Office of the Chief Investigator
Transport Safety

Rail Safety Investigation
Report № 2011 / 02

End of Track Overrun

MTM Train 4506

Carrum Siding

03 March 2011

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THE CHIEF INVESTIGATOR

The Chief Investigator, Transport Safety is a statutory position under Part 7 of the *Transport Integration Act 2010*. The objective of the position is to seek to improve transport safety by providing for the independent no-blame investigation of transport safety matters consistent with the vision statement and the transport system objectives.

The primary focus of an investigation is to determine what factors caused the incident, rather than apportion blame for the incident, and to identify issues that may require review, monitoring or further consideration. In conducting investigations, the Chief Investigator will apply the principles of 'just culture' and use a methodology based on systemic investigation models.

The Chief Investigator is required to report the results of an investigation to the Minister for Public Transport or the Minister for Ports. However, before submitting the results of an investigation to the Minister, the Chief Investigator must consult in accordance with section 85A of the *Transport (Compliance and Miscellaneous) Act 1983*.

The Chief Investigator is not subject to the direction or control of the Minister in performing or exercising his or her functions or powers, but the Minister may direct the Chief Investigator to investigate a transport safety matter.

EXECUTIVE SUMMARY

On the evening of 3 March 2011, a Comeng train being driven into Carrum № 3 siding could not be stopped before reaching the end of the line, causing it to overrun the end-of-line baulks, derail and collide with a steel stanchion supporting the overhead contact wire.

As a consequence, the stanchion was uprooted and the overhead contact wire parted. The stanchion fouled the adjoining main line causing rail services between Carrum and Frankston to be suspended. There was also considerable damage to the leading car of the train.

The investigation found that the two drivers involved did not follow standard operating procedures when changing driving ends, resulting in the train being driven into the siding without the braking system correctly set up.

Since the incident Metro Trains Melbourne has issued a Train Driver Safety Bulletin advising drivers to "fully and correctly" comply with documented procedures at all times, and the likely consequences of not complying.

The investigation found that Comeng trains can be operated without normal braking being available and recommends that Metro Trains Melbourne consider the provision of a suitable intervention system to prevent such occurrence.

1. CIRCUMSTANCES

1.1 The incident

On 3 March 2011, a Metro Trains Melbourne (MTM) train consisting of six cars operated a scheduled passenger service from Flinders Street to Frankston. The train arrived at Frankston railway station at about 1800, being driven from car 323M.

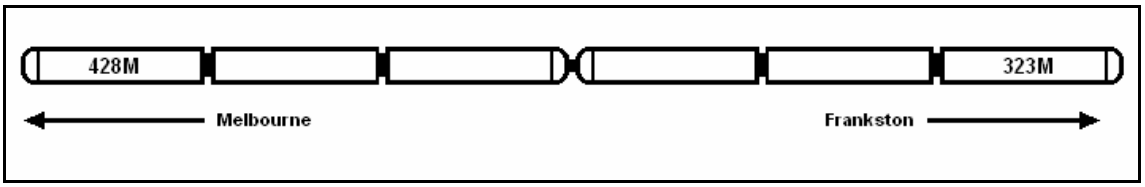

Figure 1 - Comeng six-car consist

After terminating at Frankston, the train was scheduled to be driven 'out of service' to Carrum, to be stabled at № 3 siding. The driver de-activated the driving cab of 323M but did not move the Trip Switch[1] to the 'Up' position in accordance with standard operating procedures. He then proceeded to the other end of the train to drive it to Carrum.

The train departed Frankston railway station at 1803 being driven from car 428M and arrived at Carrum railway station at 1811. At Carrum the driver de-activated the driving cab of 428M but once again did not raise the Trip Switch, and in this instance did not exhaust the brake pipe in accordance with standard operating procedures.

Another driver entered the driving cab of 323M to operate the train into the siding. He noticed that the Brake Pipe Air Pressure Gauge was displaying 550 kPa and that the Trip Switch was in the 'Down' position and assumed that the train was ready to be driven from this end.

The train was driven into the siding at a speed of 18 km/h (as recorded by the train event data recorder); however, when the driver attempted to slow the train he found that the brakes would not apply. The train overran the baulks[2] at the end of the line, derailed, and collided with a steel stanchion supporting the overhead contact wire before coming to a stop.

As a consequence, there was significant damage to the front cowling, coupler and leading bogie of car 323M. The collision uprooted the stanchion causing the overhead contact wire to part. The stanchion fouled the overhead power cables on the adjoining main line resulting in services between Carrum and Frankston being disrupted until the next day. The driver was the only occupant of the train and he was not injured in the incident.

The incident occurred in daylight. There was no precipitation or reports of adverse weather conditions at that time.

[1] Controls the train Trip-lever and is described in section 2.1.2.
[2] A length of sawn timber—most often a railway sleeper—usually applied across the rails in sets of two and designed to impede the movement of rail vehicles along a rail track.

2. FACTUAL INFORMATION

2.1 The train

2.1.1 Specifications

The Comeng train was made up of two three-car sets (see Figure 1). It had a total length of 142.4 metres and a weight of 272.4 tonnes. The cars were manufactured by Commonwealth Engineering in Dandenong, Victoria and were introduced into the Melbourne metropolitan service in 1981.

2.1.2 Braking system

The Comeng braking system has three functional modes:

- Automatic Air Brake
- Electro-Pneumatic (EP) Brake (the air brake functionality is actuated electrically), and
- Electrical (rheostatic) brake.

The braking used is primarily rheostatic blended with EP. In rheostatic braking, the traction motors are employed as generators, which tend to impede their rotation and therefore retard the speed of the train. If the rheostatic brake does not work, or is switched off, then the brake system will operate in the EP mode. The EP brake is electrically actuated throughout the train by application valves mounted on each car. When the brake signal (proportional to the movement of the driver's brake handle) is received by these valves, they respond by admitting main reservoir air into the brake cylinders, thus applying brake-block force to the wheel treads.

If the EP brake fails, or is switched off, the brake system will revert to automatic air brake mode. In this mode, a pneumatic signal is applied along the train by a reduction in brake pipe pressure proportional to the movement of the driver's brake handle. The brake pipe reduction causes valves on each car to allow air stored in auxiliary reservoirs to flow to the brake cylinders.

2.1.3 Comeng driving cab

Figures 2 and 3 depict the driving controls, indicators and gauges found in a Comeng driving car.

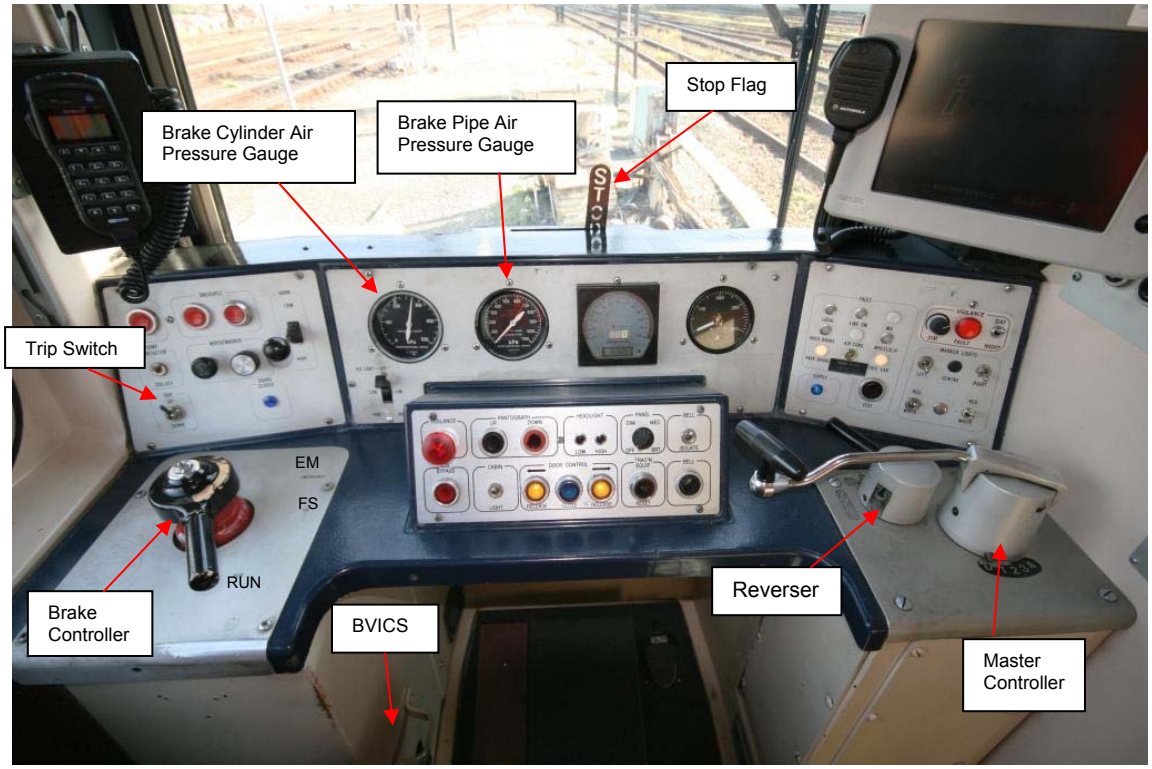

Figure 2 - Comeng cab driving console

Brake Controller: The Brake Controller commands the train's pneumatic braking system. In the 'Run' position the brakes are released; in the 'FS' (Full Service) position the service brakes are fully applied. There are seven notch positions (braking steps) from 'Run' to 'FS'. The emergency brake is activated when the Brake Controller is moved to the 'EM' (Emergency) position.

Trip Switch: This toggle switch controls raising and lowering of the Trip-lever (see section 2.1.3).

Brake Cylinder Air Pressure Gauge: Indicates the amount of pressure in the brake cylinders. When the brakes are released, the Brake Cylinder Air Pressure Gauge will read zero and when the brakes are fully applied the pressure will read about 270 kPa.

Brake Pipe Air Pressure Gauge: Indicates the amount of pressure in the train brake pipe. The brake pipe gauges in all driving cabs are inter-connected and will indicate the same air pressure. The Control Governor (see section 2.1.3) is activated and de-activated by the presence or otherwise of brake pipe pressure.

Stop Flag: The Stop Flag is automatically raised when: the Brake Valve Isolating Cock and Switch (BVICS) is closed; the Electro-Pneumatic Brake is de-activated; the main reservoir air pressure falls below 500 kPa; or the brake pipe pressure falls below 325 kPa.

BVICS: The BVICS operating lever is located below the driving console adjacent to the driver's left leg (see Figure 3). When this device is closed it cuts off the air supply to the brake pipe and all connections to the Brake Controller, rendering the rheostatic, electro-pneumatic and pneumatic brakes inoperative. In this position only emergency air braking is operative. The BVICS operating lever must be in the 'Open' position in the activated cab for the brake system to operate.

Figure 3 - Comeng train BVICS (in 'Closed' position)

Reverser: Controls the direction of travel of the train. The handle has four positions - Off (O), Neutral (N), and Forward and Reverse (designated by opposite-facing arrows ⬆ and ⬇). The Master Controller can be operated only when the Reverser is in the 'Forward' or 'Reverse' positions.

Master Controller: Controls the amount of power to the traction motors. The handle has five positions (0 to 4) and incorporates a pilot valve. When the weight of the driver's hand is released from the handle, the pilot valve is released and an emergency brake application occurs, cutting traction power.

Foot pedal: A foot pedal (see Figure 3) may be used to control the pilot valve as an alternative to maintaining pressure on the Master Controller handle.

2.1.4 Other control features

Control Governor: The Control Governor is a mechanical switch activated by brake pipe air pressure. Electrical power to operate the train is supplied from the overhead contact wire through the pantograph to the traction motors via the Control Governor. When the BVICS is opened to commence activation of the cab, brake pipe air pressure must rise above 400 kPa to close the Control Governor, completing the electrical circuit for power to reach the traction motors. Once closed, brake pipe pressure must fall below 325 kPa before the Control Governor opens and electrical power to the traction motors is cut off. At that time the Stop Flag, above the control panel, is also automatically raised.

Trip-lever: The Trip-lever (see Figure 4) is installed adjacent to the leading left hand wheel (in the direction of travel) of the leading bogie of an 'M' car and is connected to a brake pipe vent valve. When a driving cab is active, the lever projects vertically downwards. If the Trip-lever is actuated an emergency brake application is made.

Train-stop: A Train-stop is a trigger device installed on the track, usually adjacent to a fixed signal and operating in conjunction with the signal indication. It has a movable arm that is raised when the signal to which it applies is at Stop, and is lowered when the signal provides a Proceed indication. If a train runs directly past a signal at Stop, the Train-stop will actuate the Trip-lever and cause an emergency brake application.

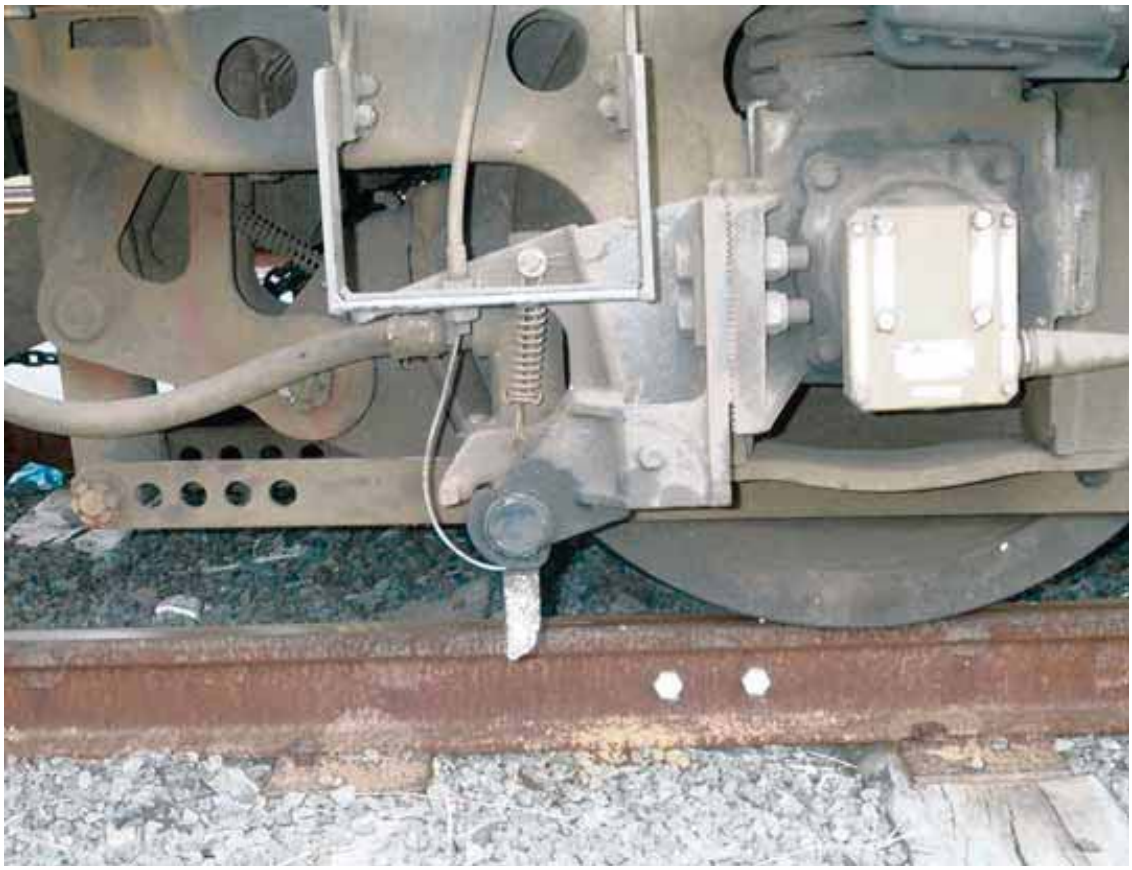

Figure 4 – Trip-lever in the lowered position

2.2 Comeng operating procedures

2.2.1 Normal driving condition

Under normal driving conditions, when a train being operated is brought to a stand, the position of the driving controls and gauge readings will be as follows:

- BVICS handle at 'Open' position
- Trip Switch in 'Down' position (and thus Trip-lever down)
- Brake Controller handle at 'FS' position
- Reverser in 'Forward' position
- Brake Pipe Air Pressure Gauge reading approximately 500 kPa
- Brake Cylinder Air Pressure Gauge reading approximately 250 kPa, and
- Stop Flag retracted.

2.2.2 Procedure for de-activating a Comeng driving cab

In accordance with MTM's standard operating procedure, and from observations of the post-incident demonstration, the following actions should have been undertaken by the driver de-activating the cab of 323M at Frankston and the cab of 428M at Carrum:

1. Place Reverser to 'Off' and remove the controller key. This applies the park brake.

2. Set the Trip Switch to 'Up' position and note:
    (a) sound of air exhausting from the trip valve
    (b) brake pipe pressure falls to around 100 kPa, and
    (c) brake cylinder pressure rises slightly.

3. Place the Brake Controller handle to 'EM'. Brake pipe pressure falls to zero and brake cylinder pressure rises slightly to approximately 275 kPa.

4. Return the Brake Controller handle to 'Run'. Brake pipe pressure starts rising, indicating that the Trip-lever has reset to its raised position. Wait until brake pipe pressure is steady.

5. Place the Brake Controller handle back to 'EM' to re-apply the automatic air brake. Brake pipe pressure will fall to zero and brake cylinder pressure will remain steady.

6. Turn the BVICS to the 'Closed' position – the Stop Flag is automatically raised.

7. Return the Brake Controller handle to 'Run'.

Had the driver de-activated the driving cabs correctly, the controls and gauges of driving cab 323M prior to activation by the relief driver at Carrum would have been as follows:

- BVICS handle at 'Closed' position
- Trip Switch in 'Up' position (thus Trip-lever up)
- Brake Controller handle at 'Run' position
- Reverser in 'Off' position
- Brake Pipe Air Pressure Gauge reading zero
- Brake Cylinder Air Pressure Gauge reading approximately 275 kPa, and
- Stop Flag raised.

2.2.3 Procedure for activating a Comeng driving cab

In accordance with MTM's standard operating procedure, and from observations of the post-incident demonstration, the following actions should have been undertaken by the drivers activating 428M at Frankston and 323M at Carrum:

1. Turn the BVICS to the 'Open' position. The Stop Flag will retract and the brake pipe air pressure will increase to about 550 kPa. Brake cylinder pressure drops to zero.

2. Place the Trip Switch to 'Down'. The Trip-lever will extend downward and brake pipe pressure reduces to about 75 kPa.

3. Move the Brake Controller to 'EM' position to reset the trip valve. Brake pipe air pressure drops to zero and brake cylinder pressure rises to about 275 kPa.

4. Move the Brake Controller handle to 'Run'. Brake pipe pressure will increase to approximately 550 kPa, the Stop Flag will retract, and brake cylinder pressure will slightly reduce.

5. Return the Brake Controller to the 'FS' position.

6. Insert the controller key into the Reverser and when ready to depart place it to the 'Forward' position.

2.3 Drivers actions

2.3.1 The incident driver

On 3 March 2011, the incident driver commenced his shift at 1755 at Carrum and his first job was to stable the train in № 3 siding.

The driver stated that when the train arrived at Carrum railway station, he entered the trailing cab (323M), sat in the driver's seat and noticed that the Trip Switch was down and the brake pipe air pressure was displaying 550 kPa. He did not notice that the Brake Cylinder Air Pressure Gauge read zero, the Stop Flag was raised, and that the BVICS was closed.

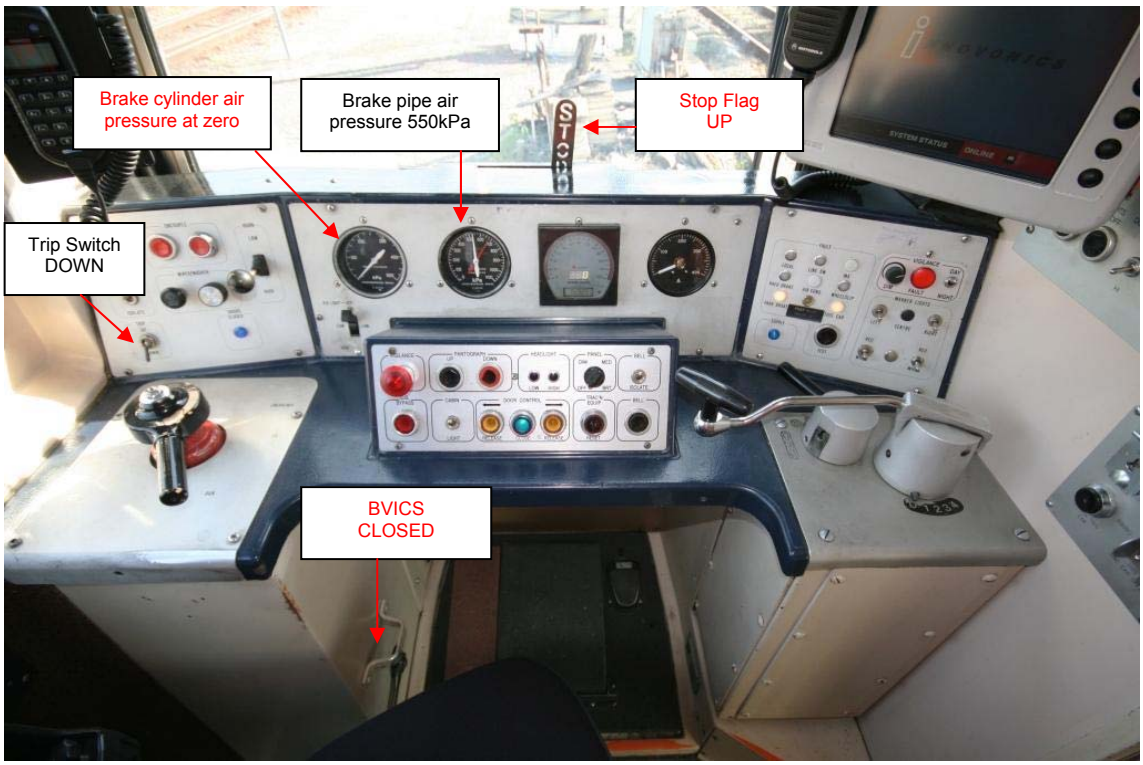

Figure 5 - Status of 323M driving cab console at Carrum when taken over by the relief driver. Items not noticed by the relief driver are in red.

The driver stated that when he received the signal to proceed, he released the park brake and placed the Master Controller handle in notch 1 and proceeded from the platform toward the siding. When the train reached a speed that he estimated to be 10-12 km/h he shut off power and let the train coast.

The driver stated that he then applied braking to control the speed. He heard air exhaust from the brake valve but realised that the brakes were not applying as they normally would at this low speed.

The driver moved the Brake Controller handle into 'FS' but still the brakes did not respond. He then checked the EP circuit breaker and noted that it was "in the normal position for operation". At this point, the driver stated that he could see the baulks fast approaching so he placed the Brake Controller handle to the 'EM' position but the train continued over the baulks and collided into the stanchion before finally coming to a stand.

2.3.2 The Frankston to Carrum driver

On 3 March 2011, the driver commenced his shift at 1256 at Carrum. His shift comprised of a run to Flinders Street, then a return trip to Werribee followed by the Flinders Street to Frankston, Frankston to Carrum runs.

The driver stated that on arrival at Frankston railway station he opened the saloon doors then 'cut out' the BVICS and left the Trip Switch in the 'Down' position to expedite 'cutting in' of the other cab at Carrum. He then changed ends and ran the train 'empty cars' to Carrum.

On arrival at Carrum railway station the driver brought the train to a stop at the platform. He stated that he then closed the BVICS and placed the Brake Controller handle into the 'Run' position without depleting the brake pipe because the incident driver was in position to take over the train and it would make it quicker for him to depart once he had 'cut in' the brake. Again, the driver did not raise the Trip Switch.

The driver then placed the Reverser in the 'Off' position and removed the controller key. He noted that the park brake had applied, switched the marker lights to red and exited the cab. After observing the train depart to the siding, the driver stated that he entered the office to wait for his next assignment.

2.4 Post-incident verification

2.4.1 Test and inspection

During the post-incident inspection of the driving cars, the investigation noted a Train Malfunction Message[3] displayed in the cab of 323M stating that the rheostatic brake was not working. The cab of 428M also had a Train Malfunction Message informing that the PA system was not working.

Post-incident tests of the train's driving and braking systems indicated that driving cabs 323M and 428M were operating normally and the cabs could be activated and de-activated in accordance with the prescribed procedure.

2.4.2 Post-incident demonstration

Two of MTM's Principal Driver Specialists independently provided the investigation with a practical demonstration of activating and de-activating a Comeng driving cab. The investigation noted that each procedure was completed by each driver in about 30 seconds.

The investigation also noted that when the cab was de-activated correctly, the Brake Pipe Air Pressure Gauge reading was zero and the brake cylinder air pressure was about 275 kPa, indicating that the brakes were applied. When the cab was deactivated in accordance with the driver's statement, the brake cylinder pressure was zero, indicating that the brakes were released. In this condition, the train was being held stationary solely by the park brake application.

[3] A fault notification completed by the driver on a prescribed pro-forma and affixed in the driving cab for display to other drivers and maintenance staff.

2.5 Infrastructure

2.5.1 Carrum to Frankston

The line between Carrum and Frankston consists of two unidirectional tracks (Up and Down). Rail traffic is controlled by three-position colour-light signalling and associated Train-stops, applicable to the direction of travel. There are no crossovers or intermediate sidings between Carrum and Frankston. Shunt signals at Frankston and at Carrum do not have associated Train-stops.

2.5.2 The siding

№ 3 siding runs parallel to and on the west side of the Up main line. It is about 450 metres in length and is provided with baulks at its dead-end. Access to the siding is from the Up line at Carrum railway station (platform 1). The speed limit in the siding is 15km/h.

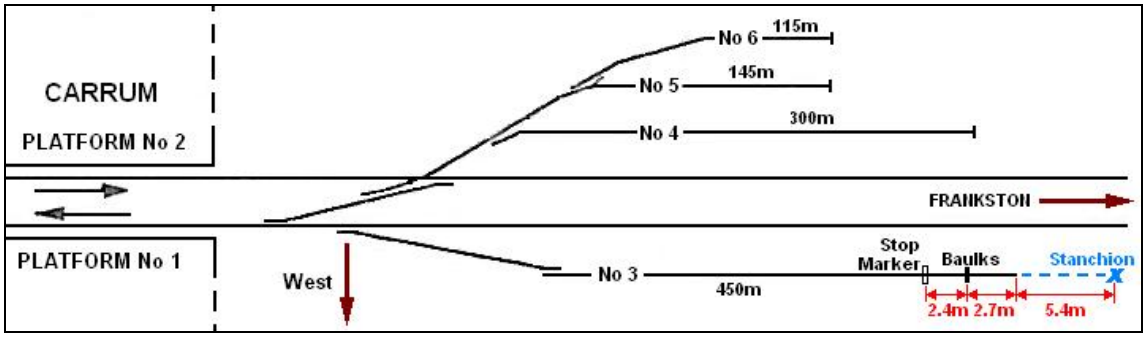

Figure 6 - Diagram of Carrum sidings.

At № 3 siding, the Stop Marker[4] was located 2.4 metres prior to the baulks and the track ended 2.7 metres beyond the baulks. The stanchion supporting the overhead wire was located 5.4 metres beyond the end of the track, or 8.1 metres beyond the baulks. The train came to a stop about 10.8 metres beyond the baulks.

2.6 Recorded data

2.6.1 Train event recorder

Each Comeng driving cab is fitted with a Vigilance Control Event Recorder System (VICERS) data logger that records the operational status of the driving controls. At the time of the incident the event recorder for car 428M was not operational. The event recorder of car 323M was downloaded and indicated that:

- The train stopped at Carrum railway station for about 38 seconds before proceeding to the siding
- The BVICS was not opened; therefore the logger did not record the Brake Controller handle positions
- The brake pipe was pressurised, confirming that the driver did not exhaust it before exiting the driving cab of car 428M at Carrum railway station, and
- The train entered the siding at 18 km/h.

[4] One of the track sleepers is painted white to mark a limiting point beyond which train movements are not permitted.

2.6.2 CCTV

CCTV footage at Carrum railway station indicated that the relief driver entered driving cab 323M about 22 seconds after the train stopped at the station, and about 16 seconds later the train started moving towards the siding.

2.7 Metro Trains Melbourne

2.7.1 Role and responsibility

Metro Trains Melbourne (MTM) is the Accredited Rail Operator (ARO) of the Melbourne metropolitan rail service. Specific areas of responsibility include the operation and maintenance of rolling-stock, the track structure, the overhead electrical distribution system and substations, signalling systems, and communications and control.

As an ARO, MTM is required to maintain a Safety Management System that provides, among other things, for hazard identification and risk management in accordance with their statutory obligations. The application of these obligations is administered by the rail safety regulator through an audit and compliance program. The provision of adequate end-of-track infrastructure protection is part of MTM's obligations.

2.8 Train drivers

2.8.1 The incident driver

The incident driver joined the previous metropolitan rail operator in November 2005 and qualified as a driver in February 2007. Since that time he has been stationed at Carrum depot.

At the time of the incident the driver's qualification to drive Comeng trains was current. He was also current with his safeworking and other required competencies. He completed the mandatory Train Driver Safety Audit in July 2010 and was reported to have performed all tasks in a safe and reliable manner. He completed his health assessment for Safety Critical Worker (Rail) in August 2010 and was declared fit for duty.

2.8.2 The Frankston to Carrum driver

The driver commenced training as a Melbourne metropolitan train driver in June 2006 and qualified in December 2007. Since then he has been based at Carrum depot.

At the time of the incident his qualification to drive Comeng trains was current. He was also current with his safeworking and other required competencies. He completed the mandatory Train Driver Safety Audit in December 2010 and was reported to have performed all tasks to the standard required. He completed his health assessment for Safety Critical Worker (Rail) in December 2010 and was declared fit for duty.

3. ANALYSIS

3.1 The incident

When the train reversed direction at Carrum railway station it was able to be driven from the opposite end because sufficient air pressure had been retained in the brake pipe to maintain the Control Governor closed (thereby permitting traction power to be applied) and the brakes released.

When the train entered the stabling siding it was travelling at about 18 km/h. The driver attempted to slow the train using normal braking. However, since the BVICS was closed, normal braking was unavailable.

It appears that the driver did not identify the deficiency with the braking system in time, leaving him with insufficient distance to stop the train before the end of the siding even after the emergency brake application.

3.2 Train driving controls

3.2.1 Brake Valve Isolating Cock and Switch (BVICS)

A characteristic of Comeng trains is that the driver can apply traction power despite the braking system being de-activated when the BVICS is closed in such a manner that a residual air pressure of at least 325 kPa is retained in the brake pipe.

The only safeguard against the train being operated when the air brake system is isolated after de-activation of a driving cab is by the action of the driver exhausting the brake pipe prior to closing the BVICS (in accordance with the operating procedure). In this instance the Frankston to Carrum driver did not follow the correct procedure.

3.2.2 Trip Switch

When he entered the driver's cab the incident driver noticed that the Trip Switch had been left in the 'Down' position. Had the previous driver followed the required procedure and raised the switch when changing ends at Frankston, the incident driver might not have assumed that the train was ready to be driven.

Additionally, had the previous driver raised the Trip Switch in driving cab 428M when de-activating it at Carrum, it would have caused brake pipe air pressure to drop to about 100 kPa, thereby opening the Control Governor and rendering the train inoperable.

3.2.3 Car 323M rheostatic brake

The investigation noted a Train Malfunction Message displayed in the cab stating that the rheostatic brake was not working. This was not critical to the safe operation of the train as the electro-pneumatic and automatic-air braking were fully functional. The rheostatic brake fault was not a factor in this incident.

3.3 Non-compliance with procedures

In his statement, the driver who ran the empty train from Frankston to Carrum justified his decision to use an incorrect cab de-activation procedure as an attempt to expedite the change of cabs at Carrum. However, the investigation noted that there was no time constraint upon the drivers requiring them to hasten the move to the siding. The investigation noted that the entire process of de-activating a cab correctly took less than 30 seconds. Therefore, to circumvent one or two steps in the process would have saved less than 15 seconds.

By not depleting the brake pipe prior to closing the BVICS, the train's air brakes were not applied. At Carrum, the driver relied solely on the park brake application (as occurs automatically when the Reverser is placed in the 'Off' position and the controller key is removed) to secure the train. The investigation has not been able to confirm whether the driver relied solely on the park brakes to hold the train when changing driving ends at Frankston too.

It is likely that when the incident driver entered the train at Carrum he had an expectation that the cab would be already partially activated for him. The only action that he would have been required to take to successfully drive the train was to position the BVICS lever to 'Open'. The reason he did not notice the Stop Flag (which would have retracted with the BVICS lever in 'Open') and conclude that the train was not in an appropriate configuration to be operated, indicates that he was in some way distracted from the task at hand.

The circumstances of this event suggest that the processes used on this occasion for changing ends were commonplace at this location.

3.4 End-of-line protection

In this incident, the baulks provided at the end of the line were unable to stop a train travelling at 18 km/h from derailing and colliding with the steel stanchion. The steel stanchion at the end of № 3 siding was supporting the overhead contact wire and after the collision the contact wire became dislodged and fouled the main line.

While it is recognised that the train was exceeding the maximum speed allowable in the siding by 3 km/h, and that the train braking system had not been set up correctly prior to departure from Carrum, had there been a more robust end-of-line infrastructure protection it is likely that the train would not have overrun the line and no damage would have been caused to the overhead infrastructure.

The issues surrounding end-of-line protection are explored in depth in the report into the overruns at Pakenham and Sandringham that occurred on 9 March 2011.

4. CONCLUSIONS

4.1 Findings

1. Both drivers were appropriately trained and qualified to drive Comeng trains.

2. The train's driving and braking systems operated normally when driving cab controls were correctly conditioned.

3. Neither driver followed the standard operating procedure for activating and de-activating a driving cab.

4. Unless brake pipe air pressure is properly exhausted prior to closing the Brake Valve Isolating Cock and Switch, Comeng trains remain able to be driven without normal braking being available.

5. The baulks at the end of № 3 siding were ineffective end-of-line protection in this instance.

4.2 Contributing factors

1. The driver of the train from Frankston to Carrum incorrectly de-activated both the driving cab of 323M after arrival at Frankston railway station and the driving cab of 428M after arrival at Carrum railway station.

2. The incident driver at Carrum did not follow the standard operating procedure for activating the driving cab of 323M.

3. Comeng trains do not have a system that prevents the train being operated when the air brake is incorrectly 'cut out', leaving the train with only emergency braking.

5. SAFETY ACTIONS

5.1 Safety Actions taken since the event

Following this incident, Metro Trains Melbourne (MTM) circulated a Train Driver Safety Bulletin reminding drivers to fully and correctly comply with documented procedures at all times, the methods by which compliance with the procedures may be verified by management, and the likely consequences of non-compliance.

Also, MTM have completed a risk review of all stabling sidings. The investigation has been advised that this has produced a prioritised list of sidings with the highest likely consequence in the event of a train overrun.

5.2 Recommended Safety Actions

Issue 1

The train was able to be operated despite all normal braking being rendered inoperative.

RSA 2012001

That MTM considers providing an engineering solution to prevent the application of traction power when the Brake Valve Isolating Cock and Switch (BVICS) in an active cab is closed.