Australian Government
Australian Transport Safety Bureau

Derailment of freight train 9501V

South Dynon Junction, West Melbourne, Victoria | 2 March 2013

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
RO-2013-009
Final – 4 September 2014

Cover photo: Chief Investigator, Transport Safety (Victoria)

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Addendum

Page	Change	Date

Safety summary

What happened

At about 0623 on 2 March 2013, Pacific National freight train 9501V, travelling from Appleton Dock to Tottenham Yard, derailed at South Dynon Junction near Melbourne, Victoria. Due to a track closure, the Network Control Officer (NCO) had been routeing all train movements via an alternative route through the South Dynon junction area via the North Dock line, signal DYN114, and 113 points. All of these train movements were standard-gauge trains. The NCO set the same route through South Dynon for train 9501V, a broad-gauge train. However, the route selected was for a standard-gauge train only as it did not contain a broad-gauge rail beyond signal DYN114, other than the 40-metre length leading to its truncation.

Having detected the train as broad-gauge and therefore incompatible with the remainder of the established route, the signal interlocking system prevented signal DYN114 from clearing. Train 9501 stopped at signal DYN114 and, through discussion, both the NCO and the locomotive crew assumed a signal failure. The NCO subsequently issued a verbal authority to the driver to pass signal DYN114. The locomotive crew then proceeded past signal DYN114 for a distance of about 40 m where the broad-gauge rail ended, resulting in train 9501V derailing at low speed.

What the ATSB found

The ATSB found that when the NCO established the route, the train control system provided no indication that sections of it were dual-gauge and sections were single-gauge. When train 9501V approached signal DYN114, there was minimal indication to the NCO that the train gauge and the selected route were incompatible. As the train proceeded past signal DYN114 and 113 points, it derailed because the configuration of the dual-gauge points assembly led to a truncated broad-gauge rail in the selected turnout direction.

The ATSB also found that there were deficiencies and ambiguity in the procedures for authorising movement past signals that display a Stop indication. There were also deficiencies in the route knowledge information provided to drivers and no additional indications to a train driver that the broad-gauge track terminated.

What's been done as a result

ARTC has modified the train control system to alert network control officers when a route is set that is not compatible with the gauge of the train, and has amended processes regarding authorising train movements past signals that are displaying a Stop indication.

Safety message

This report emphasises the need for rail transport operators to provide adequately designed system displays that are not provocative of decision-making error by operators. It also highlights the need for train crew and NCOs to ensure they have considered the possibility that an unexpected Stop indication is not always due to signal failure.

Contents

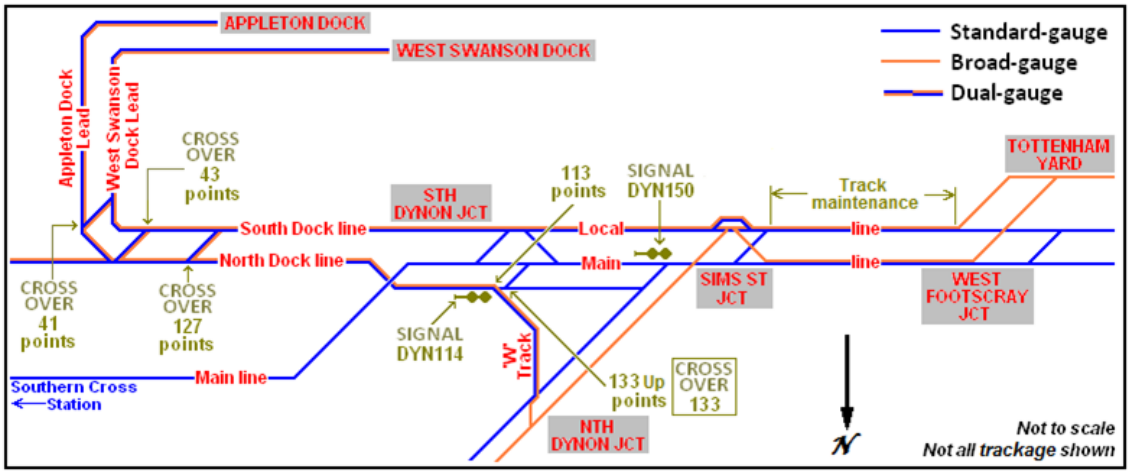
The occurrence

On the evening of 1 March 2013, the Australian Rail Track Corporation[1] (ARTC) had closed a section of the Local line situated between the South Dynon Junction and West Footscray Junction to undertake track works. Due to this track closure, the NCO was routeing train movements through the South Dynon junction area via the North Dock line, signal DYN114 and 113 points (Figure 1). All of these movements were standard-gauge trains.

At about 0600[2] on 2 March 2013, broad-gauge freight train 9501V[3] was preparing to depart Appleton Dock for Tottenham Yard. The Appleton Dock rail supervisor contacted the NCO to advise that the train was ready to depart. The NCO then set up a route for train 9501 to travel towards Tottenham via the dual-gauge[4] Appleton Dock Lead, the North Dock line, and toward signal DYN114, as he had done for all the previous train movements routed through the South Dynon junction area.

The route selected, however, was for a standard-gauge train and did not contain broad-gauge track beyond signal DYN114 or provide access through to Tottenham yard.

Figure 1: Simplified area track plan



Source: Chief Investigator, Transport Safety (Victoria)

Train 9501 departed Appleton Dock yard and as it approached the Appleton Dock Lead, the gauge detection system[5] identified it was broad-gauge. When train 9501 arrived at signal DYN114, the crew observed that the signal was displaying a Stop indication. The locomotive driver contacted the NCO to report that signal DYN114 was at Stop. The NCO and locomotive driver then discussed the indication on signal DYN114. As the driver reported that he could see a signal beyond DYN114 that was displaying a Proceed indication (Main line signal DYN150), they assumed that the Stop indication was due to a signal failure.

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1 The Australian Rail Track Corporation is a Federal government-owned company created in 1997. It is responsible for maintaining the infrastructure and the flow of traffic on various intra- and interstate corridors that it owns or are leased from state transport agencies, as well as managing access by train operators.

2 The 24-hour clock is used in this report and is referenced from Eastern Daylight Saving Time (EDT), UTC +11 hours.

3 Although the train should have been designated with the gauge-descriptor 'V' to denote operation in Victoria, this was not used by network control officers or train operator staff when discussing the train, nor was it used on the network controller's train control diagram. The 'V' descriptor is not applied throughout the remainder of the report.

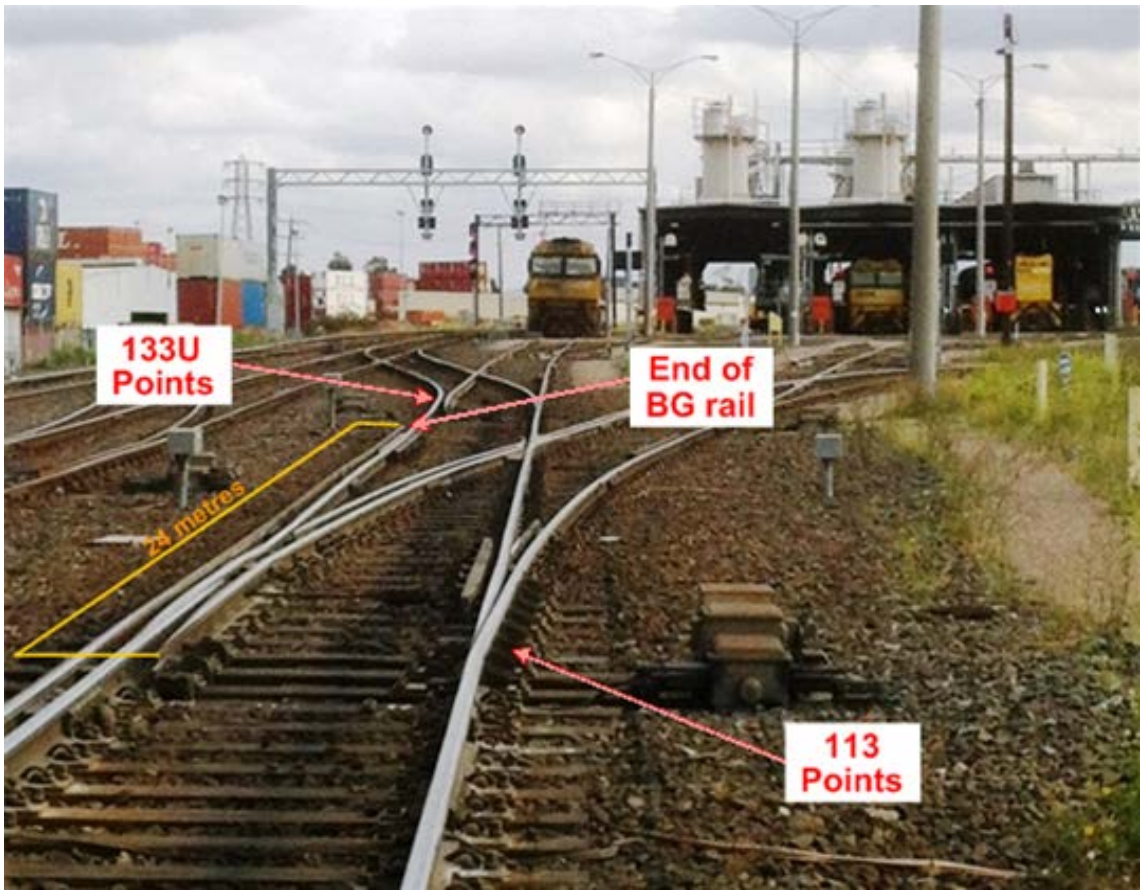
4 The gauge of railway track is the horizontal distance between the inner faces of a pair of running rails. All vehicles on a network must have running gear that is compatible with the track gauge. Dual-gauge track is a line of railway that accommodates two track gauges where one of the rails is common to both of those gauges.

5 The 'gauge detection system' functions by registering wheel flanges passing sensors on dual gauge track, providing a signal to the interlocking identifying the gauge of the train passing that location.

At about 0623, the NCO issued verbal authority to the driver to pass signal DYN114. The locomotive crew then proceeded past signal DYN114 for a distance of about 40 m, where the broad-gauge rail ended (Figure 2) and the lead bogie and leading wheel set of the trailing bogie on locomotive A77 derailed.

The derailment was at low speed and there was no injury to the train crew, but there was minor damage to the bogies of the lead locomotive (A77) and track infrastructure. The derailment resulted in the closure of the main line out of Melbourne (Southern Cross Station) for a number of hours, affecting interstate passenger and other movements both inbound and outbound.

Figure 2: View of derailment site in the direction of travel



Source: Chief Investigator, Transport Safety (Victoria)

Context

Area layout

The Port of Melbourne precinct is a major hub for rail freight traffic in the Dynon area. The track layout adjacent to the port precinct had undergone significant development as part of various projects to improve the access for rail traffic. Two dual-gauge tracks connected the Port of Melbourne to South Dynon Junction and the ARTC rail network (Figure 1).

The Appleton Dock Lead connected the port precinct to the North Dock line, which was also dual-gauge. The dual-gauge track diverged at 113 points at South Dynon Junction, where the dual-gauge track continued to become W track[6] which lead to North Dynon Junction. The standard-gauge track continued straight ahead from 113 points, to provide access to Pacific National Locomotive Provisioning Centre (LPC) and the Main line that connected to West Footscray Junction and the northern and western standard gauge interstate routes.

The other dual-gauge track originating from the port was the West Swanson Dock Lead, which became the South Dock Line. This connected to the Local line, which also lead to West Footscray Junction, the Tottenham rail yard and northern and western standard-gauge interstate routes. The South Dock Line also enabled access to Tottenham Yard via the Main Line. Between Sims Street Junction and West Footscray Junction, the Main and Local lines were parallel to each other, bi-directional and dual-gauge.

Typically, trains departing the port precinct for Tottenham Yard along the Appleton Dock Lead would travel onto the South Dock line via either of the crossovers comprised of points 43 or 127[7]. Tottenham yard is approximately four kilometres from South Dynon and located adjacent to West Footscray Junction.

Signal DYN114

Signal DYN114 was commissioned in late 2010 as part of the works associated with the South Improvement Alliance (SIA)[8] Missing Link project[9]. DYN114 was a Home[10] signal that protected the dual-gauge points 113 and was equipped with gauge and Theatre Route indications (Figure 3). These indications only illuminated when the signal displayed a Proceed indication. As the signal was displaying a Stop indication to train 9501, neither indicator was illuminated.

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6 This is a dual-gauge connection between the North Dynon and South Dynon Junctions. W Track provides broad- and standard-gauge access between the Port of Melbourne and the Melbourne Freight Terminal, and between the Port of Melbourne and suburban broad-gauge trackage.

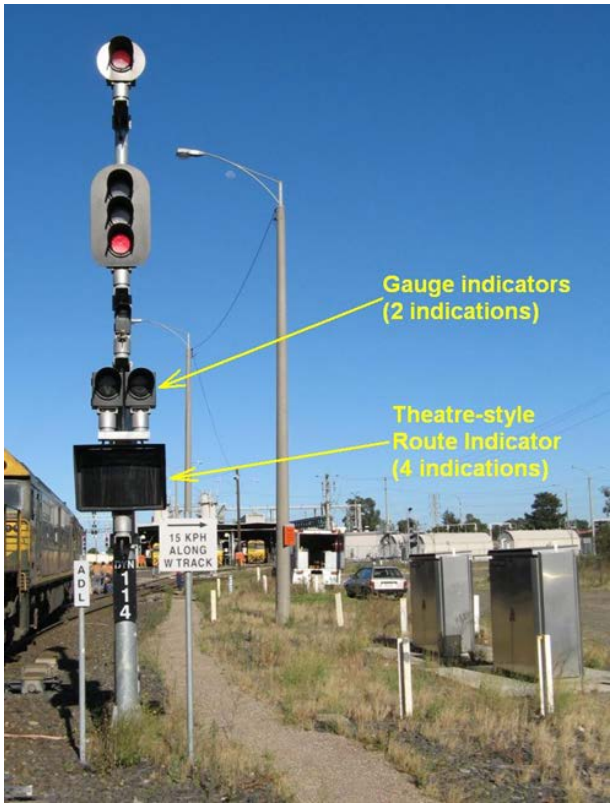
7 The № 127 crossover is also formally referred-to as the ‘Greensill Lead’.

8 The South Improvement Alliance comprised a group of engineering construction organisations, established by ARTC to plan, design, and deliver infrastructure improvements to the Melbourne-Sydney rail corridor.

9 The Missing Link project was designed to improve standard gauge rail connection between the Port of Melbourne and the interstate freight network.

10 Home signals are ‘absolute’ (Stop-and-Stay) signals connected to an interlocking at which the potential exists for a conflict of traffic. The most restrictive indication of any absolute signal is 'Danger - Stop', which prohibits passage. Trains cannot pass them in this condition without obtaining special authority.

Figure 3: Signal DYN114



Source: Chief Investigator, Transport Safety (Victoria)

The train control system

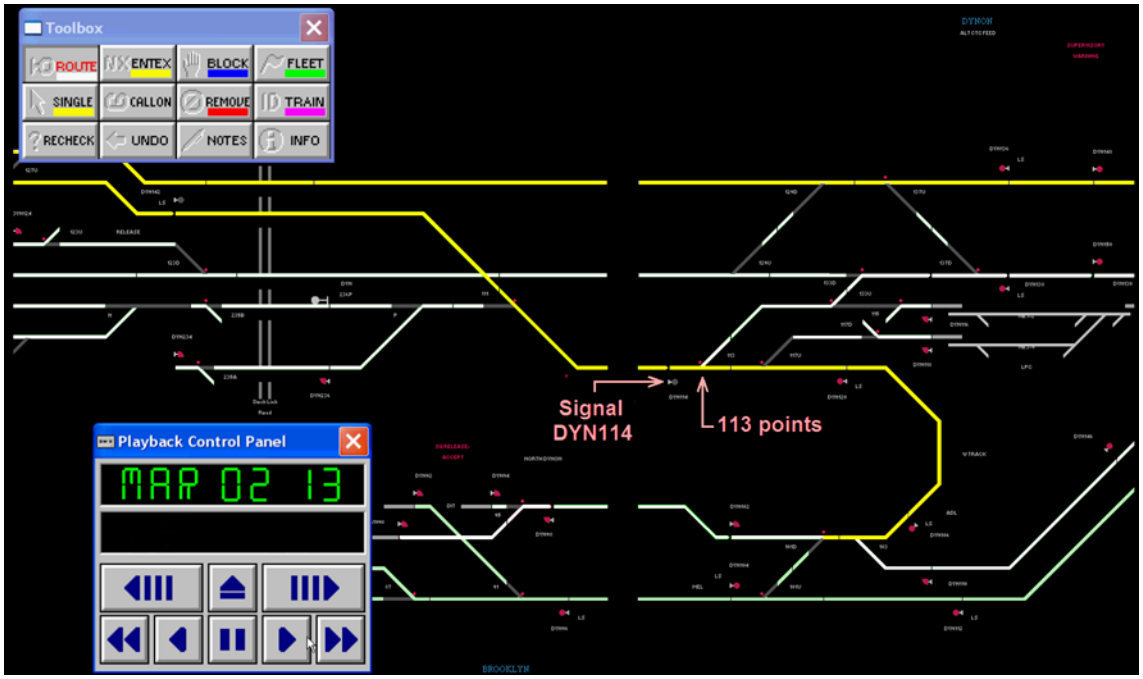
Traffic control of the Melbourne metro portion of the ARTC corridor between Adelaide and Melbourne was accomplished by NCOs in the ARTC's Network Control Centre West, at Mile End in South Australia, using the proprietary Phoenix TD Pro micro-processor-based desktop Traffic Control System. This technology presented the track layout and points and signals in plan view on a series of contiguous display monitors, displaying standard-, broad-, and dual-gauge trackage in separate colours. The distinction in colour presentation, however, was no longer evident once a route was selected by the controller and validated by the system. At this point, the selected route became a bold green colour irrespective of its gauge and despite the fact that its gauge configuration might vary at some point along its length.

On this occasion, a transition in the gauge configuration of the track (from dual-gauge to single-gauge trackage) occurred partway along the established route, with the dual-gauge component turning away at the 113 points. However, despite this variation in the gauge configuration, the system determined the route to be viable and continued to present it to the network controller as such.

Figure 4 depicts a portion of the network controller's display. It shows available dual-gauge (yellow), standard-gauge (white), and broad-gauge (pale green)[11] track.

[11] Note that the pale green colour displayed to the network controller is not as clearly apparent in this illustration. The broad-gauge track (with connecting trackage) is the lowermost line.

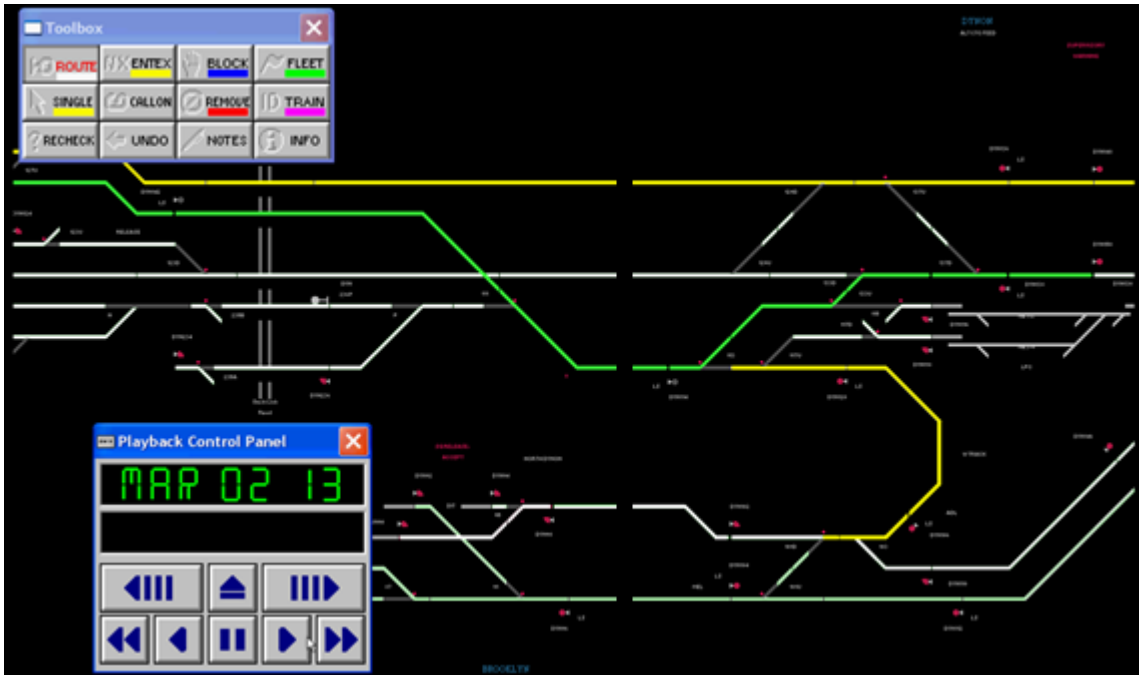
Figure 4: Phoenix train control system display. Trackage and track gauges - Dynon area



Source: ARTC: annotated, and with colour enhancement by Chief Investigator, Transport Safety (Victoria)

The same portion of the network controller's display is depicted in Figure 5 showing the selected route for train 9501 (left-to-right in bold green), through South Dynon Junction.

Figure 5: Phoenix train control system display with multi-gauge[12] route selected

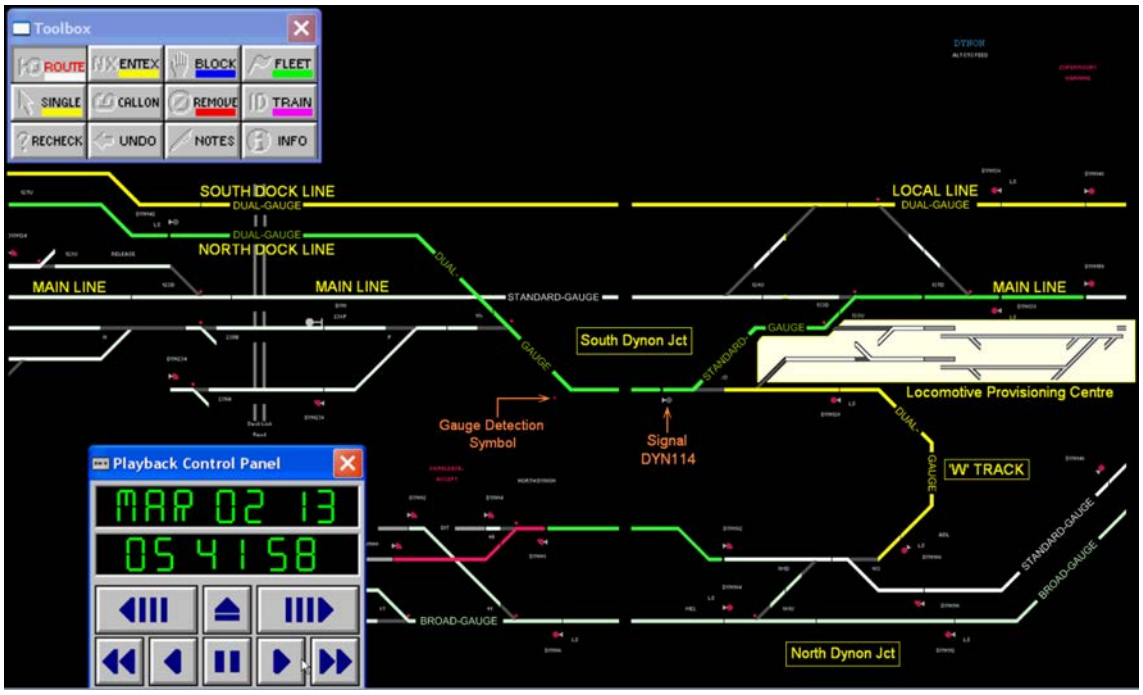


Source: ARTC: colour enhancement by Chief Investigator, Transport Safety (Victoria)

[12] The terms dual-gauge and multi-gauge have different meanings in this report. Dual-gauge track is a line of railway that accommodates two track gauges where one of the rails is common to both of those gauges. Multi-gauge describes a stretch of track that consists of more than one configuration; for example, where part of the route might be dual-gauge and part standard-gauge.

Figure 6 depicts the same display as Figure 5, with the addition of annotation to highlight the degree of interpretation required of the NCO. Although shown as a singular colour on the display, the selected route was dual-gauge as far as signal DYN114 and standard-gauge beyond.

Figure 6: Phoenix train control system display – interpretation of multi-gauge routes



Source: ARTC: annotated, and with colour enhancement by Chief Investigator, Transport Safety (Victoria)

The train

Train 9501 was operated by Pacific National Rail (Rural & Bulk division), a subsidiary of Asciano Limited and consisted of five locomotives led by A77 hauling 41 wagons, with a trailing load of approximately 1,017 t and a length of around 924 m. It operated as a regular, non-scheduled shunt movement to Tottenham yard and this was also the case on the morning of 2 March 2013.

The speed of train 9501 throughout the journey between the Appleton Dock and the point of derailment was not recorded on the on-board data logger fitted to each of the locomotives[13]. Although the speed of the train was not recorded, available evidence indicates that train 9501 had stopped prior to signal DYN114 and following the receipt of authority to proceed by the crew, was travelling at a low speed immediately prior to the derailment. ATSB concluded that the speed of the train did not contribute to this incident.

Identifying the gauge of train

The train was despatched from the port precinct following a phone call from the Appleton Dock supervisor to the NCO advising that the train was ready to depart for Tottenham Yard. There was no direct communication between the train crew and the NCO prior to the train's departure.

Although there was no specific mention in the discussion between the supervisor and NCO of 9501 being a broad gauge movement, the NCO was familiar with the train's identification number as denoting a broad gauge train and that only broad gauge trains could access the Tottenham Yard. Nevertheless, the absence of the clear identification of the gauge of the train to the NCO

[13] The train was operating with five locomotives operating as a group. Although these units were equipped with the ability to record speed (on a waxed paper tape) this functionality was inoperative on all five units.

when notifying of its readiness to depart was a missed opportunity to confirm the train as broad-gauge.

The NCO recorded the train number against the corresponding plot line on the train control diagram, adhering to the V/Line Train Describer protocol for train numbering. This numbering protocol differed from ARTC numbering practice defined in the ARTC Route Access Standard [14] for the numbering of Victorian intrastate trains. Apart from the variance in the numbering protocol, the ARTC practice still included the application of the letter 'V' to denote 'operating in Victoria' (originally to denote broad-gauge). The variance in the numbering of the train did not, however, contribute to the decision of the NCO in routeing train 9501 via the North Dock Line and signal DYN114.

The network control officer

The NCO had been with ARTC in this capacity at the Network Control Centre West for almost four years and was qualified to manage rail traffic in the region pertinent to this incident. He completed his On-Job competency assessment for ARTC's Melbourne Metro Area Control Board on 25 March 2011 and, at the time of this incident, held current safeworking qualifications and a medical assessment consistent with his rostered duties. Over several days in late 2011, the NCO undertook a familiarisation trip over the Melbourne Metro area, and between July 2011 and March 2013 had completed 115 shifts on the Melbourne Metro Board.

ARTC network controller On-Job competency assessments are conducted through observation of the performance of the NCO in managing their task and workstation. An NCO under assessment for a control board competency qualification is also questioned on possible train controlling scenarios and the reason why certain tasks are performed in certain ways, with the results being recorded on the Network Controller Assessment in Train Control Board competency check-sheet. This instrument is a prompt for the assessor in observing the general procedures for operation by an NCO of a particular train control board and management of the corridor, and is also a record of the outcomes.

The check-sheet included an element for assessment called 'Train Working on Appleton Dock Line' and this was the only such element that concerns those activities of the NCO that are pertinent to this incident. However, this element includes no instruction or examination on the subject of the processes applicable to departing trains from Appleton Dock, or particulars of the various routes that may be used. It was also found that some of the material on signalling infrastructure upon which NCOs are examined was out-of-date and applied to infrastructure that no longer exists.

The NCO was familiar with the area layout and typical train movements through the control area. He was also familiar with train 9501 and its regular movement from the port to Tottenham Yard. Although the Appleton dock rail supervisor did not specifically identify the train as broad-gauge when he contacted the NCO, the controller had managed this move previously and was aware that Tottenham Yard was a broad-gauge only destination.

Typically, an NCO would route this train via the Local line (accessed from the South Dock line). However, in this case track works were being conducted on a portion of the line between Sims Street Junction and West Footscray Junction that required an out-of-course action in using the Main line as a detour in order to manage the movement.

The NCO had routed several standard-gauge train movements via signal DYN114 and the Main line throughout his shift, and so had developed a routine. For train 9501, however, the route set was not suitable for broad-gauge.

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[14] Version 1.4, November 2013.

The control system displayed that a route was available as the train approached signal DYN114 and no significant prompts were displayed to draw the NCO's attention to the contrary. His expectation that the route was valid, reinforced through discussion with the locomotive driver, likely influenced their assumption that a signal failure had occurred.

The locomotive crew

The crew members' health assessment records and competencies established that they were fit for duty and had the required competencies for operating a train through this location.

Pacific National (PN) advised that a Driver Trainer performed competency assessments of a crew member for each route through verbal examination and an appraisal of the crew members documented experience (from crew diary and rosters). PN provided detailed Route Knowledge Packages for the corridors over which a locomotive crew member operated and undertook re-certification of the crew member's task performance and knowledge levels against its competency requirements at three yearly intervals.

Although these arrangements were in place, and the crew members had operated in this area on previous occasions (on movements toward W Track and North Dynon) they did not identify that it was not possible for a broad-gauge train to access a route to Tottenham Yard from signal DYN114 and proceeded until derailing the train.

Both locomotive crew primarily operated broad-gauge trains and had satisfied Pacific National's requirements for route knowledge in this area. Each crew member had experience in operating broad-gauge trains out of the Port of Melbourne precinct and through the South Dynon Junction area. Both crew members, however, stated they usually departed the port precinct via the South Dock Line (this being the typical path for broad-gauge movements from the port precinct toward the west) and had travelled over the North Dock Line on only a few occasions previously. On these occasions, they had travelled in a direction away from Tottenham Yard.

There was no broad-gauge access to Tottenham Yard from the North Dock line. The locomotive crew did not identify that the routeing of train 9501 was abnormal or that the broad-gauge rail ended a short distance after signal DYN114, and drove train 9501 into derailment.

The assumption by the NCO and train crew of the existence of a system fault is pivotal to this incident. In the case of the locomotive crew, there were a number of factors that potentially influenced their perception that the route ahead was valid:

- One crew member reported that the Home signal controlling their exit from the port precinct had displayed a 'V' symbol denoting that the gauge detection system had identified them as a broad-gauge train. He stated 'I was therefore in no doubt that the controller was aware that [train 9501] was a broad-gauge train and that the signalling system was set up for a broad-gauge movement.'
- The co-driver believed that signals throughout this locale were approach-activated. Although incorrect, this is significant, since any anticipation on the part of a locomotive crew that signal DYN114 would clear on approach might lead to an assumption that, were it not to do so, it must be faulty.
- When the locomotive driver reported to the network controller that signal DYN114 was 'at Red' but that the next signal (DYN150 on a standard-gauge portion of the Main line ahead) was displaying a Proceed indication and the points next in advance (standard-gauge points No. 133U) were correctly set, the network controller attempted to re-clear DYN114. When this was unsuccessful he informed the driver that he would provide authorisation to take the train past the signal and the driver did not challenge this intent. In the process of issuing this verbal authorisation the network controller informed the locomotive driver that the points (No. 113, protected by signal DYN114) were 'set and locked'. The nature of this exchange between driver and controller created a perception that the intended action (of continuing past signal DYN114) was an unexceptional event.

After being authorised to pass signal DYN114, the locomotive driver expected the route to be correctly set as he had sighted another signal ahead displaying a Proceed indication. This signal did not apply to train 9501, and the locomotive crew proceeded past signal DYN114 without observing that the broad gauge rail ended a short distance beyond.

Fatigue

In the context of human performance, fatigue is a physical and psychological condition primarily caused by prolonged wakefulness and/or insufficient or disturbed sleep.[15] Fatigue can have a range of influences on performance, such as decreased short-term memory, slowed reaction time, decreased work efficiency, reduced motivational drive, increased variability in work performance, and increased errors of omission.[16]

The derailment occurred at about 0625, part way through the train crew's shift that had commenced at about 0200 that day. The NCO was into the final hour of an 8-hour shift that started at 2300 the previous day. Immediately prior to the commencement of their shifts, the NCO, driver and co-driver were off duty for a period of 16, 16 and 13 hours respectively. The duration of the off-duty period meant that there was opportunity available for the NCO, driver and co-driver to attain restorative sleep prior to commencing work.

Early shift start times, such as existed in this case, are associated with increased safety risk attributable to fatigue effects. Some research suggests that approximately 15 minutes of sleep are lost for every hour of start time prior to 0900.[17] However, fatigue-related error can also be influenced by cognitive workload. The term 'cognitive workload' refers to a measure of the type or nature of work being undertaken with regard to its demands on an individual's cognitive resources. Cognitive (mental) workload can be in 'overload' where the demands on working memory are excessive, or 'underload' brought on by periods of relative inactivity and boredom. The relationship between workload and fatigue can be thought of as a U-curve, with increased likelihood of fatigue-related error when workload is either very high, or very low.[18]

In this instance, train 9501 was stopped at signal DYN114 and the crew were discussing the situation with the NCO. These conditions would suggest that there was no increased likelihood of fatigue-related error since it is unlikely that the crew or NCO's cognitive workload was either over- or underloaded.

Considering the opportunities available for restorative sleep prior to commencing work and the cognitive workload of the crew and NCO at the time of the incident, it is unlikely that fatigue had adversely affected their performance.

Other occurrence

This incident follows a similar derailment investigated by the Chief Investigator Transport Safety (Victoria) in October 2010.[19] This investigation identified a Safety Issue regarding the design of dual gauge turnouts where the standard gauge track continues but the broad-gauge rail terminated.

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15 National Transport Commission (2008). National Rail Safety Guideline. Management of Fatigue in Rail Safety Workers.

16 Battelle Memorial Institute (1998). An Overview of the scientific literature concerning fatigue, sleep, and the circadian cycle, Report prepared for the Office of the Chief Scientific and Technical Advisor for Human Factors, US Federal Aviation Administration.

17 Roach, G.D., Sargent, C., Darwent, D. & Dawson, D. (2012). Duty periods with early start times restrict the amount of sleep obtained by short-haul airline pilots. Accident Analysis and Prevention, 45S, 22-26.

18 National Transport Commission (2008). National Rail Safety Guideline. Management of Fatigue in Rail Safety Workers.

19 Office of The Chief Investigator, Rail Safety Investigation report 2010/11, Derailment of Pacific National Locomotives Melbourne Operations Terminal 2 November 2010.

Safety analysis

Train Control System (TCS) – design and screen display

An 'error-provocative' environment is one that lacks sufficient controls so that it provokes, entices or stimulates individuals to make errors. These errors are manifested as unsafe acts. Chapanis posits that '…an error-provocative situation almost literally invites people to commit errors'.[20]

The train control system screen display presented the route—which included a portion of standard-gauge-only trackage—as being viable even after gauge detection identified the train as being broad-gauge. Other than the Stop indication on signal DYN114, there was minimal warning to alert the network controller that a portion of the established route was incompatible with the approaching train.

The presence and graphical clarity of track and train gauge information assumes critical significance under circumstances where an intervening Home signal will not clear and the network controller is intending to issue a proceed authority. The manner in which the TCS display was graphically presented led the network controller to believe the route was valid when it was not. Essential TCS display information that could have supported the network controller's decision-making was lost after the route was selected, at which point the explicit differentiation between the various lines of the different track gauges was no longer apparent. In addition, the small on-screen symbol that served to indicate that the approaching train was occupying the broad-gauge was diminutive and therefore inconspicuous and inadequate as an alert.

Authorising movement past Home signals at Stop

Two ARTC operating instructions (Standing Train Notices No. 2533, 12/12/08, and No. 2529 15/12/09) described protocols for the operation of signalling between South Dynon Junction and West Footscray Junction subsequent to commissioning of the Missing Link project.

The instructions prescribed that where signals have '…failed to assume a Proceed indication for a movement applicable to the ARTC Main Line'; the NCO will provide a 'verbal authority' for movements to pass them. In this prescription there was no recognition of the potential for such signals to be legitimately at Stop rather than being defective (that is to say, having 'failed'), and no prescribed requirement that an assessment be made to establish any such potential reasons.

Standing Train Notice 2533 listed four signals that '... move [trains] to the ARTC Main line'. These were all dwarf signals authorising trains to start from terminal areas, for which approval to pass in the Stop condition was a 'verbal authority'. However, there was another signal (DYN114) in this locality that allowed movements to proceed toward the ARTC Main line. This signal was omitted[21] from the list. Signal DYN114 also controlled access to the ARTC Main line, and since it is a Home signal a Caution Order[22], rather than 'verbal authority', was required to be issued by the NCO before the signal was passed when displaying a Stop indication.

Signals in the Dynon area may be passed at Stop following NCO authorisation through either a 'verbal authority', or a 'Caution Order' in the case of a Home signal. The verbal authority to pass applies to signals such as shunting signals that do not exist to protect an interlocking. Issue of verbal authority simply requires the controllers to determine, from their own situational awareness, whether a signal is safe to be passed despite its Stop indication.

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[20] Chapanis A: 'The Error-Provocative Situation', in The Measurement of Safety Performance, ed Tarrants W E, New York: Garland Publishing, 1980.

[21] ARTC advised that the exclusion of signal DYN114 from this instruction was an oversight at the time the project was commissioned.

[22] The full title for this instrument is Signalman's Caution Order For Driver To Pass A Home Signal At The 'Stop' Position.

A Caution Order, on the other hand, requires more circumspection in the process to be used for bypassing. A Caution Order is issued if the controller cannot determine why the signal will not clear to a Proceed indication, or is aware of a likely reason and has determined that it should be safe to pass subject to certain precautions to be taken by the train crew (such as proceeding with caution). In this incident, the network controller issued 'verbal authority' to the train crew to pass the Home signal at Stop when the correct procedural requirement was a Caution Order, a more formal type of authority.

A Caution Order consists of both verbal and written aspects. The verbal aspect is similar to the prescribed process known as 'verbal authority' except that in the case of a Caution Order a specific warning '...to proceed cautiously as far as the next fixed signal' is included and the controller must take several other prescribed actions to issue one. Caution Orders are also documented by the NCO and archived on a book-fast copy. In Automatic Block Signalling territory[23], as applied in this incident, the locomotive crew member receives the authority as a verbal instruction and does not document it.[24] An NCO's responses in situations such as this will potentially be influenced by any ambiguity in guidance and procedural documentation. Since verbal communication is common to both, the procedures can be confused in discussion. This is further reinforced within the Pacific National Route Knowledge Package (refer to the following section) where an informal amalgamation of the official terms 'verbal authority' and 'caution order' has resulted in the expression 'verbal caution order' being adopted. This creates the potential for confusion regarding the actual process intended and required to be followed. When the distinction between the two processes is not clearly understood by operating personnel the more expedient option is likely to be used instead of the more rigorous but correct one. Further to this, the two terms are no longer formally defined within the applicable Book of Rules (TA-20).[25]

Three ARTC reference documents, describe the process for authorising a movement past signals at Stop. Home signal DYN114 is marked on one document as requiring that the NCO issue a Caution Order whereas the other two sources state, inconsistently, that the NCO will provide verbal authority to pass signals at Stop. As well as increasing the opportunity for confusion, this inconsistency introduces the potential risk that a train could be authorised to pass an absolute signal that is expected to have assumed a Proceed indication but has not.

The action of issuing a Caution Order is more significant for complex areas of mixed-gauge trackage, such as exist at South Dynon Junction, where there is a greater potential for gauge incompatibility between train and track. The process did not require that a check be made of compatibility between the train gauge and the track gauge in the established route.

Route Knowledge Package

PN provided locomotive crews with a Route Knowledge Package for each corridor over which a crew member operates. These packages were designed as a resource for driver training and as a general operating reference, and it was the expectation of PN that drivers would use them as necessary to maintain their familiarity with those corridors. The Pacific National Route Knowledge Package for the corridor from Southern Cross [Station] to Dimboola covered the territory relevant to the operation of train 9501 from Appleton Dock to Tottenham Yard. The Route Knowledge Package also described the signals applicable to South Dynon.

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[23] Automatic Block Signalling is railway safeworking system in which signals divide a line into a series of track sections, or 'blocks'. The system controls the movement of trains between the blocks using automatic signals and is designed to allow trains operating in the same direction to follow each other in a safe manner without risk of rear-end collision.

[24] This process differs from that applying to Centralised Traffic Control territory, where the train crew member must write out the Caution Order on the appropriate form and retain it in the driving cab.

[25] TA 20 is ARTC's implementation of railway Safeworking procedures for operations of trains in Victoria. It is based on the Victorian Public Transport Corporation Book of Rules (1994).

The description for signal DYN114 included its location on the Main line plus a description of the gauge indicator lights and Theatre-type Route Indicator displays. The description in the Route Knowledge Package of the displays provided by the Theatre Route Indicator were incorrect in that the description included an 'L' display indicating route availability to the Local line. However, the Theatre Route Indicator on signal DYN114 did not include an 'L' indication[26] and the signal could not convey authority for a movement to the Local line, which was not immediately accessible from this location. The correct displays were; 'M' denoting a standard-gauge route direct to the Main line; 'N' for the dual gauge W track connection to North Dynon Junction; 'P1' for a direct, standard-gauge route onto track 1 of the LPC; and 'P3' for a standard-gauge route onto track 3 of the LPC, accessed off W track.

The Route Knowledge Package did not include track layout diagrams or any specific warnings for dual-gauge points (such as the No. 113 points) where one of the track gauges terminated on one leg of the turnout shortly after the points.

Had the dual-gauge points configuration—where a particular track gauge was not available on one leg of the turnout—been specifically identified, the train crews' awareness of the potential risk of derailment arising from this type of configuration may have prompted them to greater diligence in their scrutiny of the route ahead or to query the authority to proceed.

As mentioned in the previous section, signal instructions contained within the locomotive driver's Route Knowledge Package were also prescriptive but inaccurate. They specified that 'verbal caution orders' are issued from the signaller in Adelaide' ('signaller' meaning the ARTC NCO working the Melbourne Metro Board) as authority to pass signals at South Dynon Junction that are displaying a Stop indication. The term 'verbal caution order' was in this case a misleading reference to the ARTC Caution Order.

Use of dual-gauge points assemblies

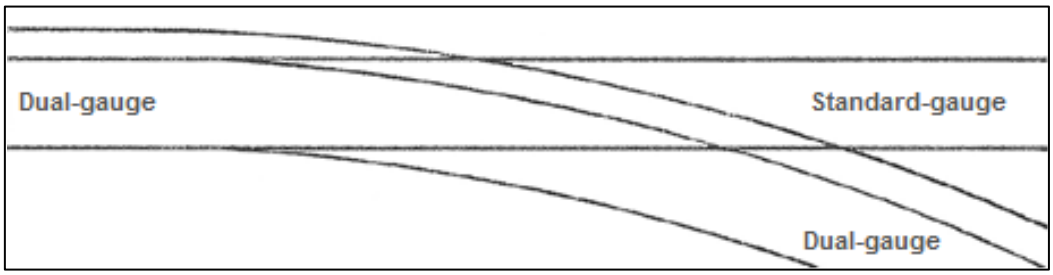
It was ARTC engineering practice to install dual gauge points assemblies when constructing layouts incorporating multiple track gauges. This allowed a single type of points installation rather than various site-specific configurations. The introduction of this type of points assembly, where one of the track gauges is truncated in one of the exit directions, has created the potential for this type of derailment, and defences provided to date have proven inadequate.

In both this occurrence and the prior October 2010 occurrence, the derailments occurred after the train was authorised to proceed beyond a signal displaying a Stop indication, and the train was taken forward without its crew noticing that the broad-gauge rail ended. In neither case was there any indication suitably positioned to warn of the end of broad-gauge track.

Previous practice within Victoria in the provision of points installations where both broad- and standard-gauge tracks enter the switch, but where only the standard-gauge continues in the straight-ahead direction is shown in Figure 7. With this type of assembly the broad-gauge train cannot be directed to truncated track and were the points to be set incorrectly, this would be more visible to the crew prior to passing the signal. Derailments of this type would then be less likely.

[26] Ref: South Kensington Signalling Diagram № 20/14.

Figure 7: Dual-gauge turnout with only standard-gauge switchable



Source: Chief Investigator, Transport Safety (Victoria)

Findings

From the evidence available, the following findings are made with respect to the derailment of Pacific National freight train 9501V at South Dynon Junction, West Melbourne on 2 March 2013. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing factors

- The network control officer established a route for the broad-gauge train on which there was no broad-gauge track available
- **The train control system screen display provided no direct indication to the network control officer that one section of the established route was dual-gauge and another section single-gauge. [Safety issue]**
- **When train 9501 approached signal DYN114, which was displaying a Stop indication, there was minimal indication to the network control officer that the train gauge and the selected route were incompatible. [Safety issue]**
- The network control officer assumed that signal DYN114 was defective and authorised the locomotive crew to pass it when it was displaying a valid Stop indication.
- The locomotive crew did not observe that the broad-gauge rail ended a short distance beyond signal DYN114.
- **The configuration of the dual-gauge points assembly led to a truncated broad-gauge rail in one of the turnout directions. [Safety issue]**

Other factors that increased risk

- **The train operator's Route Knowledge Package did not include track layout diagrams, or specific information warning of the existence of dual-gauge turnouts where track terminated in one direction. [Safety issue]**
- **There was no warning indication at signal DYN114 to warn train crews that the broad-gauge rail terminated in the straight-ahead direction. [Safety issue]**
- **The guidance documentation and procedures for authorising movement past signals displaying a Stop indication was ambiguous. [Safety issue]**
- **The process undertaken by the network control officer for issuing a Caution Order did not require validation of compatibility between the gauge of the train and the established route. [Safety issue]**

Other findings

- Train 9501 was despatched from Appleton Dock by a route that was not the usual one for this train and did not provide a connection to Tottenham Yard.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Train control system screen display – route information

Number:	RO-2013-009-SI-01
Issue owner:	Australian Rail Track Corporation
Operation affected:	Rail: Operations control
Who it affects:	Infrastructure managers

Safety issue description:

The train control system screen display provided no direct indication to the network control officer that one section of the established route was dual-gauge and another section single-gauge.

Response to safety issue and/or Proactive safety action taken by Australian Rail Track Corporation

Action number: RO-2013-009-NSA-059

The network control officer currently receives a warning dialogue box if the train gauge and route selected are incompatible. The signal interlocking will hold the signal at stop if the route selected and train gauge are incompatible.

Action number: RO-2013-009-NSA-060

In addition, ARTC will investigate with the Train Control System provider (Ansaldo) the option of removing the ‘route set’ functionality from the screen display where there is incompatibility between the route selected and the train gauge required.

Current status of the safety issue

Issue status: Adequately addressed.

Justification: The Australian Transport Safety Bureau is satisfied that the action proposed by ARTC will adequately address the safety issue.

Train control system screen display – incompatible gauge warning

Number:	RO-2013-009-SI-02
Issue owner:	Australian Rail Track Corporation
Operation affected:	Rail: Operations control
Who it affects:	Infrastructure managers

Safety issue description:

When train 9501 approached signal DYN114, which was displaying a Stop indication, there was minimal indication to the network control officer that the train gauge and the selected route were incompatible.

Response to safety issue and/or Proactive safety action taken by Australian Rail Track Corporation

Action number: RO-2013-009-NSA-061

ARTC advised that the train control system software has been modified to provide for an interactive on-screen alert dialogue in the event that a network control officer attempts to set a route that includes the wrong gauge for the train that is to use it.

Current status of the safety issue

Issue status: Adequately addressed.

Justification: The Australian Transport Safety Bureau is satisfied that the action taken by ARTC adequately addresses the safety issue.

Configuration of dual-gauge points assembly

Number:	RO-2013-009-SI-03
Issue owner:	Australian Rail Track Corporation
Operation affected:	Rail: Infrastructure
Who it affects:	Infrastructure managers

Safety issue description:

The configuration of the dual-gauge points assembly led to a truncated broad-gauge rail in one of the turnout directions.

Response to safety issue and/or Proactive safety action taken by Australian Rail Track Corporation

Action number: RO-2013-009-NSA-062

Australian Rail Track Corporation is aware of the hazard posed by the cessation of the broad-gauge rail and will include consideration of it in future risk assessments as well as the option for additional controls (such as [1] the installation of indicators at dual-gauge turnouts to indicate track gauge configuration on both the straight and turnout routes; and, [2] the application of white, reflectorised branding to the top of the rail head near the end of the broad-gauge rail, and/or the welding of short lengths of thin steel to the head of the broad-gauge rail at such regular intervals as to create a ‘rumble-strip’ effect.).

Current status of the safety issue

Issue status: Adequately addressed.

Justification: The Australian Transport Safety Bureau is satisfied that the action proposed by ARTC will adequately address the safety issue.

Route knowledge information to train drivers

Number:	RO-2013-009-SI-04
Issue owner:	Pacific National
Operation affected:	Rail: Operations control
Who it affects:	Rail operators

Safety issue description:

The train operator's Route Knowledge Package did not include track layout diagrams, or specific information warning of the existence of dual-gauge turnouts where track terminated in one direction.

Response to safety issue and/or Proactive safety action taken by Pacific National

Pacific National is conducting a training review of the Southern Cross-to-Dimboola Route Knowledge Package and will distribute the amended package to all South Dynon train crew.

ATSB comment in response:

The ATSB notes that Pacific National is reviewing the relevant Route Knowledge Package.

ATSB safety recommendation to Pacific National:

Action number: RO-2013-009-SR-066

Action status: Monitor

The Australian Transport Safety Bureau recommends that Pacific National undertake further work to address this safety issue.

Current status of the safety issue

Details of the current status of this safety issue are available at www.atsb.gov.au.

Indicating the termination of broad-gauge track

Number:	RO-2013-009-SI-05
Issue owner:	Australian Rail Track Corporation
Operation affected:	Rail: Infrastructure
Who it affects:	Infrastructure managers

Safety issue description:

There was no warning indication at signal DYN114 to warn train crews that the broad-gauge rail terminated in the straight-ahead direction.

Response to safety issue and/or Proactive safety action taken by Australian Rail Track Corporation

Action number: RO-2013-009-NSA-063

ARTC will install signage onsite at the end of the turnout to indicate the cessation of the broad gauge track, e.g. 'End of Broad Gauge', provided a suitable and effective location free of any OH&S concerns can be identified. Additionally, ARTC will investigate the option of applying additional controls through:

- The installation of indicators at dual-gauge/single-gauge turnouts to indicate track gauge configuration for train movements on the straight and diverging routes, e.g. DG/SG
- Affix white reflectorize branding on the top of the rail head near the end of the broad gauge rail to indicate the physical cessation of the broad gauge

Current status of the safety issue

Issue status: Adequately addressed.

Justification: The Australian Transport Safety Bureau is satisfied that the action proposed by ARTC will adequately address the safety issue.

Authorising movement past a signal at stop

Number:	RO-2013-009-SI-06
Issue owner:	Australian Rail Track Corporation
Operation affected:	Rail: Infrastructure
Who it affects:	Infrastructure managers

Safety issue description:

The procedures and guidance documentation for authorising movement past signals displaying a Stop indication was ambiguous.

Response to safety issue and/or Proactive safety action taken by Australian Rail Track Corporation

Action number: RO-2013-009-NSA-064

ARTC has mandated that network control officers complete a written Signalman's Caution Order form prior to verbally transmitting the instruction to the crew on all occasions when it is necessary to issue such an authority.

Australian Rail Track Corporation has developed a draft Standing Notice to supersede Standing Notices SN2533 (2008) and SN2529 (2009). The draft Standing Notice will contain the procedure for managing failure of points and the process for issuing an authority (Caution Order) to proceed past a signal that does not display a Proceed indication as expected. The draft Standing Notice will contain information of the 'End of Broad Gauge' signage and the DG/SG turnout indicators.

The Caution Order process will be amended to include the passing of dwarf signals that do not display a Proceed indication as expected.

The draft Standing Notice once approved will be distributed to all Operators and stakeholders.

Current status of the safety issue

Issue status: Adequately addressed.

Justification: The Australian Transport Safety Bureau is satisfied that the action proposed by ARTC will adequately address the safety issue.

Caution Orders - validating train and route compatibility

Number:	RO-2013-009-SI-07
Issue owner:	Australian Rail Track Corporation
Operation affected:	Rail: Operations control
Who it affects:	Infrastructure managers

Safety issue description:

The process undertaken by the network control officer for issuing a Caution Order does not require validation of compatibility between the train gauge and the established route.

Response to safety issue and/or Proactive safety action taken by Australian Rail Track Corporation

Action number: RO-2013-009-NSA-065

Australian Rail Track Corporation advised that they have taken the following action:

Modify the network control officer’s copy of the Signalman's Caution Order form to include check boxes identifying that:

- the established route is gauge-compatible with the train about to receive the Signalman's Caution Order;
- route integrity has been verified by reference to the TCS display.

Current status of the safety issue

Issue status: Adequately addressed.

Justification: The Australian Transport Safety Bureau is satisfied that the action taken by ARTC adequately addresses address the safety issue.

General details

Occurrence details

Date and time:	2 March 2013 – 0620 EDT	
Occurrence category:	Incident	
Primary occurrence type:	Derailment	
Location:	No. 113 points, South Dynon Junction, West Melbourne	
	Latitude: 37° 48.282' S	Longitude : 144° 54.622' E

Train details

Train operator:	Pacific National	
Registration:	Train No. 9501	
Type of operation:	Rail - freight	
Persons on board:	Crew – 2	Passengers – 0
Injuries:	Crew – 0	Passengers –0
Damage:	Minor to locomotive	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- Australian Rail Track Corporation Ltd
- Pacific National Pty Ltd

References

Battelle Memorial Institute (1998). An Overview of the scientific literature concerning fatigue, sleep, and the circadian cycle, Report prepared for the Office of the Chief Scientific and Technical Advisor for Human Factors, US Federal Aviation Administration.

Chapanis A: 'The Error-Provocative Situation', in The Measurement of Safety Performance, ed Tarrants W E, New York: Garland Publishing, 1980.

National Transport Commission (2008). National Rail Safety Guideline. Management of Fatigue in Rail Safety Workers.

Office of The Chief Investigator, Rail Safety Investigation report 2010/11, Derailment Pacific National Locomotives Melbourne Operations Terminal 2 November 2010.

Roach, G.D., Sargent, C., Darwent, D. & Dawson, D. (2012). Duty periods with early start times restrict the amount of sleep obtained by short-haul airline pilots. Accident Analysis and Prevention, 45S, 22-26.

Submissions

Under Part 4, Division 2 (Investigation Reports), 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. Section 26 (1) (a) of the Act 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 ARTC, Pacific National, Office of the National Rail Safety Regulator, ARTC network controller and the crew of train 9501V.

Submissions were received from ARTC, Pacific National and the Office of the National Rail Safety Regulator. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (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 Commonwealth 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 fare-paying passenger operations.

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.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
Derailment of freight train 9501V
South Dynon Junction, West Melbourne, Victoria, 2 March 2013

RO-2013-009
Final – 4 Septemner 2014