major contributory factor in this derailment event.' It highlighted previous brake-related maintenance, and suggested that it was indicative of unresolved braking issues. The report attributed the observed wheel defects, including flat-spotting, skids, spalls, and the fatigue crack to these braking issues.

The investigation also looked at train handling and crew performance during the incident journey, and found all actions to be in accordance with accepted procedures and good driving practice.

### *Related occurrences*

#### *ATSB Investigation (RO-2019-001)*

On 6 January 2019, SCT Logistics freight train 6MP9 derailed near Cook, South Australia after a wheel fragmented on one of the wagons. Inspection of the failed wheel found that thermal damage resulted in the initiation of a fatigue crack that propagated into the wheel, ultimately leading to its fragmentation.

At the last inspection—carried out by Gemco—the flange crack was likely observable but was either not detected, or was deemed acceptable under the provided work instruction. This work instruction was less conservative than the Australian Standard, but it was not possible to establish whether compliance with the standard would have prevented the occurrence.

Following the derailment, SCT Logistics worked with Gemco to improve inspection processes for wheels with brake issues. SCT Logistics also instructed Gemco to only install Class B wheelsets in future, after the wheel manufacturer stated that Class C wheelsets—such as the one that failed—were more prone to thermal issues.

## Safety analysis

Visual examination of the wheel fracture surfaces found that a fatigue crack initiated at the surface of the wheel tread, in the vicinity of a spalling defect. The fatigue crack propagated into the wheel tread and the flange, consuming approximately 40 per cent of the wheel rim cross section prior to failure. The dark colour of the fatigue region was indicative of corrosion in a low-oxygen environment—before the crack opened at wheel failure. This suggested that the fatigue crack had existed for some time, and was certainly present before the incident journey. However, it was not possible to determine whether or not this crack existed in some form the last time the wheel was reprofiled or examined by maintenance personnel. Given that the fatigue crack might have been present when the wheel was last reprofiled (removing visible spalls), then the nearby spalling defect may have been unrelated.

The skid marks, flat spot and heat-affected regions at fracture A (Figure 2) all indicated that a skidding event occurred at this location, probably when the automatic brakes were applied before the restricted speed zone. This skidding event would have generated considerable heat, and the heat tint observed on the fracture surface is evidence that the brittle cracking occurred at the same time as this heat generation. It is therefore likely that the skidding event induced the brittle cracking at fracture A. Once the brittle cracking commenced, it quickly propagated through the wheel, resulting in the failure and subsequent derailment.

In SCT Logistics' independent report, it was suggested that the flat spotting might have occurred on a previous journey, gone undetected by wayside monitoring, and even contributed to the fatigue crack. However, if this was the case, a second skidding event would had to have occurred

at the same location during the incident run in order to generate the heat tint seen on the fracture surface.

Wagon ARFY2253s had a number of issues with brakes and overheated wheels in the 12 months leading up to the derailment. It is not clear whether these were resolved through maintenance actions, so it is possible that they contributed to the development of the fatigue crack as well as the skid during the incident journey. However, without additional evidence, it was not possible to determine the degree of contribution, if any.

## Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition 'other findings' may be included to provide important information about topics other than safety factors.

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

From the evidence available, the following findings are made with respect to the derailment of SCT Logistics freight train 2PM9, near Koolyanobbing, Western Australia on 27 October 2020.

### *Contributing factor*

- Prior to the incident journey, a transverse fatigue crack initiated in the vicinity of a spalling defect on the tread surface, and propagated into the wheel rim and flange.
- During the incident journey, a skidding event likely induced rapid crack growth from a pre-existing fatigue crack. This resulted in fragmentation of the trailing left wheel and subsequent wagon derailment.

### *Other factor that increased risk*

- In the 12 months prior to the occurrence, wagon ARFY2253s experienced various issues with brakes and overheated wheels, which can increase the risk of wheel failure.

## Safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

### *The operator and maintenance provider*

As a result of this occurrence, SCT Logistics and Gemco have developed a process for monitoring wagons that experience repeated issues, such as with braking. Gemco staff are completing refresher courses on the field inspection of wheels, and inspection procedures for thermal cracks and overheated wheels have been refined. Non-destructive crack detection is being investigated for use on inspections following overheated or skidded wheels.

## Sources and submissions

### *Sources of information*

The sources of information during the investigation included the:

- SCT Logistics
- Gemco Rail
- Bureau Veritas

- the Rail Industry Safety and Standards Board.

## *Submissions*

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the following directly involved parties:

- the Office of the National Rail Safety Regulator
- SCT Logistics
- Gemco Rail
- Bureau Veritas
- the wheel manufacturer.

Submissions were received from:

- the Office of the National Rail Safety Regulator
- SCT Logistics
- Gemco Rail
- Bureau Veritas
- the wheel manufacturer.

The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

# General details

## Occurrence details

| | | |
|---|---|---|
| Date and time: | 27 October 2020 – 0843 WST | |
| Occurrence category: | Serious incident | |
| Primary occurrence type: | Derailment | |
| Location: | Near Koolyanobbing, Western Australia | |
| | Latitude: 30º 50.521' S | Longitude: 119º 29.619' E |

## Train details

| | | |
|---|---|---|
| Track operator: | ARC | |
| Train operator: | Twentieth Super Pace Nominees Pty. Ltd. | |
| Train number: | 2PM9 | |
| Type of operation: | Bulk Freight | |
| Departure: | Perth | |
| Destination: | Melbourne | |
| Persons on board: | Crew – 4 | Passengers – Nil |
| Injuries: | Crew – Nil | Passengers – N/A |
| Damage: | Substantial | |