



**Australian Government**

**Australian Transport Safety Bureau**

# Runaway loaded ore train M02712

211 km mark south of Port Hedland, WA on 5 November 2018

**ATSB Transport Safety Report**  
Rail Occurrence Investigation  
RO-2018-018  
Preliminary – 12 March 2019

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

#### Publishing information

**Published by:** Australian Transport Safety Bureau  
**Postal address:** PO Box 967, Civic Square ACT 2608  
**Office:** 62 Northbourne Avenue Canberra, Australian Capital Territory 2601  
**Telephone:** 1800 020 616, from overseas +61 2 6257 4150 (24 hours)  
Accident and incident notification: 1800 011 034 (24 hours)  
**Email:** [atsbinfo@atsb.gov.au](mailto:atsbinfo@atsb.gov.au)  
**Internet:** [www.atsb.gov.au](http://www.atsb.gov.au)

© Commonwealth of Australia 2019



#### Ownership of intellectual property rights in this publication

Unless otherwise noted, copyright (and any other intellectual property rights, if any) in this publication is owned by the Commonwealth of Australia.

#### Creative Commons licence

With the exception of the Coat of Arms, ATSB logo, and photos and graphics in which a third party holds copyright, this publication is licensed under a Creative Commons Attribution 3.0 Australia licence.

Creative Commons Attribution 3.0 Australia Licence is a standard form license agreement that allows you to copy, distribute, transmit and adapt this publication provided that you attribute the work.

The ATSB's preference is that you attribute this publication (and any material sourced from it) using the following wording: *Source:* Australian Transport Safety Bureau

Copyright in material obtained from other agencies, private individuals or organisations, belongs to those agencies, individuals or organisations. Where you want to use their material you will need to contact them directly.

#### Addendum

Page	Change	Date

# Preliminary report

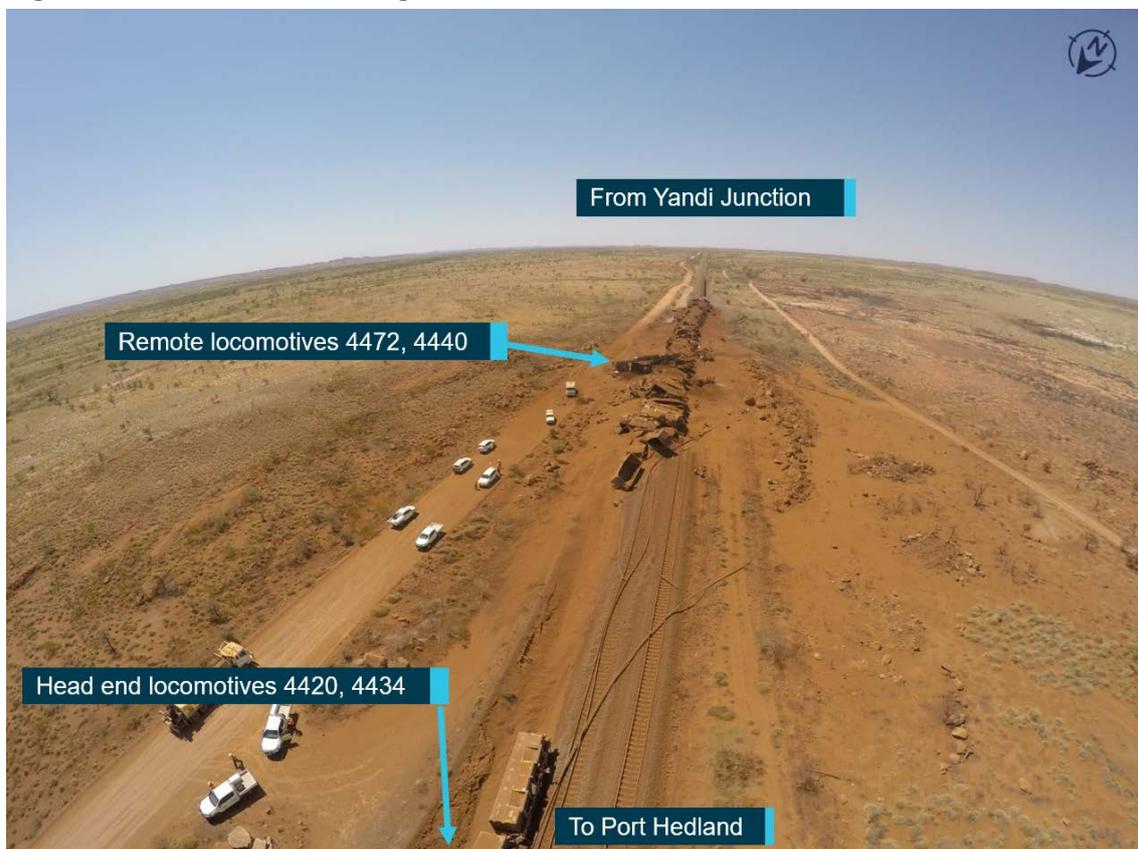
## The occurrence

### Overview

At approximately 0440<sup>1</sup> on 5 November 2018, loaded BHP ore train M02712 rolled away from the 210.7 km mark located near Garden South on the Nelson Point to Newman railway, Western Australia. There was no driver on board the train at the time. The train travelled uncontrolled on the west track for about 91 km before Hedland train control decided to derail the train by routing it from the west track to the east track at a crossover located at Turner South.

At about 0526, the head end locomotives traversed the crossover. Shortly after, 245-ore cars and the two remote locomotives, located mid consist, derailed. There was significant damage to rolling stock and track infrastructure at Turner South (Figure 1). There was no injury to any person from the derailment.

**Figure 1: Train M02712 wreckage at Turner South**



Aerial image viewed in a southerly direction of train wreckage and track damage at Turner South. The lead locomotives 4420 and 4434 and one ore car (out of frame in the foreground) remained on track Source: BHP, annotated ATSB

### Sequence of events

At about 0337 on 5 November 2018, train M02712 was travelling at 60 km/h on the west track approaching the BHP access road level crossing at the 211.6 km mark. The driver had set the throttle control for maximum dynamic braking and commenced moving the Electrically Controlled Pneumatic (ECP) braking control toward a 39 per cent application.

<sup>1</sup> WST, Western Standard Time, UTC plus 8 hours.

At about 0339, communication between the lead locomotive and the combined end of train monitor (CEOT) was lost, triggering an automated 120 per cent ECP emergency brake application, stopping the train as it approached Garden South. Shortly after, the driver made an emergency radio call to Hedland train control reporting the occurrence, his location (at the 210.737 km mark between Shaw and Garden), and the details of alert messages displayed to him by the locomotive on-board systems.

The train controller placed blocks to signals on the adjacent east track between Garden South and Shaw North to protect the train (from other rail movements) and contacted personnel from the Redmont<sup>2</sup> maintenance gang to assist the driver. The controller advised the driver that assistance was en route and requested he confirm the train's location from a kilometre mark<sup>3</sup> closest to the lead locomotive.

The driver stated that the FIRE<sup>4</sup> system displayed 210 km, but would detrain and check the kilometre mark on the ground to confirm. At about 0351, the driver placed the reverser<sup>5</sup> control to the centre (neutral) position, turned the generator field<sup>6</sup> off and fully applied the locomotive independent brake before exiting the locomotive cab. The 120 per cent emergency brake application was active and the automatic brake handle remained set at the position equating to a 39 per cent ECP brake application.<sup>7</sup>

After receiving confirmation of the 210.7 km mark, the controller instructed that 101 per cent handbrakes<sup>8</sup> were required to secure a loaded train on the falling track grade. The controller asked the driver if he wanted to start applying them now or go back up to the locomotive and wait for the arrival of personnel from the Redmont gang. At about 0353, the driver decided to commence applying handbrakes to the 268 ore cars from the front of the train.

At about 0355, an empty ore train (M02727) travelling on the adjacent east track toward Yandi Junction stopped at Garden South due to the blocking protections set up previously. About 30 minutes later, personnel from the Redmont gang advised train control of their arrival at the 210 km mark to assist the driver in applying handbrakes. The train controller suggested the gang start applying handbrakes from the rear of the train and proceed toward the driver who was working from the front.

Hedland control continued to maintain contact with the driver of M02712 at 10-minute intervals during which the driver advised that he had found a disconnection in the train-line cable<sup>9</sup>. The train-line cable was located on the opposite side of the train and not accessible safely, so the driver continued to apply handbrakes to secure the train. During one of the scheduled calls, the driver reported to the controller that the application of handbrakes was progressing well despite having trouble walking along the ballast shoulder next to the stationary train. The driver also reported that he was aware the Redmont gang had arrived to check the integrity of the rear of the train and to apply handbrakes. The driver said that he planned to continue working toward the locomotives mid train, report to train control then return to reinstate the break in the train-line cable.

At about 0440, the driver heard air venting from the ore car brakes and shortly after noticed the train begin to move forward. The driver first attempted a radio call to the Redmont gang alerting

---

<sup>2</sup> Redmont is a remote maintenance camp accommodating track workers. Redmont was located near Garden South.

<sup>3</sup> Kilometre markings on rail.

<sup>4</sup> Functionally Integrated Railroad Electronics (FIRE) system forming the interface between the operating crew and locomotive computer systems.

<sup>5</sup> Lever in locomotive cab to select 'forward' 'centred/handle-out' or 'reverse' for the direction of operation.

<sup>6</sup> Power source for generator field excitation.

<sup>7</sup> Automated ECP penalty brake application overrides manual setting of the automatic brake handle.

<sup>8</sup> Handbrake calculator tool determined number of handbrakes required based on track grade and loaded/empty state of train.

<sup>9</sup> The interruption in the train-line cable was due to a disconnected connector between the tenth and eleventh ore-car in the first unit rake.

that the brakes had 'bled off' but there was no response. Shortly after train M02712 began to roll away, the ATP system requested a penalty brake application but it was ineffective in stopping the train.

About four minutes later, the driver of the empty ore train standing at Garden South (M02727) contacted train control advising train M02712 was moving and had passed his location at an estimated speed of about 50 km/h with brakes dragging.<sup>10</sup>

At 0446, train control received an emergency call from the driver of M02712 alerting that the brakes had bled off and the train was now a 'runaway'. Train control acknowledged the emergency call and advised he had set signal GNN4 at Garden North to red, attempting to stop the train by triggering the locomotive on-board automatic train protection system. Train M02712 passed signal GNN4 at about 80 km/h and continued to increase in speed. Although the ATP system requested a penalty brake application in response to signal GNN4 at red and to an over speed, these penalty applications were also ineffective in stopping the train.

About 80 km ahead, another train (M02728) travelling on the eastern track was approaching Abydos North. Hedland control contacted its driver instructing him to stop, detrain and move to a safe place. Hedland control also contacted the drivers of the two other trains (M02729, M02710) operating between Garden North and Port Hedland, instructing the drivers to stop, detrain and move to a safe place. Trains M02729 and M02710 stopped at locations north of Turner (Figure 2).

At about 0502, the driver of the empty ore train (M02727) stopped at Garden South, contacted Hedland control advising that the Redmont gang had mistakenly applied handbrakes to his train rather than to train M02712.

Train M02712 continued through Spring and Coonarie reaching a speed of 162 km/h before slowing on the rising grades toward Woodstock (Figure 2). At about 0509, train M02712, travelling at about 128 km/h, passed over the level crossing at the 154.3 km mark before Woodstock South. After Woodstock, the track grade again began to fall toward Port Hedland and train M02712 gained speed to about 130 km/h as it passed train M02728 stopped at the 130.5 km mark on the eastern track north of Abydos.

At about 0520, Hedland control set the crossovers at Turner South and Turner North to switch train M02712 between adjacent tracks in an attempt to derail it as the traversed the crossover at speed. About six minutes later, the head end locomotives travelling at 144 km/h traversed the crossover at the 119.4 km mark at Turner South. Locomotives 4420, 4434 and the first ore car remained coupled and on track, travelling about 1.6 km further before stopping. Ore cars in position two to 134 of the first rake, the remote locomotives 4472 and 4440 and ore cars one to 112 from the second unit rake derailed near the crossover. The last 22-ore cars of the second unit rake remained coupled and on track.

The derailment destroyed two locomotives, 245-ore cars and 2 km of track infrastructure at Turner South.

---

<sup>10</sup> Brakes applied on head end locomotives and a number of ore cars from the first rake.

Figure 2: Location map BHP Port Hedland railway



Source: BHP, annotated ATSB

## Context

### **Train information**

#### **Train M02712**

The ore train operated as a unit train weighing approximately 42,500 t and was 2,860 m long. It consisted of two SD70ACe type locomotives (4420, 4434) leading, a unit rake of 134-ore cars, two remotely operated SD70ACe type locomotives (4472, 4440) located mid-train, and a second unit rake of 134-ore cars. The ore train was operating between the loading facility at Mining Area C situated on the spur line extension from Yandi, and the unloading facility at Nelson Point, Port Hedland (Figure 2).

#### **Locomotive on-board automatic train protection system**

The four locomotives on train M02712 were each equipped with an Alstom Ultra-Cab II (UCII) microprocessor controlled automatic train protection (ATP) system. The UCII system was not a standalone system; it interfaced electronically with other on-board equipment including FIRE, Electrically Controlled Pneumatic (ECP) braking systems, wayside transponders<sup>11</sup> and other control systems that combined to provide for the safe operation of the train within the parameters defined in the BHP iron ore rules and regulations.

<sup>11</sup> Signalling and other associated equipment located adjacent to the rail track.

The ATP functions included monitoring the locomotive speed and supervising its operation within the limits imposed for the track section. If the locomotive was moving faster than the target speed limit, alarms would sound prompting the driver to reduce speed.

The locomotives carry a radio transmitter, transponder reader and antenna. Transmissions are relayed between the locomotive and transponders fastened to the track cross-ties (sleepers) at key locations such as ATP entry and exit points and interlocked wayside signals along the railway. Unique location identification and target speed data is relayed from the track mounted transponders to the locomotive UCII microprocessor.

The driver must reduce speed to the target limit within a predetermined time. If this does not occur, the ATP automatically interfaces with the braking system to initiate a brake application to stop the train. The type of brake application is dependent on the setup of the locomotive at the time of the command. If the locomotive is configured for conventional pneumatic braking, the ATP initiates a service brake application. If this was ineffective in slowing the train, the ATP then initiates a penalty brake application. For an ECP braking configuration, the ATP requests a penalty brake application.

Additionally, when the locomotive was stationary with its reverser in the neutral (centre) position and the ATP detected a train movement of more than 0.5 m, the ATP requested a penalty brake application to prevent a potential locomotive runaway.

Each ATP automatically configures to mirror the ECP brake setup for that locomotive as a head end unit (HEU), trail or remote unit. The ATP would not enforce target speed limits or runaway protection on locomotives configured as either a trail or remote unit. The ATP in each of the four locomotives in train M02712 (4420, 4434, 4472 and 4440) functioned respectively as a HEU, trail and two remote units.

### ***Braking and Distributed Power systems***

Train M02712 was equipped with an EP-60 New York Air Brake electrically controlled pneumatic (ECP) braking system. The system consisted of locomotive equipment, ore car braking control equipment, an end of train monitor, and a power and communications distribution system.

Locomotive equipment comprised a train-line communications controller, power supply and identification module. The lead locomotive 4420 functioned as the HEU. The HEU communicated with each of the 268-ore car braking control devices (CCD) and remote locomotives via embedded transmissions in the train-line cable comprised of a single set of wires forming the intra-train power and communications network. The CCD unit used 230 Volt Direct Current power from the train-line to charge its batteries and supply power to its electronics.

In ECP mode, the EP-60 system used the position of the HEU automatic brake handle to control the operation of the locomotive and ore-car brake cylinders. The FIRE system provided the interface to the driver displaying braking parameters related to the ECP system mode, alarms, diagnostic messages and brake command input.

The FIRE system displayed the level of brake command input as a percentage (%TBC)<sup>12</sup>, typically a number between 0 and 100 per cent or as 120 per cent:

- 0% = Release
- 10% = Minimum Service
- 100% = Full Service/Penalty application
- 120% = Emergency.

The Combined ECP end of train monitor (CEOT) installed on the last ore car coupler marked the end of the train, provided a termination point for the train-line and a transducer for end of train information, such as brake pipe pressure, back to the HEU to establish the integrity of the train-

---

<sup>12</sup> Train Brake Command.

line and train consist. The CEOT used 230 Volt Direct Current power from the train-line to charge its batteries and supply power to its electronics.

If the power from the train-line is lost, the CCD and CEOT devices each continue to operate on battery power until the batteries run low or a 60 minute time period elapses. The CCD and CEOT devices will then enter shutdown mode. When a CCD shuts down it releases its ECP brake application and relinquishes control of brake cylinder pressure to the conventional pneumatic braking system. If the brake pipe is charged and a pneumatic application is not in effect, the brake cylinder pressure will release.

The BHP locomotive fleet was equipped to enable control of multiple distributed power units within the train. Communication of synchronous control and indication signals between the HEU, trailing and remote locomotives, located mid consist, also occurred via the train-line system.

As a contingency, the ECP overlay braking system and train-line could be shut down and the HEU configured to communicate power and brake commands via UHF radio communications to the remote locomotives. This configuration disables ECP braking and train braking reverts to conventional pneumatic operation via the train brake pipe. The HEU configuration establishes communication with the CEOT by radio.

The locomotive independent brake handle is located immediately below the automatic brake handle and controls the locomotive braking independently of the automatic train brake. It also applies the brakes on other locomotives in the train. The independent brake control only applies to the locomotives (lead and remote) and not the ore cars in the train. The independent brake control operates pneumatically irrespective of the HEU configuration.

The independent brake control handle can be positioned to:

- REL (release), releasing the locomotive brakes provided the automatic brake handle is also in the REL position
- SERVICE, moving the handle through the service zone increases locomotive braking effort
- APPL position applies full braking effort on the locomotive(s)
- Bail off function, depressing the handle in either the REL position or SERVICE zone suppresses any automatic train brake application in progress on the locomotive(s).

### ***Vigilance control***

The vigilance control system functions to monitor driver activity and stop the locomotive/train when there was no response from the driver to aural and visual warnings displayed via the FIRE system. The vigilance system uses random timing and task linking to monitor driver activity.

The vigilance system is active when the locomotive air brake is set as HEU and the air brake cylinder pressure is less than a predetermined level. Vigilance system suppression occurs when the locomotive air brake cylinder pressure is greater than a predetermined level, when the braking system is set to trail or remote, when the reverser is in the centred position, or when the locomotive configuration is set for operation at a defined slow speed.

### ***Track***

The BHP iron ore railway is a standard gauge track structure constructed with continuously welded 68 kg/m rail fastened with resilient clips to concrete sleepers. The sleepers are contained in crushed rock ballast. The track structure configuration enabled the operation of rolling stock with 40 t axle load.

In the direction of travel, the track gradient from Mining Area C was primarily a rising grade approaching Shaw located in the Chichester Range before transitioning to a mainly falling grade toward Nelson Point. The roll away occurred between Shaw North and Garden South where the track gradient was -1.5 per cent—the steepest track gradient of the track section between Yandi Junction and Nelson Point.

The ATP governed the maximum permissible track speed for the various sections dependent on the mode of operation, with the target speed displayed to the driver via the FIRE system. The maximum track speed for the Newman to Port Hedland railway was 75 km/h for loaded ore trains.

### ***Train control***

BHP manages train movements remotely from its train control centre located in the Integrated Remote Operations Centre in Perth. The train control centre has five operational control areas (desks) identified as Hedland, Newman, 6PG, Hub control and Yard control. All communications between the Perth control centre, train movements, control systems and wayside equipment is via a dedicated VHF radio system.

The runaway occurred within the operational area managed by Hedland train control that extended from the 67 km mark located south of Walla to the 260 km mark located south of Cowra.

## **Safety action**

The BHP preliminary investigation recommended a series of actions for implementation over the short (prior to recommencing movements of trains), medium (within approximately one year) and long term (over one year).

### ***Short term***

- Issue communications to all train drivers regarding the release of ECP brakes under certain conditions.
- Amend operating instruction related to Brake Pipe Emergencies and Penalties.

### ***Medium term***

- Investigate improvements to ECP braking system Handbook in relation to any of the short term controls.
- Review the processes for issuing operating instructions and disseminating information to drivers and assess value in presenting a measure of criticality with each operating instruction to avoid dilution of critical instructions amongst non-critical information.
- Undertake a review of the ECP braking system timeout function to explore software options to increase timeout period at a sacrifice to ECP braking system battery performance.
- Investigate a hardware/software solution whereby the on-board control system, FIRE or brake computer automatically dumps the air from the train brake pipe under different conditions.

### ***Long term***

- In conjunction with the BHP existing signalling upgrade project, introduce new automatic train protection system on-board every locomotive, track maintenance machine and Hi-rail in the BHP fleet.

## **Ongoing investigation**

The ATSB investigation has obtained relevant material and conducted interviews with a number of BHP staff. The ATSB is continuing to gather documentation about the design of train braking systems operated by BHP and the procedures contained in the BHP safety management system for the management of risk and the development and dissemination of safety critical information to rail safety workers.

The ongoing ATSB investigation will include consideration of the following:

- examination of factors associated with train-line cable connectors
- design, operation and serviceability of the locomotive and ore car electrically controlled pneumatic and pneumatic braking systems, and the interface between them at time of the occurrence

- effectiveness of critical control management process in identifying and managing operational risk from a runaway occurrence
- arrangements for the dissemination of safety critical information and associated driver training
- effectiveness of recovery controls—runaway protection
- effectiveness of emergency management plan response systems and actions
- factors influencing the driver's response to a penalty brake application
- train handling, driver qualifications, experience and health information
- Status of BHP short, medium and long term actions following the occurrence.

---

The information contained in this interim report is released in accordance with section 25 of the *Transport Safety Investigation Act 2003* and is derived from the initial investigation of the occurrence. Readers are cautioned that new evidence will become available as the investigation progresses that will enhance the ATSB's understanding of the accident as outlined in this report. As such, no analysis or findings are included.

# General details

## Occurrence details

Date and time:	5 November 2018 – 0440 WST	
Occurrence category:	Accident	
Primary occurrence type:	Runaway	
Location:	210.7 Km mark, Nelson Point to Newman railway	
	Latitude: 22° 2.694' S	Longitude: 118° 59.71' E

## *Train details*

Train operator:	BHP	
Registration:	M02712	
Type of operation:	Bulk ore freight	
Departure:	Mining Area C, Yandi Junction, WA	
Destination:	Nelson Point, Port Hedland, WA	
Injuries:	Crew – 0	Passengers – 0
Damage:	Substantial	