Australian Government
Australian Transport Safety Bureau

Derailment of SCT Logistics freight train 6MP9

near Cook, South Australia on 6 January 2019

ATSB Transport Safety Report
Rail Occurrence Investigation
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Addendum

Page	Change	Date

Safety summary

What happened

On 6 January 2019, SCT Logistics freight train 6MP9 derailed near Cook, South Australia, while travelling from Melbourne, Victoria to Perth, Western Australia. The number 36 vehicle on the consist, wagon ARFY 2198T, experienced a ruptured wheel, resulting in the derailment. No other wagons derailed in the occurrence and there were no injuries.

What the ATSB found

Thermal damage to the wheel resulted in the initiation of a fatigue crack in the flange which propagated into the plate. Cracking then continued propagating around the plate, branching out to the rim, resulting in the wheel failure and ultimate derailment of the wagon.

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

What's been done as a result

SCT Logistics has worked with their primary maintenance provider to develop an improved inspection process for wheels exhibiting issues with brakes (e.g. sticking brakes), as these issues can lead to heat-related fatigue cracks.

SCT Logistics also plans to phase out the type of wheelsets that ruptured in the occurrence, in favour of a type that is less prone to the development of fatigue cracks due to thermal issues.

Safety message

Vigilant field inspections are a useful tool for the detection and monitoring of fatigue cracks. However, they are not infallible, and should be utilised with an understanding of their limitations.

Further, selection of the appropriate materials can assist in reducing the occurrence of fatigue cracks and subsequent wheel failures.

The occurrence

What happened

On the evening of 4 January 2019, SCT Logistics freight train 6MP9 departed Melbourne, Victoria for Perth, Western Australia. At 0635 Central Daylight-saving Time[1] on 6 January 2019, the train derailed at 869.700 km in the Fisher-Thomiar section, near Cook, South Australia. The derailment involved the number 36 vehicle on the consist, wagon ARFY 2198T. One of the wheelsets on the 'B' end of the wagon experienced a ruptured wheel, resulting in the derailment (Figure 1). No other wagons derailed as a result of the rupture, however gouges in the rail were found, as well as some broken sleepers and missing clips.

Prior to the derailment, the train passed over two wayside detectors designed to alert the operator of abnormalities that might indicate wheel or bearing damage. There was no record of any alerts received from these detectors.

Figure 1: The ruptured and derailed wheel in situ

Source: SCT Logistics

Context

Wheelset examination

The majority of the failed wheelset pieces were recovered from the accident site. These pieces and the adjacent wheelset were sent to SCT Logistics' primary maintenance provider, Gemco Rail (Gemco), for a preliminary inspection. This examination was attended by the ATSB, the Office of the National Rail Safety Regulator, and independent consultants, Bureau Veritas.

A visual examination of the wheel found two potential fatigue regions on the ruptured wheel. One of these was within the flange of the wheel, while the other was within the plate (Figure 2). The wheelset and fragments were then provided to Bureau Veritas for an independent metallurgical examination, in order to determine the nature of, and possible reasons for, the failure.

[1] Central Daylight-saving (CDT) Time: Coordinated Universal Time (UTC) +10.5 hours.

Figure 2: Two fatigue regions in the flange (left) and the plate (right)

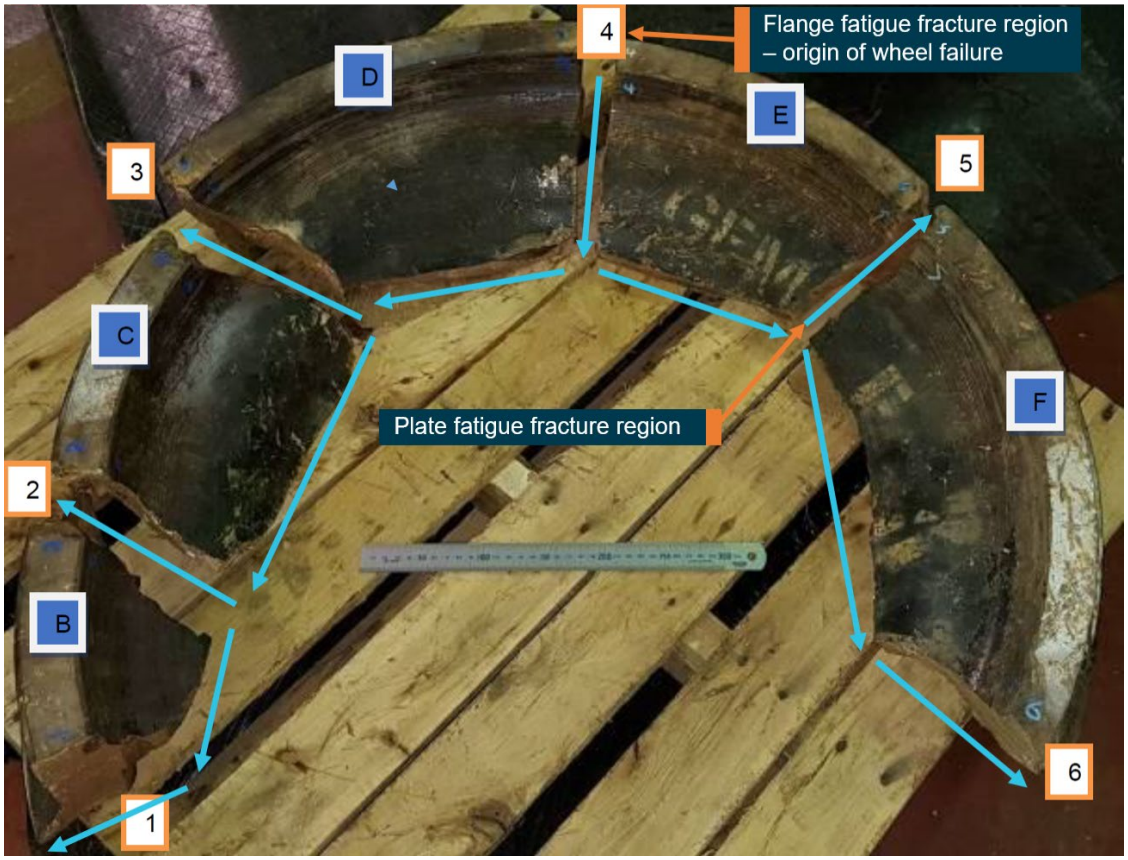
Source: ATSB

Metallurgical examination

Bureau Veritas found that the wheelset met the chemical and hardness requirements for Class C wheel material, as specified by the Association of American Railroads (AAR). The second wheelset on the derailed bogie was recorded as Class B. Both wheel-types were permitted, but Class C wheels were harder with less ductility.

The examination confirmed that two regions of fatigue cracking were present in the wheel. The wheel failed as a result of cracking that initiated at the wheel flange. The fatigue crack on the flange propagated into the rim, and the mode of cracking changed from fatigue to brittle fracture. The crack then propagated into and around the wheel plate, connecting to the second fatigue crack within the plate. The propagation continued through the plate, branching out into the rim at various locations and resulting in the wheel rupturing into multiple pieces when it finally failed. This fracture sequence is illustrated in Figure 3, where blue arrows indicate the direction of crack propagation.

Figure 3: Recovered wheel fragments with direction of crack propagation.



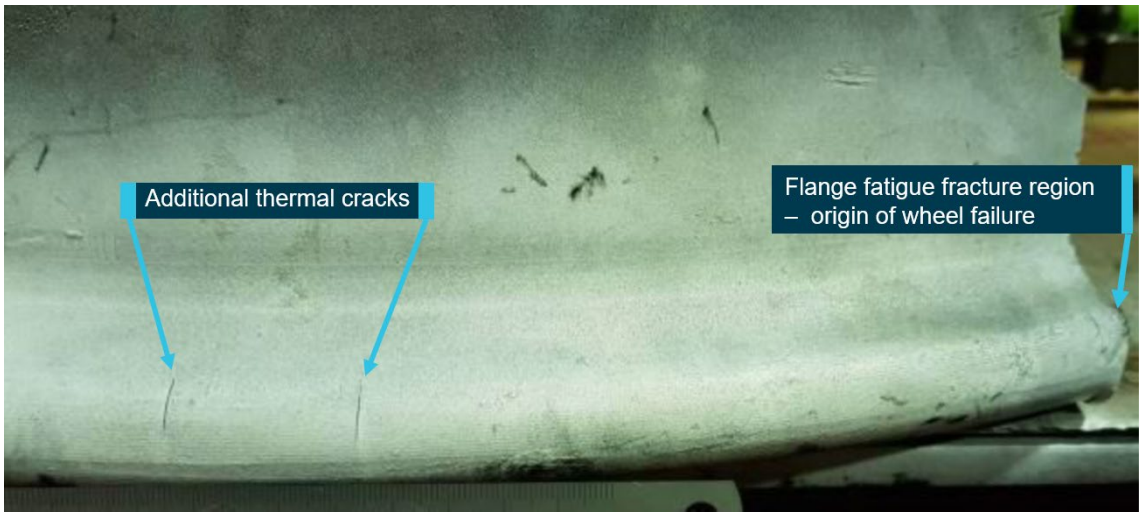
The blue arrows indicate the direction of crack propagation. The letters and numbers were used in the Bureau Veritas examination report to identify the different fragments and cracks, respectively.
Source: Bureau Veritas, modified by ATSB

The fatigue crack on the flange (crack 4 in Figure 3) was determined to be a thermal crack, 20 mm in length at the surface, formed in a white etching layer. Thermal cracks are caused by rapid changes in the temperature at the surface of the wheel. The presence of a white etching layer confirms a rapid temperature change occurred, as these layers are regions where the steel has transformed into martensite. Martensite is a brittle form of the metal created by heating and rapid cooling, and is more susceptible to cracking than the original flange material.

Bureau Veritas reported that the fatigue crack in the plate region may have initiated at non-metallic inclusions found in that part of the wheel. However, this could not be confirmed due to damage at the fracture region because of the wheel failure.

Additional thermal cracks were identified near the crack on the flange (crack 4), although these did not propagate into the rim or the plate. The two largest additional cracks measured 12 mm and 15 mm in surface length (Figure 4). Bureau Veritas reported that the cracks in Figure 4, including the one that propagated into the plate, occurred in a region with evidence of sliding, rather than rolling, contact. Sliding contact can lead to rapid temperature changes in the flange, and the resultant formation of a white etching layer.

Figure 4: Thermal cracks adjacent to the flange fatigue fracture region



The surface has been cleaned and prepared for examination. Coloured dye has been used to highlight the cracks.
Source: Bureau Veritas, annotated by ATSB

Comments from the wheel manufacturer

Following the release of Bureau Veritas' examination report, the wheel manufacturer reviewed and provided comment on the included observations/findings. The manufacturer assessed that the inclusions observed near the plate fatigue cracking were innocuous, and unlikely to provide a suitable site for the initiation of a fatigue crack. They also asserted that the size of the inclusions was within the acceptable range under AAR standards. The manufacturer believed that the fatigue crack likely initiated after the flange crack propagated into the plate, and the wheel lost its rigidity.

The manufacturer also noted that class C wheels were relatively hard, and that:

> Class C material being high carbon, high hardness and lower ductility is not generally recommended for tread breaking applications with high thermal load and potential thermal issues.

Wheel maintenance history

Wheelset 39867 was originally fitted with Class C forged wheels on 22 February 2015. It was inspected and reprofiled on 12 October 2016 and again on 19 September 2018. The wheelset was installed on the occurrence wagon (ARFY 2198T) on 28 September 2018. A field inspection, known as an A2 inspection, was performed on the wagon on 10 December 2018, which included an examination of the wheelset. The wagon passed the inspection and returned to service. No wheel cracking or other damage was noted prior to the derailment on 6 January 2019.

The A2 inspection was performed with the wagon on rails, so a small part of the wheel would have been obscured. The inspection involved various checks, which included:

- ensuring the wheel dimensions were within limits
- looking for defects or damage on the tread
- looking for signs of overheating
- inspecting any visible cracks.

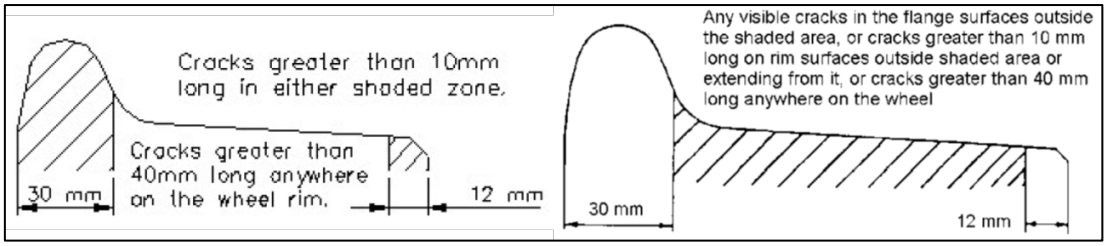
Inspection standards for thermal cracks

Gemco provided a work instruction to personnel performing A2 inspections, which instructed them to classify thermal cracks based on their size and location. A Class 4 thermal crack was defined as one longer than 10 mm within the flange or edge of the rim, or any crack longer than 40 mm. This definition was based on the Rail Industry Safety and Standards Board (RISSB) *Wheel Defects Code of Practice*. The Code of Practice, which was referenced by the Australian Standard for rolling stock wheels, defined Class 4 thermal cracks as any crack visible on the flange, cracks

longer than 10 mm on the edge of the rim, or any crack longer than 40 mm. The presence of a Class 4 crack required the train speed to be limited to 40 km/h until the wheel could be replaced.

Figure 5 compares the definition provided by Gemco's document with the one from the RISSB Code of Practice. The only difference between the two definitions was that Gemco permitted flange cracks up to 10 mm long, while RISSB did not permit flange cracks of any size. Under Gemco's work instruction, flange cracks below 10 mm did not fit under any classification and therefore did not need to be recorded.

Figure 5: Definition of Class 4 thermal cracks provided by Gemco (left) and RISSB (right)



Source: Gemco, RISSB

Safety analysis

The white etching layer observed on the flange fatigue crack indicated that the wheel was exposed to abnormally high temperatures at some point, probably due to sliding contact with the rail. Exposure to such temperature altered the material property of the steel and facilitated initiation of a fatigue crack, which propagated from the flange into the rim and then the plate. The Class C wheel type may have increased the wheel's susceptibility to fatigue cracking compared with the softer Class B wheels on the adjacent wheelset.

The crack progressed through the plate and joined with a second fatigue crack. The reason for this second crack's initiation could not be determined, nor could it be determined whether it initiated as a result of the flange crack or if it was already present in the wheel. However, given the extent of cracking at this point, it did not appear to have a significant effect on this wheel failure. Cracking then continued propagating around the plate, branching out to the rim, resulting in the wheel failure and ultimate derailment of the wagon.

Examinations following the derailment found that the flange fatigue crack and the adjacent thermal cracks were longer than the 10 mm stated in the work instruction. As an inspection for thermal cracks was carried out 27 days prior to the wheel failure and derailment, it is likely that one or more of these cracks were present at the inspection, but they may have been missed, or obstructed by the rail.

It is also possible that the cracks were observed by the inspector, but were visually assessed as smaller than 10 mm long. If the cracks had a surface length below 10 mm, then under Gemco's work instruction they would not have required any action, and their presence would not need to be recorded.

Without further details from the thermal crack inspection, it was not possible to determine whether or not the derailment would have been prevented if the work instruction prohibited all thermal cracks on the flange, as described in the more conservative RISSB Code of Practice.

Findings

From the evidence available, the following findings are made with respect to the derailment of SCT Logistics freight train 6MP9, near Cook, South Australia on 6 January 2019. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

- Thermal damage led to the initiation and propagation of a fatigue crack through the wheel flange. This may have been exacerbated by the wheel type, which was more susceptible to

thermal cracking. The crack progressed through the wheel plate, and ultimately resulted in the wheel failing.

- The flange crack that led to the wheel failure was likely present at the last inspection, but was either not detected, or was an allowable length based on the maintenance provider's work instruction.
- The maintenance provider's work instruction for classifying thermal cracks on the wheel flange was not as restrictive as the Australian Standard.

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 worked with Gemco to develop an improved inspection process for wheels exhibiting issues with brakes (e.g. sticking brakes) – as these issues can lead to the development of thermal cracks.

SCT Logistics has also instructed Gemco to only install Class B wheelsets when replacements are needed, so that Class C wheelsets are phased out of the fleet through attrition.

General details

Occurrence details

Date and time:	6 January 2019, 0635 CDT	
Occurrence category:	Serious incident	
Primary occurrence type:	Derailment	
Location:	Near Cook, South Australia	
	Latitude: 30º 33.798' S	Longitude: 130º 50.969' E

Train details

Train operator:	SCT Logistics	
Registration:	6MP9	
Type of operation:	Bulk Freight	
Departure:	Melbourne	
Destination:	Perth	
Injuries:	Crew – Nil	Passengers – N/A
Damage:	Substantial	

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within the ATSB's jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to operations involving the travelling public.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

About this report

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, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.