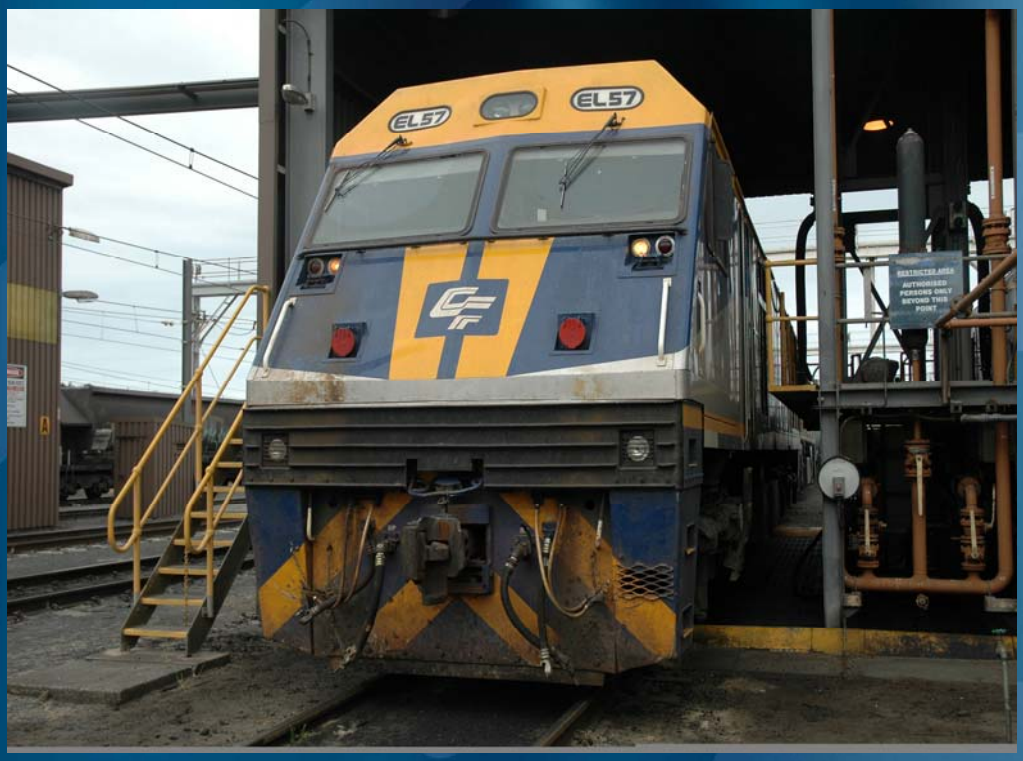
OTSI Office of Transport Safety Investigations

RAIL SAFETY INVESTIGATION REPORT

UNCONTROLLED MOVEMENT OF EL ZORRO GRAIN SERVICE 3996

UNANDERRA

7 FEBRUARY 2011



RAIL SAFETY INVESTIGATION REPORT

UNCONTROLLED MOVEMENT OF EL ZORRO GRAIN SERVICE 3996

UNANDERRA

7 FEBRUARY 2011

Investigation Reference: 04505

Published by: The Office of Transport Safety Investigations

Postal address: PO Box A2616, Sydney South, NSW 1235

Office location: Level 17, 201 Elizabeth Street, Sydney NSW 2000

Telephone: 02 9322 9200

Accident and incident notification: 1800 677 766

Facsimile: 02 9322 9299

E-mail: info@otsi.nsw.gov.au

Internet: www.otsi.nsw.gov.au

THE OFFICE OF TRANSPORT SAFETY INVESTIGATIONS

The Office of Transport Safety Investigations (OTSI) is an independent NSW agency whose purpose is to improve transport safety through the investigation of accidents and incidents in the rail, bus and ferry industries. OTSI investigations are independent of regulatory, operator or other external entities.

Established on 1 January 2004 by the Transport Administration Act 1988, and confirmed by amending legislation as an independent statutory office on 1 July 2005, OTSI is responsible for determining the causes and contributing factors of accidents and to make recommendations for the implementation of remedial safety action to prevent recurrence. Importantly, however, OTSI does not confine itself to the consideration of just those matters that caused or contributed to a particular accident; it also seeks to identify any transport safety matters which, if left unaddressed, might contribute to other accidents.

OTSI's investigations are conducted under powers conferred by the Rail Safety Act 2008 and the Passenger Transport Act 1990. OTSI investigators normally seek to obtain information cooperatively when conducting an accident investigation. However, where it is necessary to do so, OTSI investigators may exercise statutory powers to interview persons, enter premises and examine and retain physical and documentary evidence.

It is not within OTSI's jurisdiction, nor an object of its investigations, to apportion blame or determine liability. At all times, OTSI's investigation reports strive to reflect a "Just Culture" approach to the investigative process by balancing the presentation of potentially judgemental material in a manner that properly explains what happened, and why, in a fair and unbiased manner.

Once OTSI has completed an investigation, its report is provided to the NSW Minister for Transport for tabling in Parliament. The Minister is required to table the report in both Houses of the NSW Parliament within seven days of receiving it. Following tabling, the report is published on OTSI's website at www.otsi.nsw.gov.au.

OTSI cannot compel any party to implement its recommendations and its investigative responsibilities do not extend to overseeing the implementation of recommendations it makes in its investigation reports. However, OTSI takes a close interest in the extent to which its recommendations have been accepted and acted upon. In addition, a mechanism exists through which OTSI is provided with formal advice by the Independent Transport Safety Regulator (ITSR) in relation to the status of actions taken by those parties to whom its recommendations are directed.

CONTENTS

TABLE OF FIGURES

ACRONYMS AND ABBREVIATIONS

ARTC ..... Australian Rail Track Corporation
AWB..... Australian Wheat Board
CFCLA ..... CFCL Australia
CARS ..... China International Marine Containers Rolling Stock Australia Pty Ltd
DIP ..... Directly Involved Party
El Zorro..... El Zorro Transport Pty Ltd
ITSR ..... Independent Transport Safety Regulator
LAU..... Local Appendix Unit
NCCS ..... ARTC's Network Control Centre South at Junee
NOS..... Network Operations Superintendent
OTSI..... Office of Transport Safety Investigations
PKS…… ..... Power Knockout Switch
QRRS..... Qiqihar Railway Rolling Stock Co Ltd
RISSB ..... Rail Industry Safety and Standards Board
SPAD…… ..... Signal Passed at Danger
TOB……..... Tonnes per Operative Brake
TOC..... Train Operating Conditions (Manual)

GLOSSARY OF TERMS

Exhaust Chokes	Exhaust chokes are devices that delay the release of the brakes in order to give the operator of a train time to re-charge air reservoirs on the wagons.
Full Mechanical Inspection (FX1) and General Mechanical Inspection (FX2)	Full mechanical inspection includes the visual inspection of each vehicle in respect to the adjustment, condition and/or security of a designated list of mechanical apparatus by a qualified worker; whereas a general mechanical inspection includes a visual inspection of each vehicle in respect to the adjustment condition and/or security of designated apparatus by the train crew.
Local Appendix Unit (LAU)	Local Appendix Units contain information pertaining to local conditions such as layout diagrams and descriptions, and local procedures.
Network Control Officer (NCO)	A Train Controller for an unattended location, a Signaller for an attended location, or a delegate carrying out some functions of a Train Controller or Signaller.
Qualified Worker	A worker certified as competent to carry out the relevant task.
Section	The line between the departure-end yard limit of one location and the arrival-end yard limit of another location.
Signaller (RailCorp only)	A Qualified Worker who works points, signals and other signalling equipment to manage routes for safe and efficient transit of rail traffic.
Single /Dual Pipe Trains	A single pipe train is a train that only has one airline pipe running through the consist for braking and recharging air reservoirs. The disadvantage of a single pipe train is that it takes much longer to recharge the air brake system. Therefore, on long steep descending grades, drivers have to wait longer before they can reapply the brakes of their trains. Dual piped trains comprise of two types, the first type is fitted with a main reservoir pipe which recharges the air brake system – these are true dual pipe systems. The second type is fitted with a main reservoir system, but instead of recharging the main air brake system it feeds auxiliary equipment such as roof hatches and discharge chutes.
Tonnes per Operative Brake (TOB)	Gross trailing tonnage of the train divided by the total number of wagons (i.e., not including locomotives) having operative brakes.
Track	The combination of rails, rail connectors, sleepers, ballast, points and crossings.
WB Radio	Local or WB radio provides open channel communications on the UHF frequency 450.050 MHz and is used as a backup to the CountryNet radio system.

EXECUTIVE SUMMARY

At approximately 6.38am[1] on 7 February 2011, loaded El Zorro Transport Pty Ltd grain service 3996, en route from West Wyalong to Port Kembla, passed signal WG 1014 at danger before coming to a stand 527 metres beyond the signal which is located on the Northern side of Unanderra Station. The driver had not been able to control the speed of the train towards the end of its descent of the steeply sloping Illawarra Mountain. No injuries resulted from the incident and there was no damage occasioned to any rolling stock or infrastructure.

The investigation found that the train became uncontrolled during its descent because the manner in which it was driven did not provide for effective braking. Initial braking effort was too 'light', but then was progressively increased until a full brake application was achieved using the brake valve "handle-off" position rather than the full service or emergency position. At a critical point in the sequence of events, braking became unbalanced when the dynamic brake was disengaged and then re-engaged. In addition, on a number of occasions throughout the journey, the train was allowed to travel well in excess of the designated speed of 25 km/h for single pipe trains (see *Glossary of Terms*) as well as the posted speed of 30 km/h.

Although it did not contribute directly to the uncontrolled movement, there was a difference between the type of braking system actually fitted to the train and the system that was listed in the Train Operating Conditions (TOC) manuals. The WGBY class of wagon making up the consist of the train was fitted with a 'dual pipe' braking system. However, this was not documented or recognised as such during the certifying process on their introduction into service or during subsequent operations. Consequently, they were listed in the RailCorp and Australian Rail Track Corporation (ARTC) Train Operating Conditions (TOC) manuals as 'single pipe' wagons.

In response to the incident, El Zorro instituted a range of remedial actions in relation to the route between Moss Vale and Inner Harbour concerning driver route knowledge, training and assessment, and random auditing of train safety. El Zorro

[1] All times referred to in this report are in Eastern Daylight Saving Time (UTC+11 hours).

has also introduced additional checks during train inspections, reminded drivers of the use of the CountryNet radio 'emergency' function and updated internal rolling stock registration procedures.

In relation to the categorisation of wagons on introduction into service, it is recommended that RailCorp and the ARTC review their procedures for the certification of new and modified rolling stock with particular emphasis on the process of verification of the information provided by rolling stock owners and operators, and also validate the accuracy of categorisation of single and dual pipe wagons in their TOC manuals. It is also recommended that China International Marine Containers Rolling Stock Australia Pty Ltd (CARS), who were contracted to manage the design, manufacture, importation and commissioning of the WGBY wagons, review their procedures for the presentation of new and modified rolling stock for certification with particular emphasis on complete and accurate preparation of documentation.

It is further recommended that the Rail Industry Safety and Standards Board (RISSB) develop a standard defining what constitutes single and dual pipe wagons.

Full details of the Findings and Recommendations of this investigation are contained in Parts 3 and 4 respectively.

PART 1 CIRCUMSTANCES OF THE INCIDENT

Incident Synopsis

1.1 At approximately 6.38am on 7 February 2011, loaded El Zorro grain service 3996, en route from West Wyalong to Port Kembla, passed signal WG 1014 at danger before coming to a stand 527 metres beyond the signal which is located on the Northern side of Unanderra Station (see *Figure 1*). The driver had not been able to control the speed of the train towards the end of its descent of the steeply sloping Illawarra Mountain. No injuries or damage resulted from the incident.

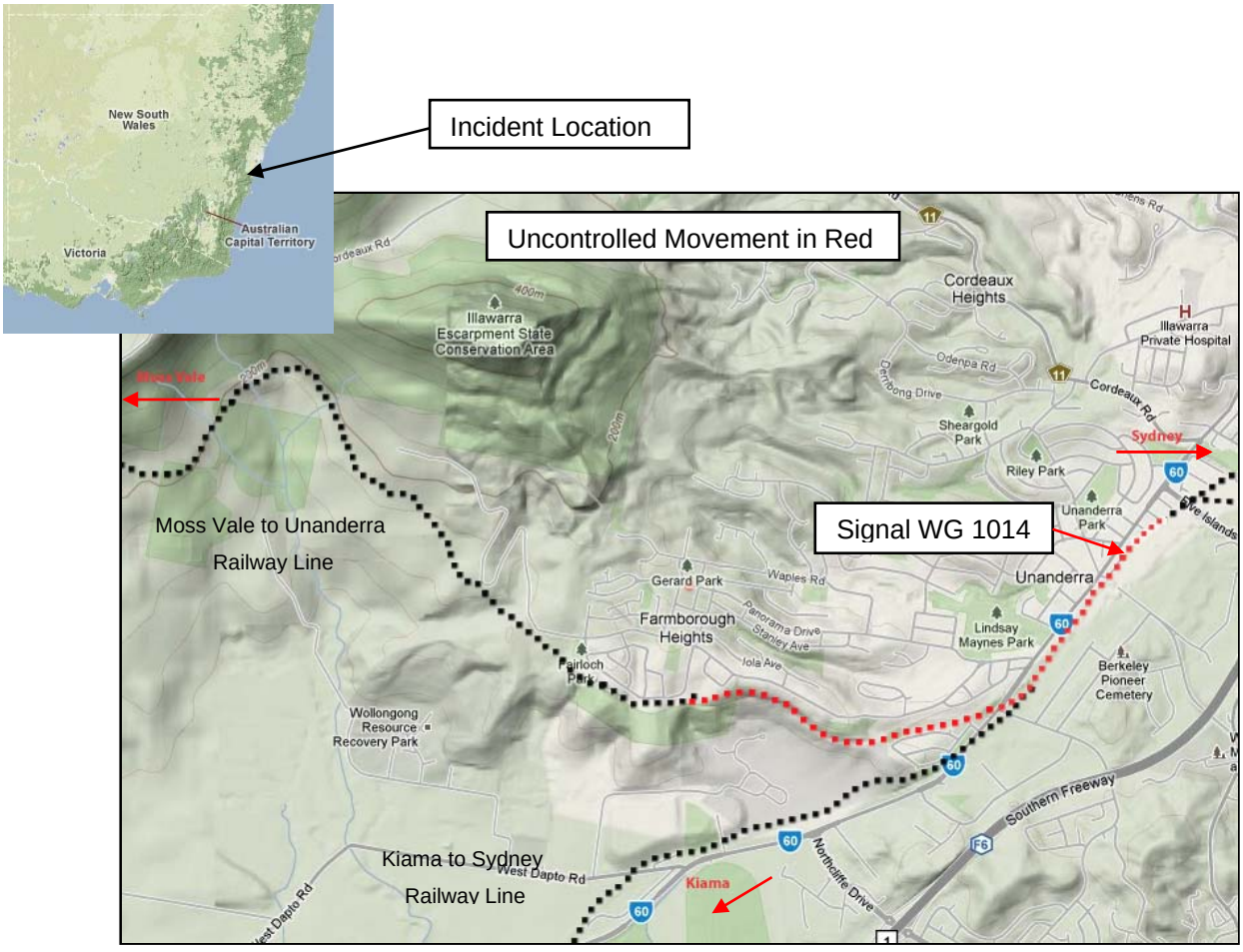


Figure 1: Illawarra and incident locations

Location and Track Information

1.2 The Moss Vale to Unanderra railway line is approximately 63 km in length and has one of the steepest grades in the NSW rail network. The last 20 km (approximately) has a near continuous descending gradient of 1 in 30 (see *Figure 2*) which is known colloquially among railway personnel as the 'Illawarra Mountain' or the 'Illawarra'. The incident occurred on the Eastern section of the line as it flattens out on reaching the base of the Illawarra Mountain and turns North East towards Wollongong.

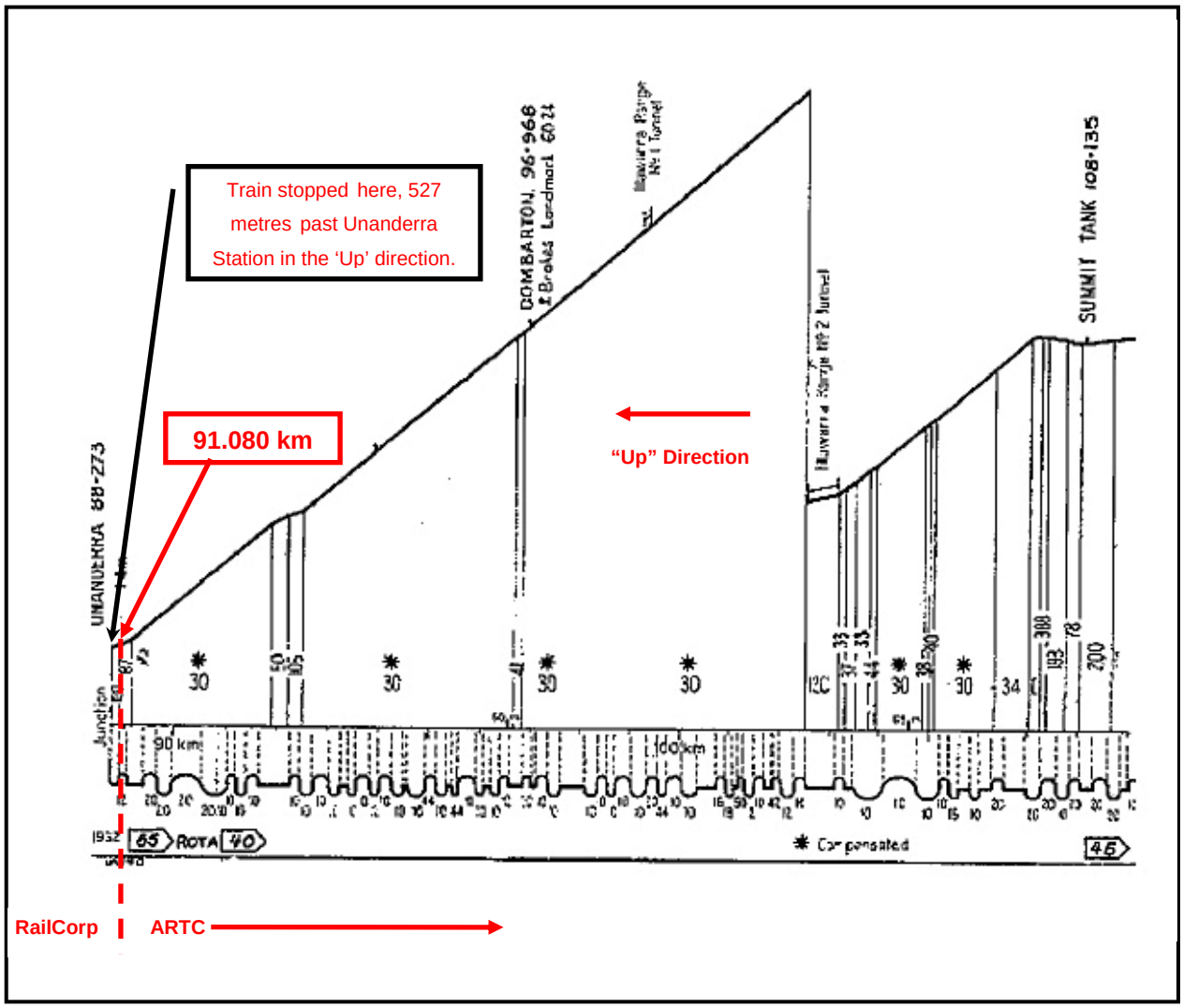


Figure 2: Illawarra Mountain gradient diagram

1.3 Unlike other areas with similarly steep descending gradients, such as the Blue Mountains, there are no relief sections of line down the Illawarra Mountain where the gradient flattens out so as to enable the recharging of brake air reservoirs. The descent requires skilled and experienced drivers

who fully understand the working of their train braking systems and the techniques used to properly control trains on long descending gradients.

1.4 The track from Moss Vale to Unanderra supports the movement of intermodal[2] freight, bulk commodities such as coal and grain, and passenger services. Train movements on the single line between Moss Vale and Dombarton and the double line from Dombarton to kilometrage 91.080 are controlled from the Australian Rail Track Corporation's (ARTC) Network Control Centre South at Junee (NCCS) under Network Rule ANSY 500 *Rail Vehicle Detection* system. From kilometrage 91.080, approximately 2.8 km West of Unanderra, train movements are controlled by RailCorp under Network Rule NSY 500 *Rail Vehicle Detection* system. In the 'Up' direction,[3] the last signal controlled from NCCS is signal WG 1052 just prior to Dombarton. From Dombarton onwards the signals are controlled from the RailCorp Signal Box at Wollongong (see *Figure 3*).

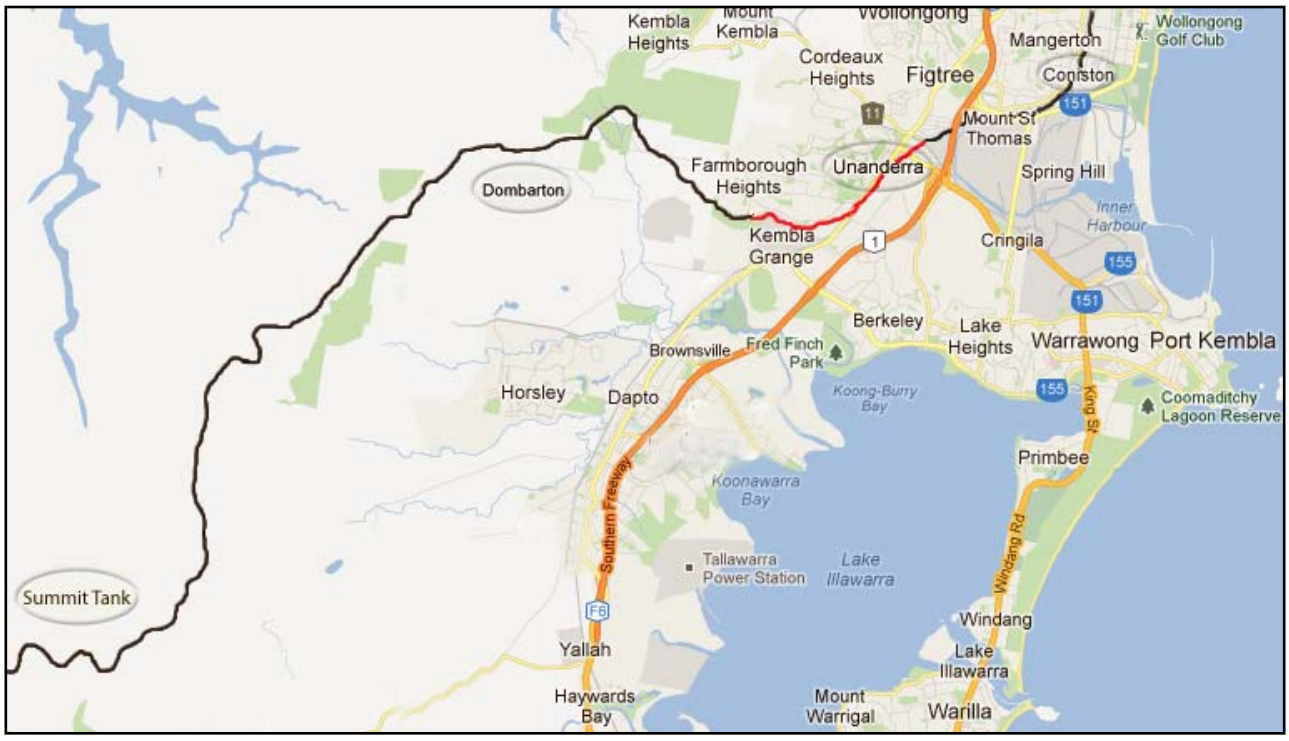


Figure 3: Key locations from Summit Tank to Coniston

2 Intermodal refers to containerised traffic.

3 Trains travelling in the "Up" direction are those travelling towards Sydney.

1.5 The track under ARTC's control is classified as a Class 1 line under its Engineering Standard TDS 11 *Standard Classification of Lines*. The track under RailCorp's control meets the specification for a mixed passenger freight main line in accordance with its Engineering Standard ECS 200 *Track System*. The speed limit on the track varies between Moss Vale and Unanderra but is signposted at 30 km/h over the last 20 km of line. Intermodal and single brake pipe trains are further restricted to 25 km/h on this segment of line.

The Train

1.6 The train consisted of two locomotives, EL57 and VL352, both leased from CFCL Australia (CFCLA), and 40 WGBY grain hopper wagons, 39 of which were loaded. All WGBY wagons currently in Australia are owned by the Australian Wheat Board (AWB). The train weighed 2988 tonnes and measured approximately 691 metres in length. It was being worked under El Zorro's accreditation.

1.7 Although both the RailCorp and ARTC train operating conditions manuals stated that the WGBY wagon was of single pipe configuration, at the time of the incident, all wagons in the consist were dual piped with all hoses including brake pipe and main reservoir hoses connected, including the connection to the adjoining EL and VL class locomotives.

The Crew

1.8 The two crew members of 3996 were employees of El Zorro Transport Pty Ltd and based at Carrington in Newcastle, although they were working out of Moss Vale for the grain season. Both crew members were within their respective medical and competency assessment periods and familiar with the area. The driver qualified for the route from Moss Vale to Wollongong on 14 December 2010. Although not qualified for the section of line, the co-driver was familiar with the route having travelled over it on many occasions, and understood train management requirements on steep descents.

The Journey

1.9 The crew signed on for duty on the day of the incident at 4.00am at Moss Vale. They relieved the crew that had driven train 3996 from Stockinbingal and then departed Moss Vale at 4.34am.

1.10 The journey from Moss Vale to Summit Tank was uneventful with 3996 passing through Summit Tank, the beginning of the 20 km steep descent, at 5.46am. After passing Summit Tank the driver made a number of progressively larger brake applications on the descent into Unanderra. At 6.36am, as the train approached the bottom of the Illawarra Mountain, braking effort was lost. The train then proceeded uncontrolled through Unanderra Station and signal WG 1014, which was as STOP, before coming to a stand on the slight uphill gradient 527 metres beyond the signal.

1.11 When the driver realised they were in difficulties, he told the co-driver to contact the signaller to have signal WG 1014 cleared for them. The co-driver stated that he tried to do so on nine occasions using a mobile telephone but was unsuccessful. The signaller explained that he was busy on other calls at the time.

Initial Response

1.12 Once the train had come to a stand the crew again attempted to contact the Wollongong Signal Box by mobile telephone. On this occasion they were successful in contacting the signaller who initially requested the crew to reverse the train back behind the signal. However, after consulting with the Rail Management Centre in Sydney, and in view of the circumstances, it was decided to leave the crew and train where they had come to a stand until the crew were relieved and RailCorp's Network Operations Superintendent (NOS) could attend and take control of the situation.

1.13 RailCorp deployed the NOS who arrived on the scene at 6.58am. Meanwhile, Police were called to breath test the crew. The breath tests returned a negative result for both crew members.

1.14 There was no requirement to deploy emergency personnel or recovery teams.

Weather Conditions

1.15 Weather conditions at the time of the incident were described as mild and slightly overcast, with a temperature of 17.7ºC recorded at 9.00am at Albion Park, 12.3 km from Unanderra.

PART 2 ANALYSIS

Route Knowledge

2.1 Train drivers have to gain extensive, specific route knowledge for each individual rail section they travel over and this can take many years to fully acquire. Aspects of route knowledge include gradients, train behaviour, location of signals and speed boards, and braking and brake release points. The driver of 3996 had travelled over the route from Moss Vale to Unanderra on nine occasions between August and December 2010; on three occasions as an observer, and subsequently on six occasions controlling a train under supervision. From 14 December 2010, the day he qualified for the route, until the day of the incident, he had travelled between Moss Vale and Unanderra in the 'Up' direction on 18 occasions.

2.2 A number of other rail operators were contacted with a view to obtaining a sense of what was "normal" for drivers to qualify for the route between Moss Vale and Unanderra, in particular the route between Summit Tank and Unanderra in the 'Up' direction. The consensus was that between six and nine trips was the norm for reasonable familiarisation with the Moss Vale to Unanderra section with the emphasis being on the challenging 20 km from Summit Tank to Unanderra.

2.3 The driver was assessed for his driving, knowledge of the gradient and various techniques of braking on steep and descending gradients on a similar train to 3996 on 14 December 2010. He was instructed to utilise the dynamic brake in conjunction with the air brake so as to demonstrate his ability to control the train down the steep grade. The driver passed the assessment and was appropriately qualified for the route.

2.4 On 19 February 2011, in line with standard industry practice following a safeworking or train management incident, the driver was re-assessed and his ability in negotiating the steep gradient tested. The train used was recorded as "*only 31 wagons - 2356 tonnes*", which indicates it would have been technically easier to handle being 22% lighter than 3996. Comments recorded by the assessor on the "Locomotive Driver's Performance Review

Checklist" included: *"the driver worked the train very slow on the grade Summit Tank to Unanderra. Can only assess on this train. He needs to be looked at after doing some more trips with other drivers over the route. Very slow and over use of the brakes on grade. Can overheat, brake blocks wouldn't work to stop train. When checking wagon wheels, were very hot. Drivers train management need some work and more training on driving down grades"*.

2.5 In the Remedial Action section, the assessor noted: "*to be rostered with other driver, re-runs over route, driver very slow, over use of brake, can be dangerous over route*". When El Zorro management became aware of the assessment outcome, the driver was immediately restricted to co-driver duties on the Illawarra Mountain. The driver was subsequently returned to the Northern region of NSW where gradients are less severe and the driving demands are not as stringent.

Descending the Illawarra Mountain

2.6 The manner in which the train was driven was determined from an examination of the information from the data logger of the leading locomotive, EL57. The data logger from the trailing locomotive was of limited use in verifying the information as its time recording function became unserviceable during the journey.

Speed

2.7 The crew claimed their maximum speed at the bottom of the Illawarra Mountain was 63 km/h as noted on the train's speedometer and not 73 km/h as recorded by the data logger. CFCLA was asked to have the data logger from EL57 checked and it was found the data logger was calibrated for a wheel diameter of 971 mm instead of 956 mm, indicating the true speed was lower than recorded. On recalculation, the true speed in the case of a data logger reading of 73 km/h was determined to be 68.9 km/h. All speed data was then corrected to take into account the calibration error (see *Figure 4*).

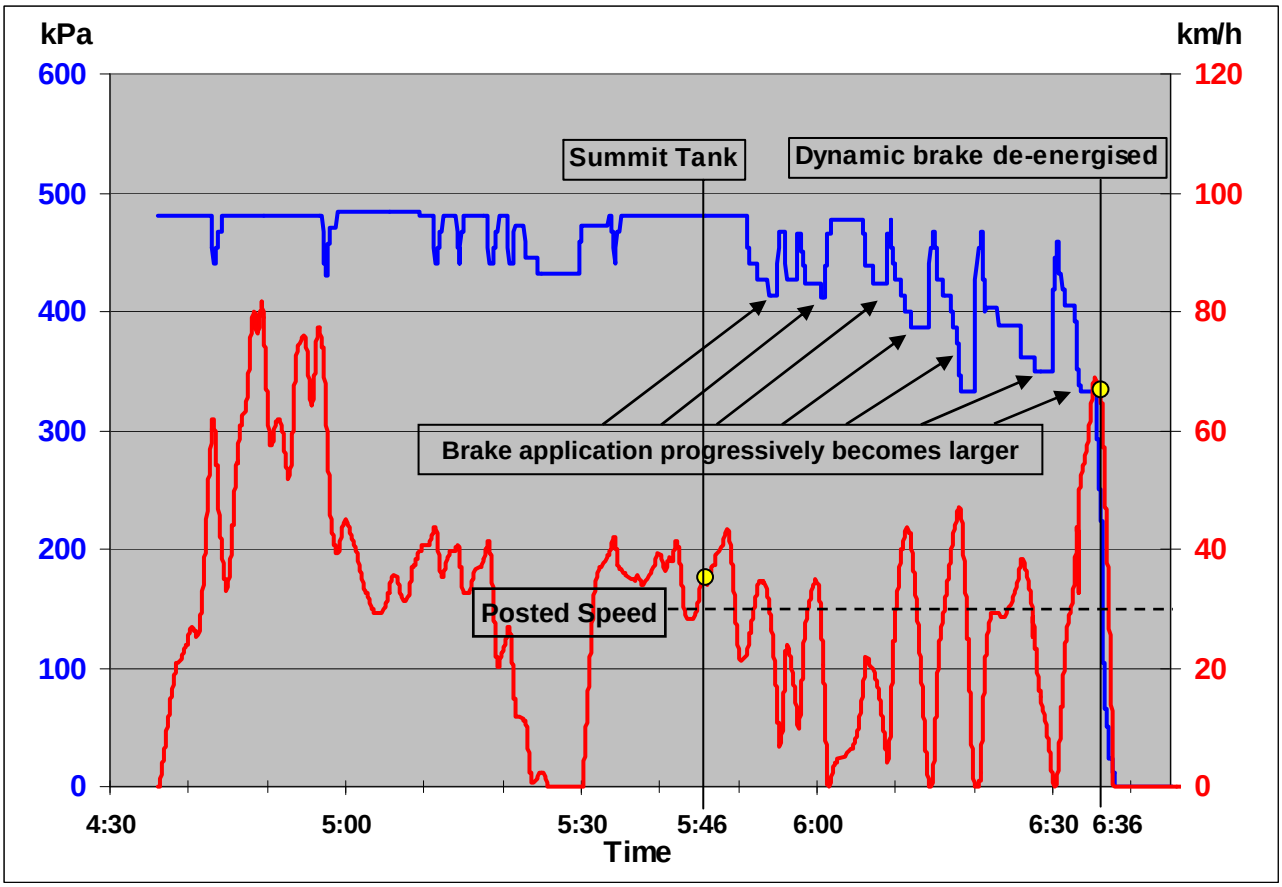


Figure 4: Brake pipe pressure, time and speed chart from Moss Vale to Unanderra

2.8 Passing through Summit Tank, the train was travelling at approximately 35 km/h, some 10 km/h over the prescribed speed limit. The section from Summit Tank to Dombarton was then covered in 34 minutes whereas the sectional running time for a train of similar weight and configuration is designated as 38 minutes.

2.9 After Summit Tank, the train exceeded the speed of 25 km/h for single pipe trains and the posted speed of 30 km/h on seven occasions. On the last occasion, it reached a maximum of 68.9 km/h before passing signal WG 1014 at STOP and coming to a stand 527 metres beyond.

Dynamic Brake

2.10 The dynamic braking function on locomotives can be used independently or in conjunction with the train's air brakes. The purpose of using dynamic braking is to reduce the use of the train's air brakes, thereby minimising costly wear and tear on brake shoes and associated equipment, and the risk of brake blocks overheating. Further, the use of dynamic brake minimises in-

train forces[4] which is particularly beneficial when descending long steep grades.

2.11 Dynamic braking operates by effectively forcing the locomotive traction motors to behave as electrical generators. Under dynamic braking, the armatures of the traction motors are made to rotate by virtue of the momentum of the train rather than by the electrical current produced by the main alternator.

2.12 The operation of the dynamic brake is interlocked with the air brake and is de-energised via a power knockout switch (PKS) should the brake pipe pressure fall below 250 kPa. This is incorporated as a safety feature within the power circuit of most Australian locomotives.

2.13 There are two different types of dynamic brake that may be fitted to locomotives operating in NSW. One is designed such that maximum braking effort is applied at only one predetermined speed. The other, known as extended range dynamic brake, is designed such that maximum braking effort is applied at a set of different speeds (as opposed to a single predetermined speed). For EL Class locomotives these speeds are 68, 53, 35 and 18 km/h, and are very similar for VL Class locomotives. Above 68 km/h and below 18 km/h the retardation effort declines significantly but still retains some effect.

2.14 Both locomotives on 3996 were fitted with extended range dynamic brakes in accordance with the ARTC train operating condition that any train descending the Illawarra Mountain must be fitted with a functional dynamic brake.

2.15 Data for the use of the dynamic brake indicated that the driver engaged full dynamic braking on departing Summit Tank. However, he disengaged it at approximately 6.28am when the train's speed fell to 0 km/h. The driver then re-engaged and maintained full dynamic braking until approximately 6.36am. As a consequence of the brake handle being placed in the handle-off position

[4] The three main forces that concern drivers are draft forces (train stretching), buff forces (train bunching) and lateral forces (experienced when negotiating curves). The longitudinal forces develop from continuous adjustment of tractive and braking effort and their magnitude is influenced by train length, weight, speed and makeup, and terrain (particularly gradient variations and steepness).

and the brake pipe pressure falling below the 250 kPa threshold, the dynamic brake was de-energised automatically by the PKS. Experience and standard practice would dictate that the dynamic brake be kept fully engaged throughout the descent of the Illawarra Mountain so as to maintain a balance in the dynamics of retardation by incorporating both the air brake and dynamic brake on the steep grade.

Air Brakes

2.16 The train's brake pipe pressure was set at 480 kPa from when the train left West Wyalong rather than the standard setting for freight trains of 500 kPa. The driver did not test his air brakes at any stage after leaving Moss Vale despite this being common practice (but not a requirement of either operators or infrastructure managers). Between Summit Tank and the point at which 3996 came to a stand, the driver made a number of brake applications. Only on two of the earlier of these occasions did the brake pipe air pressure return to the set pressure of 480 kPa. Also, successive brake applications were generally greater than the preceding application, indicating the driver was having trouble controlling the train as it increased speed (see *Figure 3*).

2.17 The pattern of air brake applications indicates that initial train air brake applications on the Illawarra Mountain were insufficient (too 'light') to be fully effective especially since the train was travelling well in excess of the posted speed. Applications then became progressively 'heavier' until the driver positioned the brake valve handle to the handle-off position resulting in the brake pipe pressure falling below the 250 kPa threshold for the dynamic brake operation. An emergency application of the locomotives' independent brakes then applied automatically.

2.18 A driver has the ability to override the automatic application of the independent brakes. However, the driver did not do so in this case, with a potential consequence being an increase in the risk of derailment due to in-train buff forces.

2.19 At 6.36am the data logger recorded a full brake application of the train brakes. This resulted from the positioning of the brake valve handle to the 'handle-off' position. Though not a correct operating procedure, anecdotal

evidence suggests it is often used by drivers. The handle-off position is not intended to be used for making a full brake application; it is designed for use when changing driving positions on a locomotive. However, it does simulate full brake application by depleting the brake pipe pressure. Should a driver require a full brake application, the full service position or the emergency position should be utilised.

Condition of the Rolling Stock

2.20 All rolling stock was examined by OTSI investigators, with particular attention given to the following:

- integrity of main reservoir and brake pipe connections throughout the train;
- brake blocks;
- the integrity of the holding feature of the first and last three wagons as per the full mechanical (FX1) and general mechanical (FX2) inspection regime;
- brake cylinder piston travel;
- any wagons with non-operative air brakes;
- the timing on all exhaust chokes;
- the overall condition of all wheels including any visual signs of 'bluing' (discolouration due to excessive heat build-up);
- build-up of condensation in air storage reservoirs;
- the functionality of the dynamic brake; and
- defects recorded in the locomotives' log books.

2.21 Apart from one loaded wagon found to have had the air brake isolated and several wagons showing evidence of minor over-travel of the brake piston, the train presented as well maintained and in good overall operating condition.

WGBY Wagons

2.22 The WGBY type wagons making up the train were built by Qiqihar Railway Rolling Stock Co., Ltd. (QRRS), located in the northern city of Qiqihar in Heilongjiang Province of the People's Republic of China. They were sourced from QRRS with the assistance of China International Marine Containers Rolling Stock Australia Pty Ltd (CARS) which was contracted by the AWB to assist in the design, manufacture, purchase, importation and commissioning of the wagons. The first of the wagons arrived in Australia in February 2009 (see *Photograph 1*).

Photograph 1: WGBY Wagon

2.23 The WGBY wagons are fitted with a dual pipe braking arrangement consisting of two continuous air pipes along the train. The basic train braking functions are operated by air supplied through the standard continuous single 'brake pipe' arrangement direct to each wheel. A separate second pipe, the 'main reservoir pipe', feeds air to supplementary reservoirs on each wagon directly from the locomotive main air reservoir. The supplementary reservoirs provide air to assist in the recharging of the brake pipe system which increases the air recharge rates thus providing a more responsive

braking capability. The supplementary reservoirs also feed wagon-mounted, air-operated ancillary equipment such as roof hatches and bottom discharge doors.

2.24 The disadvantage of the standard single pipe air brake system is that it can only be recharged once the brakes have been released. If the driver makes a number of brake applications while the brakes are being recharged, and does not allow sufficient time for the build-up of air pressure in between, the air reservoirs will become progressively depleted and the brakes ultimately rendered ineffective.

2.25 Before entering service, the wagons were modified with a 6 mm pipe connection from the main reservoir pipe to the wagon's supplementary reservoir to supply a trickle air flow and permit dual pipe operations. The specifications for this were devised by CARS's engineers. However, the modified arrangement was not subjected to feed or flow rate tests on the basis that testing was not required because the purpose of the 6 mm pipe was only to deliver a trickle flow as per Rail Corp and ARTC guidelines.

Certifying Process of the WGBY Wagons

2.26 New and substantially modified rolling stock must meet RailCorp and ARTC engineering requirements. To ensure the rolling stock conforms to these requirements, it must undergo a number of static and dynamic commissioning tests. The rolling stock owner must then supply the details of the rolling stock and the results of its testing in an information kit to the respective network owners before it is accepted and listed in their Train Operating Conditions (TOC) manuals.

2.27 Both QRRS and CARS were aware of the commissioning requirements for operation of the rolling stock in NSW as QRRS had previously built XGAY type wagons which were introduced into service in Australia from mid 2000. This type of wagon had conformed to the static and dynamic testing requirements of both RailCorp and ARTC.

2.28 Both RailCorp and ARTC certified the WGBY wagons for operation on their networks with single pipe braking. They stated that the reason the wagons

were not endorsed as having a dual pipe braking system was that the documentation supplied was unclear. An examination of the information kit provided by QRRS revealed that it did not indicate the WGBY wagon braking system was fitted with a dual pipe arrangement. The check box indicating the presence of a '*main reservoir pipe fitted*' on the wagon had not been ticked.[5] Further, the documentation stated that the wagons were similar to XGAY wagons which, at that time within NSW, were only endorsed for single pipe braking operation.

2.29 As WGBY wagons were of similar design to XGAY wagons, testing was not demanded by either RailCorp or ARTC and neither made a physical inspection of the wagons. They stated that, had they been made aware of the dual pipe system, they would have sought additional information to ensure that the wagons conformed to their respective requirements.

2.30 After the incident, RailCorp advised El Zorro that the wagons would have to continue to be operated as single pipe wagons until such time as a test was conducted or information provided which would demonstrate they could operate satisfactorily under dual pipe braking.

2.31 Also post-incident, RailCorp expressed concerns that the connection between the main reservoir pipe and the supplementary reservoir, particularly the restriction in flow due to the diameter of the 'T' piece connectors, did not conform to its requirements. As a result of these concerns, RailCorp immediately directed El Zorro to operate the WGBY wagons under conditions stipulated for single pipe wagons instead of those for dual pipe. El Zorro stopped using WGBY wagons on the Illawarra Mountain and utilised certified dual pipe wagons instead. The WGBY wagons have since been utilised within the Northern regions of NSW where braking requirements are less restrictive.

5 Both the ARTC and the RailCorp TOC manuals record single and dual pipe wagons in the same manner; a two dot prefix, "··", to the brake type designation signifies dual pipe wagons whereas there is no prefix to the brake type designation for single pipe wagons.

Train Operating Conditions

2.32 Rolling stock operators are required to work to a number of rules, procedures and conditions in order to operate trains throughout the NSW rail networks. Conditions and parameters for the operation of trains, locomotives and rolling stock are set out in the TOC manuals of the network owners and must be understood and complied with by operators, train crews, planners and train controllers. Therefore, by virtue of respective access agreements, El Zorro had to abide by the conditions set out in both the RailCorp and ARTC TOC manuals. Checking of compliance with these conditions should have been included in random checks of compliance with rules and procedures by all involved parties. The conditions for WGBY wagons were clearly set out in TOC waivers (amendments) issued on 26 and 27 February 2009 by RailCorp and ARTC respectively, both of which had WGBY wagons registered as single pipe wagons.

2.33 In accordance with ARTC's TOC manual, "Special Working" conditions applied to train 3996 from Summit Tank. It should have been operated "under mandatory dynamic brake conditions" which included:

- *"The minimum allowable vehicle mass for vehicles in the front third of the train must not be less than 25 tonne."* WGBY 1039B with a tare of 24 tonnes was positioned in the front third of the train in the 13th position.
- *"Train must have three locomotives at the front of the train and up to two locomotives at the rear of the train from Summit Tank to Unanderra."* 3996 had only two locomotives, both at the front.
- *"One locomotive shall be provided for each 800 tonnes or part thereof of train load."* On this basis, 3996 should have been hauled by four locomotives as its mass exceeded 2400 tonnes.
- *"The speed of the train must not exceed 25km/h."* 3996 was operated above 25 km/h and in excess of the posted 30 km/h limit.

Once the train entered RailCorp territory at kilometrage 91.080 on the way to Unanderra, these conditions no longer applied as RailCorp's TOC manual contained no equivalent conditions.

2.34 At interview, the train crew gave the impression of not having a full understanding of these TOC manual requirements, although the co-driver's understanding appeared to be better than the driver's understanding.

2.35 Prior to the incident, trains marshalled in the same manner and hauling the same wagons as 3996, had run on the Illawarra Mountain on some 40 occasions over 23 months since the wagons were introduced into service. At no stage had anyone identified that the consist was not being marshalled in accordance with the requirements of the ARTC TOC manual for single pipe wagons on that particular route.

2.36 An examination of ARTC's TOC manual revealed that it was significantly out of date, having not been updated since 2004, and with 592 waivers awaiting insertion in the manual. This makes identifying and accessing the current operational requirements very difficult and cumbersome for all concerned.

2.37 Further, it was found that some information in ARTC Local Appendix Units (LAU) was not current. The instructions for radio use on the Illawarra Mountain had not been amended even though they had been superseded in 2007.

2.38 Both RailCorp and ARTC issued TOC waivers to El Zorro for the operation of WGBY wagons on the RailCorp and ARTC territory respectively. Nowhere on either of the TOC waiver forms were there any instructions pertaining to dual pipe wagons. As the wagons were classified as single pipe wagons, El Zorro should have operated WGBY wagons under the specific instructions of the TOC waivers.

Braking Techniques

2.39 At the time of the incident, El Zorro had no documented policies or procedures for the control of trains descending the Illawarra Mountain. Instead, drivers were instructed to use the TOC manual. Though the TOC manual provides operating parameters, it does not provide the practical guidance necessary to assist drivers in handling a variety of trains under a variety of conditions. However, El Zorro stated that drivers received training

and mentoring prior to certification in route competency by The Instruction Company.[6]

2.40 At interview, it was evident that the driver did not understand the difference between serial and balanced braking techniques which are used for descents like the Illawarra Mountain. Serial braking is used to descend a grade relying only on the train brakes and, on the Illawarra Mountain, is used when a train has less than 80 tonnes per operative brake (TOB) and only two locomotives. Balanced braking is used when a train has more than 80 TOB and three or more locomotives, and also if serial braking is proving not to be effective. Train 3996 had 76.62 TOB as the brakes on one of the wagons were isolated; however, it is evident that the driver was having difficulties in controlling and regulating the speed of the train. The driver should have utilised the balanced braking technique once he realised he was having difficulties controlling the train's speed.

2.41 In balanced braking, the driver applies full dynamic braking at the top of a grade. When the train speed reaches 10 to 20 km/h, the driver makes a minimum application of the train brake which brings the brake pipe pressure down 50 kPa (from 500 kPa to 450 kPa). After the air pressure has equalised, the driver checks to see if the train is being held at the required speed. A speed of 25 km/h is desirable at this point. If the train speed begins to increase the driver reduces the brake pipe pressure by a further 20 kPa. Further fluctuations in train speed are then controlled using the dynamic brake, ideally, without releasing the train brake.

2.42 Advice was sought from several other rail operators on the driving procedures they applied to freight trains descending the steep portions of the Illawarra Mountain. It was generally agreed that a driver should stop in the vicinity of kilometrage 107 and make a 100 kPa application of the train brakes. After coming to a stand and only after all pressures have equalised, the driver should release the independent brakes on the locomotive and then release the train brakes. As soon as the brakes are released, the driver should note the elapsed time in seconds before the train begins rolling. This

[6] The Instruction Company, a Registered Training Organisation (RTO), is a private company involved in developing and delivering specialised training for the rail industry.

gives the driver an understanding of the recharge rate for the brake pipe air and the timing of the release of the exhaust chokes on the wagons.

2.43 Although this method of working is not incorporated in any operators' policy or procedural documentation, it is a standard practice throughout the rail industry for working over the Illawarra Mountain. Operators such as Pacific National verbally instruct all new drivers during their training to use the procedure on all occasions when travelling over this steep gradient.

2.44 On 27 February 2011, El Zorro issued all its drivers with a comprehensive Work Instruction titled "Train Management Work Instruction Moss Vale to Inner Harbour". Among the key operational issues emphasised in the document were the following directions in relation to an Air Brake Test before commencing the Illawarra descent:

> "*The train must be stopped at Km 107 after departing Summit Tank.*
>
> *A 100 kPa reduction must be used to bring the train to a stand.*
>
> *After equalization has occurred the locomotive's brakes must be bailed off and the air brake application released.*
>
> *As soon as the brake handle has been returned to the RELEASE position the release rate must be timed.*
>
> *The time must be recorded from the moment of the locomotive's brake handle has been returned to the RELEASE position to the exact second the train begins to start moving down the gradient.*
>
> *The time taken for this to occur should not be any less than approximately 60 seconds.*
>
> *If the time for movement following the 100 kPa reduction is less than 60 seconds then extra care must be made to ensure air brake re-charge times are achieved before continuing down grade after stopping to re-charge the air brake system*."

2.45 The following is included in the Work Instruction in relation to "Serial/Cycle Braking Techniques":

> "*When the train speed reaches 20 km/h – place the automatic handle into the minimum reduction position and reduce the brake pipe pressure to 450 kPa.*

When the pressure has stopped escaping from the service exhaust, make another reduction in brake pipe pressure to ensure that the train's speed is not increasing on the grade. DO NOT exceed a 100 kPa reduction if possible. ***The dynamic brake must be left in the FULL field strength position.***

If the train speed exceeds 30 km/h:

- *STOP the train and recover the situation.*

The dynamic brake must be left in the FULL field strength position whilst the train travels down the gradient."

2.46 If the crew of 3996 had had the benefit of these instructions before the incident and complied with them, there is every chance they would not have got into difficulties descending the Illawarra Mountain.

Fatigue

2.47 The rosters of both crew members for the two weeks leading up to the incident were examined to determine if fatigue was a likely contributing factor. The driver had worked three days in each of the two preceding weeks and had been on rest the two days prior to the incident. The co-driver had worked three shifts in the preceding eight days following return to work on 30 January 2011 after a period of annual leave. He had not been required to work on the two days prior to the incident.

2.48 The day of the incident was the fourth in a row that the two crew members had worked together. The pattern of the shifts was irregular and duration of shifts averaged 11 hours. All shifts were separated by at least one day. Further, both the driver and co-driver stated they had gone to bed early the day before, at approximately 7 pm and 8 pm respectively, and had slept comfortably and woken up feeling well rested. On the basis of the crew member's rosters and their own observations, it is concluded fatigue was unlikely to have affected the work performance of either crew member to any significant degree.

Risk Mitigation

2.49 Until the mid 1990s, there was a risk mitigation measure in place near Dombarton whereby an uncontrolled train could be diverted on to a dead end track.[7] This measure was subsequently removed on the basis that the brakes on modern rolling stock are more than adequate to prevent loss of control, so the measure was considered redundant.

2.50 Currently there are no risk mitigation measures in place between Dombarton and a set of catch points at Coniston on the Up Main line 3.4 km beyond signal WG 1014. Grades are relatively flat along this segment of line; descending 1 in 113 to 1 in 330 from Unanderra then ascending at 1 in 826. Train 3996 passed signal WG 1014 by 527 metres while under a limited braking effort; a complete runaway could travel a considerably longer distance if not all the way to Coniston.

2.51 The co-driver was a qualified driver and had travelled over the route on many occasions, although he had not sought to qualify for the route. At interview he stated that he had a good understanding of how a train should be driven on descending the Illawarra Mountain. He added that at one point he said to the driver that he was going "*a little bit too quick*" to which the driver replied that he had the brakes on and it was "*okay*".

2.52 It is concluded that the crew had not been practising sound crew resource management within the cab despite their overall driving experience.

Communication

2.53 The train was equipped with the standard communications equipment. The CountryNet radio system was serviceable and was the one means that provided emergency priority functionality. The WB radio provides a backup to the CountryNet radio but does not have an emergency function. However, an examination of the log book for locomotive EL57 revealed that the WB radio had been logged as defective on 2 November 2010 for what appeared to be an intermittent fault and had not yet been repaired.

[7] This piece of track was a part of the former Dombarton crossing facilities. Though not originally emplaced as a risk mitigation measure, it could act as such.

2.54 The co-driver chose to use a mobile phone to contact the Wollongong Signal Box. At interview the crew members stated that it had been their usual practice to use the mobile phone which had numbers programmed into it. It did not occur to them to try the CountryNet radio when unsuccessful in contacting the signal box by mobile phone although they confirmed that they understood the concept of the CountryNet radio 'emergency' function.

Remedial Actions

2.55 In response to the incident El Zorro initiated a range of remedial actions:

- Staff Safety Notice No. 2011/070 was issued on 9 February 2011 advising train crew, shunter-examiners and wagon maintainers of an additional check required during FX1 and FX2 train inspections to ensure that the isolating cock on the main reservoir feed to the auxiliary reservoir on the WGBY type wagons is in the open position.
- Staff Safety Notice No. 2011/071 was issued on 15 February 2011 reminding all train crew of the "emergency" function of the CountryNet radio system and its use.
- El Zorro, in conjunction with The Instruction Company, developed and issued the Work Instruction titled "*Train Management Work Instruction Moss Vale to Inner Harbour*" (EZ-WI-272) on 27 February 2011. The Work Instruction was reviewed on 1 April 2011 and a revised version issued on 15 May 2011 which was then reviewed on 1 October 2011.
- A program of on-job assessment of Moss Vale drivers against the Work Instruction commenced on 12 March 2011 with the first assessment being conducted by the Director of The Instruction Company. The assessment of all three Moss Vale train crews has been completed.
- The development of a corridor specific Route Knowledge Package for Moss Vale to Unanderra has commenced but is not yet complete. Work Instruction EZ-WI-272 serves the purpose in the interim.

- El Zorro, in conjunction with The Instruction Company, has developed and implemented a policy of ongoing, random audits of train safety on the Moss Vale to Inner Harbour route which commenced in August 2011.
- Procedures for the internal registering of rolling stock specifications have been updated and are now regularly reviewed.

2.56 CARS has conducted a number of tests, in regards to the feed and flow rates to the supplementary reservoir and including recharge times of associated air reservoirs. Currently, CARS is awaiting approval of the reclassification of the WGBY wagon, as a dual pipe wagon, from both RailCorp and ARTC.

PART 3 FINDINGS

Causation

3.1 El Zorro grain service 3996 became uncontrolled during its descent of the Illawarra Mountain because the train was not managed in accordance with good practice. The result was a loss of the necessary braking effort to be able to maintain full control of the movement.

Contributing Safety Factors

3.2 The train was allowed to travel in excess of the posted speed on a number of occasions after leaving Summit Tank with progressively larger brake applications resulting in a diminished supply of stored air available to the train's air brakes, and consequent loss of dynamic brake.

3.3 Up to the time of the incident, El Zorro had no documented policies or procedures for the control of trains descending the Illawarra Mountain. Instead, drivers were instructed to use the network managers' TOC manuals.

3.4 Despite being issued with TOC waivers from both RailCorp and ARTC which classified the WGBY wagons as single pipe wagons, El Zorro operated the grain train services under dual pipe conditions from the time of introduction of the wagons into service. This anomaly was not identified by either RailCorp or ARTC. [Recommendations 4.1 , 4.2, 4.3 and 4.6]

Other Safety Factors

3.5 The co-driver was unable to establish contact with the Wollongong Signal Box to alert the signaller to the uncontrolled movement until after the train came to a stand. He chose to use a mobile telephone in preference to the CountryNet radio emergency function.

3.6 ARTC's TOC manual had not been updated since 2004 and there were 592 waivers awaiting insertion in the manual. Some information in the Local Appendix Units was also not current. [Recommendation 4.4]

3.7 The modification to the WGBY wagon involving the addition of a connection from the main reservoir pipe to the wagon's auxiliary reservoir was not subjected to feed or flow rate tests and does not meet RailCorp's or ARTC's engineering requirements. [Recommendation 4.7]

3.8 Currently in Australia, there is no standard defining what constitutes single and dual pipe wagons, including the various engineering aspects such as the purpose, application, flow rates and timing in reference to charge rates. [Recommendation 4.7]

Other Factors

3.9 The fact that WGBY wagons were fitted with a dual pipe braking system was not documented or recognised during the certifying process on their introduction into service and during subsequent operation. Hence, the wagons were listed in TOC manuals to operate as single pipe wagons. [Recommendations 4.1, 4.2, 4.3 and 4.5]

Remedial Action

3.10 El Zorro has fully implemented all but one of the remedial actions initiated in response to the key safety issues identified in relation to crew competency and procedures for operating over the Illawarra Mountain.

PART 4 RECOMMENDATIONS

The recommendations directed to the following entities are made in relation to safety issues identified in the course of this investigation.

Australian Rail Track Corporation and RailCorp

4.1 Review procedures for the certification of new and modified rolling stock with particular emphasis on the process of verification of the information provided by rolling stock owners and operators.

4.2 Validate the accuracy of categorisation of single and dual pipe wagons in the TOC manual.

4.3 Institute a program of random checking to ensure rail transport operators are complying with TOC manual requirements.

Australian Rail Track Corporation

4.4 Update and re-issue the TOC manual and the LAUs pertaining to the Illawarra Mountain area.

China International Marine Containers Rolling Stock Australia Pty Ltd

4.5 Review procedures for the presentation of new and modified rolling stock for certification with particular emphasis on complete and accurate preparation of documentation.

EL Zorro Transport Pty Ltd

4.6 Verify that all crews, train planners and operations managers have a full understanding of the TOC manual requirements and the specifications for each wagon that EL Zorro hauls.

Rail Industry Safety and Standards Board

4.7 Develop and implement a standard defining what constitutes single and dual pipe wagons, including the various engineering aspects such as the purpose, application, flow rates and timing in reference to charge rates.

PART 5 APPENDICES

Appendix 1: Sources and Submissions

Sources of Information

- Australian Rail Track Corporation (ARTC)
- Bureau of Meteorology
- China International Marine Containers Rolling Stock Australia Pty Ltd (CARS)
- CFCL Australia (CFCLA)
- El Zorro Transport Pty Ltd
- Independent Railways of Australia Pty Ltd
- Independent Transport Safety Regulator (ITSR)
- Pacific National Pty Ltd
- RailCorp
- Southern Shorthaul Railroad

References

- ARTC Network Rules, TOC Manual, LAUs, Procedures and Safe Notices
- China International Marine Containers Rolling Stock Australia Pty Ltd Wagon Information Package
- Glossary for the National Codes of Practice and Dictionary of Railway Terminology
- Passenger Transport Act 1990 (NSW)
- RailCorp TOC Manual
- Rail Safety Act 2008 (NSW)
- Rail Safety (General) Regulation 2008 (NSW)

Submissions

The Chief investigator forwarded a copy of the Draft Report to the Directly Involved Parties (DIPs) to provide them with the opportunity to contribute to the compilation of the Final Report by verifying the factual information, scrutinising the analysis, findings and recommendations, and to submit recommendations for amendments to the Draft Report that they believed would enhance the accuracy, logic, integrity and resilience

of the Investigation Report. The following DIPs were invited to make submissions on the Draft Report:

- ARTC
- AWB
- CFCLA
- CARS
- El Zorro
- ITSR
- RailCorp
- RISSB

Submissions were received from CFCLA and the ITSR. CARS, El Zorro, RailCorp and RISSB advised they did not wish to add to comments previously provided on an informal basis. The Chief Investigator considered all representations made by DIPs and responded to the author of each of the submissions advising which of their recommended amendments would be incorporated in the Final Report, and those that would not. Where any recommended amendment was excluded, the reasons for doing so were explained.