4.8 Train Control

The system of safeworking on the Down Main South between Breadalbane to Bowning is Rail Vehicle Detection.

4.9 Environmental Factors

4.9.1 General Climatic Conditions

The incident occurred at 15:10 on 19 November 2002. Visibility for the Driver and Observer was clear.

4.9.2 Temperature

WOLO Speed Restrictions - Standard Application:

During very hot weather there is a risk that welded track will misalign (buckle). In an effort to manage this risk the speed of trains travelling over these lines is reduced when high temperatures are predicted. Rail Infrastructure Corporation's Extreme Weather Conditions Standard[19] requires the application of a track WOLO speed restriction when the air temperature is forecast to reach or exceed 38°C, on days following the 15 November each year. These restrictions apply from 12:00 to 20:00 on the day they are imposed.

The Safeworking rules in force at the time of the incident, that defined the procedural requirements for applying WOLO speed restriction notices, were contained in SWU 722. SWU 722 can be referenced in Appendix 9.11.4. This procedure required, where possible, for a WOLO speed restriction notification to be provided to Network Control prior to 10:00 on the day of their issue.

The forecast temperature at Yass on 19 November was 32°C. Compliance with the standard requirement to apply a WOLO speed restriction based on the forecasted maximum temperature on 19 November 2002 was therefore achieved.

The ambient temperatures on 19 November at Yass were recorded as:

Maximum temperature in 24 hours after 9am (local time) in °C	Minimum temperature in 24 hours before 9am (local time) in °C	Air temperature observation at 09 hours Local Time in °C	Air temperature observation at 15 hours Local Time in °C
35.5	11	22	33.4

Table 4.8 – Ambient Temperatures at Yass on 19 November 2002

The WOLO notification was however issued to Goulburn Signal Box at approximately 14:00 and therefore breached the recommended 10:00 issue

[19] Temporary "WOLO" Speed Restrictions for Welded Track Under Extreme Weather Conditions C2513 Version 3.0 November 2001, Page 7.

deadline to Train Control It is noted however that the current WOLO Network Rule NGE 210 does not contain the requirement to ensure WOLO notifications are advised to train control prior to 10:00 on the day of their application.

WOLO Speed Restrictions – Hot Spot Locations

There is provision for the Yass Team Manager to vary the times and lower the temperature at which a WOLO is applied. The Yass Team Manager may also, at any time, choose to apply a temporary speed restriction on specific sections or sites (Hot Spot locations) where track stability is of concern. At such locations Warning and Caution Boards must be erected and the speed restriction advertised in accordance with the system detailed in SWU 905[20]. Those applicable Safe Working Rules in force on 19 November can be referenced in Appendix 9.11.

The Yass Team Manager (Local Civil Engineering representative in this case) maintains a register of Hot Spot locations in which the misalignment site at 305.650km was included. Prior to, and on the day of the misalignment at 305.650km, the Yass Team Manager applied the following process in placing speed restrictions at Hot Spot locations.

- On days forecasted to reach a maximum temperature of 30˚C or above, a heat patrol would be conducted after 13:00 covering the Up and Down Main between Breadalbane 248.500km to Bowning 330.00km.
- On days forecasted to reach a maximum temperature of 35˚C or above Hot Spot speed restrictions would be applied at all Hot Spot locations.
- On days where the temperature is monitored by the Yass Civil Maintenance Team and predicted on the day by the maintenance team to reach 35˚C or above, a WOLO telegram would be prepared to cover the section of track bounded by the Hot Spot location extremities. Hot Spot speed restriction boards are not usually implemented under this scenario due to the delayed reaction time incurred in having to erect the boards at each of the Hot Spot locations.
- On days forecasted to reach a maximum temperature of 35˚C or above, prior to 15 November, a WOLO telegram is issued. Hot Spot speed restrictions would have also been applied at all Hot Spot locations.
- On days forecasted to reach a maximum temperature of 38˚C or above, following the 15 November, a WOLO telegram is issued. Hot Spot speed restrictions would have also been applied at all Hot Spot locations.

Following the misalignment on 19 November 2002 the Yass Team Manager modified this process so that Hot Spot speed restrictions would be applied at 30˚C instead of 35˚C. The process was effectively amended to require the following.

- On days forecasted to reach a maximum temperature of 30˚C, Hot Spot speed restrictions would be applied at all Hot Spot locations.

[20] The current standards defining hot weather speed restrictions include the Rail Infrastructure Corporation Network Rule NGE 210 and the Rail Infrastructure Corporation Train Operating Conditions Standard OS001IM.

- On days where the temperature is monitored by the Yass Civil Maintenance Team and predicted to reach 30°C or above, a WOLO telegram would be issued to cover the section of track bounded by the Hot Spot location extremities.

WOLO Speed Restriction Application on 19 November 2002

On 19 November the Yass Team Manager monitored the local Yass temperature and requested the Goulburn Technical Office for a WOLO to be applied between Breadalbane (248.500km) to Bowning (330.00km). The sequence of events in the application of this WOLO telegram from that point can be summarised as:

- Goulburn Technical Office advised to produce a WOLO covering the Yass Maintenance Area at approximately 13:50.
- G9821 departs Goulburn at 13:55.
- WOLO telegram filled out at Goulburn Technical Office at 13:59.
- WOLO telegram sent via facsimile to Goulburn Signal Box and received complete at 14:00.
- WOLO telegram sent via facsimile to Junee Train Control and received complete at 14:02.
- Goulburn Technical Office contact Junee Train Control via land line telephone to advise of WOLO at approximately 14:00.
- Goulburn Signal box attempts to contact G9821 via the WB radio with no success at 14:01.
- Junee Train Control attempts to contact G9821 via the CountryNet train radio with no success at 14:02:31 & 14:02:36.
- Junee Train Control graphs WOLO telegram onto train graph indicating WOLO conditions begin at 14:05. Refer to Appendix 9.12 to review the applicable train graph.
- WOLO telegram sent via facsimile to South Control and received complete at 14:28.

Historic Temperature Review

Additional temperature information was sourced from the Bureau of Meteorology dating back to 1 January 1994 for the weather station at Yass. The following figures have drawn on this data to represent climatic conditions:

- At the time of misalignment, and
- Against relevant historic maintenance tasks and misalignment records for the Main South area.

Figure 4.20 below identifies that the day of misalignment registered the highest maximum temperature (35.5°C) recorded, since the winter of 2002, up to this date.

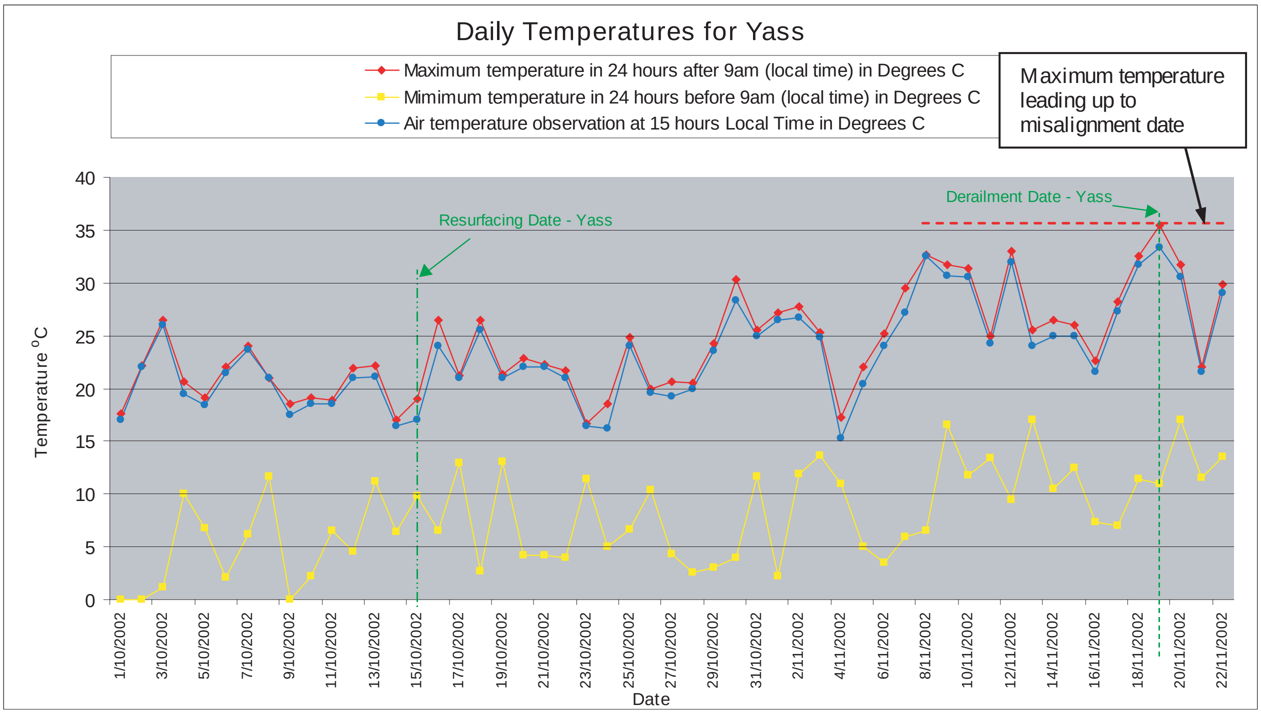


Figure 4.20 Daily Temperature for Yass Weather Station

Figure 4.21 below depicts the minimum temperature for 24hrs taken before 9:00 on the recorded day. This figure identifies that the minimum temperature in the month of October (month of track resurfacing works) for the Yass Region had not changed markedly over the last four years. The minimum temperature following track resurfacing works was registered as 2.2°C on 1 November 2002. Cold night time temperatures where also registered on 18 (2.5°C) and 28 November 2002 (2.5°C).

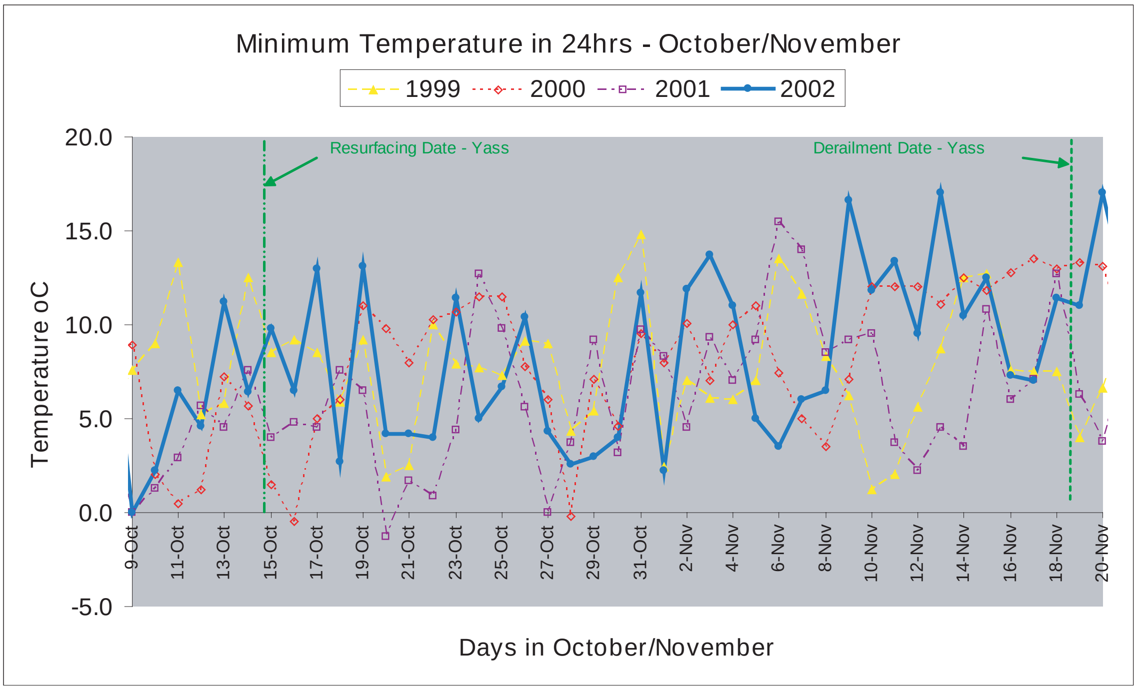


Figure 4.21 Minimum Temperature in 24hrs - October / November 1999, 2000, 2001 & 2002

Annual maximum and minimum temperature values for the Yass area of 40°C and -7°C were also sourced from the Yass Weather Station.

Rail and Ambient Temperature Testing within the Cutting at 305.650km

Rail and ambient temperature tests were conducted at the cutting located at 305.650km in order to determine if the rail temperature experienced within the cutting varied in comparison to the rail temperature outside the cutting. These test results indicated that the cutting rail temperature measured above the external rail temperature on days where there was little to no wind as measured within the cutting. Differences of 5°C where recorded on days where the wind speed was below approximately 8km/h and the ambient temperature was at or above 30°C.

4.10 Train to Train Control Communications

4.10.1 WB Radio Coverage

The WB radio coverage for trains departing Goulburn Station (224.904Km) on the Down Main Line extends some 4.6km (229.200km) south in the vicinity of Joppa Junction (230.486Km). WB radio works on a line of sight principle, where unless the broadcasting and receiving equipment is unobstructed by a line of sight, the communication connection will not reliably take place. As identified within Figure 4.22 there are significant curves and gradients, including cuttings, from Joppa Junction in the down direction, that inhibits the WB radio coverage from extending south beyond Joppa Junction.

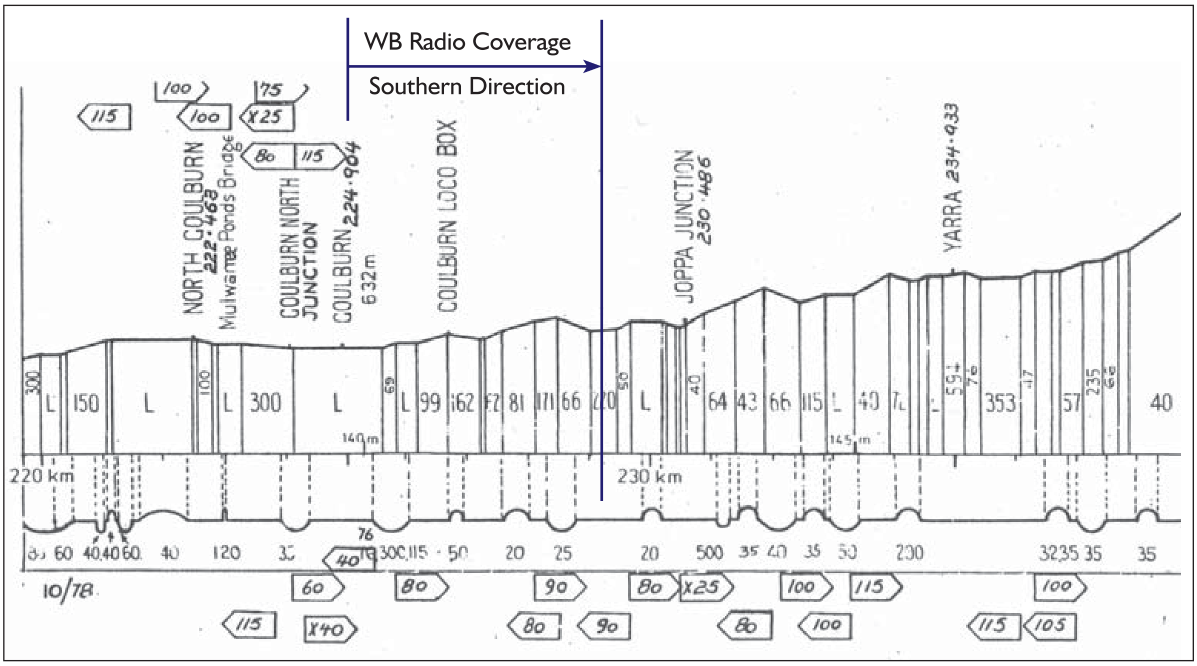


Figure 4.22 Curve and Gradient Diagram noting Goulburn, Joppa Junction and surrounding topography

The approximate position of G9821 at the time when WB radio communication was attempted can be estimated at 8kms from Goulburn Signal box (233.0km).

This estimation assumes the train's average speed was 70km/h[21] between when the train departed Goulburn station at approximately 13:55 and when Goulburn Signal Box attempted to contact G9821 at approximately 14:02.

WB radio coverage from Goulburn Signal Box is re-established at approximately 317.000Km in the Yass Junction area through the aid of a WB base station at Yass Junction. As Goulburn Signal box controls Yass Junction the WB coverage allows Goulburn signal box to communicate with trains in the area.

4.10.2 CountryNet Train Radio

An attempt was made by Junee Control to contact G9821 via the train radio for the purpose of advising the train crew of the WOLO notification. This attempt was made in response to Junee Control being advised by Goulburn Signal Box that the WOLO notification to G9821 was not successful via the WB radio. The train radio attempt was logged by the train radio system as identified by the shaded log entry at 14:02:07 in Table 4.9.

LOCO No	TIME	TRAIN CONTROLLER WORK STATION LOG
8160	14:01:47	UNREG - CALL LOCO (ALL BASES) - BY TRAIN CONTROLLER
8160	14:01:52	UNREG - CALL TIMEOUT
8160	14:01:52	UNREG - CALL LOCO (SATELLITE)
8160	14:02:07	UNREG – RINGING INDICATION
8160	14:02:22	UNREG – RINGING TIMEOUT
8160	14:02:22	UNREG - CALL DISCONNECTING
8160	14:02:24	UNREG - CALL DISCONNECTED
8160	14:02:25	UNREG - TIMEOUT DISCONNECTION
8160	14:02:25	UNREG - CANCEL REGISTRATION - ICON REMOVED BY TRAIN CONTROLLER

Table 4.9 Junee Train Control CountryNet train radio logs – Attempt to contact G9821

Confirmation that the train radio was ringing on board locomotive 8160 was made on review of the audio tape recording of the Train Controller's attempted train radio call. This tape recording indicated a ringing tone on the Train Controller's train radio telephone as he called G9821. This ringing tone verified a connection was made with locomotive 8160. If a pre-recorded out of range/ disconnected voice message had of been received by the Train Controller the train radio would have either been switched off or the satellite system was not able to establish a ringing connection.

Had the Driver or Observer of G9821 responded to the connection attempt the communication of a WOLO would have most likely occurred at that point

[21] The potential maximum track speeds between Goulburn Signal Box and just past Joppa Junction are 60km/h, 80 km/h, 90km/h, 80km/h and 100km/h.

in time. The train crew in their recount of events prior to the incident did not indicate that an incoming train radio call was detected at approximately 14:02. The locomotive's train radio was found to operate correctly having successfully received and made calls to Junee Control following the incident. No locomotive or train radio maintenance record indicated any defects with the locomotive's train radio prior to or immediately following the incident.

The train crew has the ability to vary the train radio alert volume via the loudspeaker volume control knob as identified in Figure 4.23. The loudspeaker volume cannot be completely silenced having a minimum volume level preset to ensure an adequate alert volume within the confines of the locomotive's cab environment.

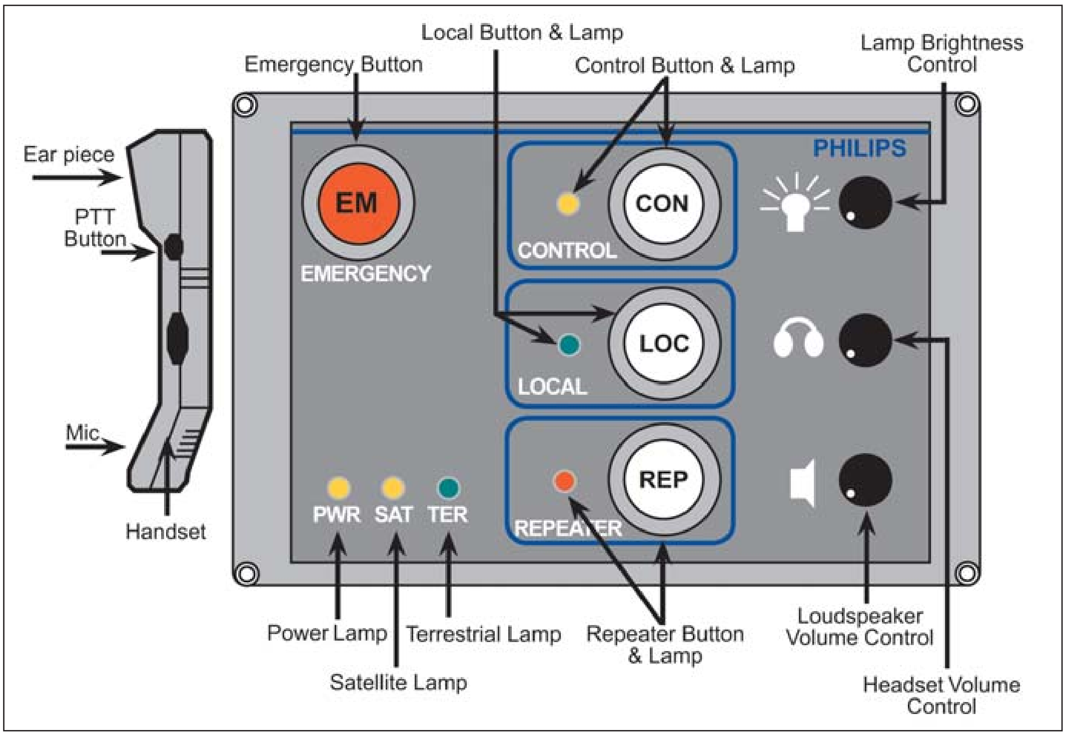


Figure 4.23 CountryNet Train Radio Operator Panel Representation

Following the Train Controller's train radio communication attempt to G9821 the Train Controller was redirected to other issues within the Train Control Centre that required his immediate attention.

The Train Controller could have attempted to make successive direct calls to G9821 or make a general broadcast train radio call to all trains within the WOLO affected section. The general broadcast call requires no handset response on behalf of the train crew. The call is received by the locomotive and broadcasted over the train radio's loudspeaker system. No such general broadcast call was made by the Train Controller.

4.11 History of Similar Occurrences

4.11.1 Misalignment Site 305.650km

Rail Infrastructure Corporation has two records of a misalignment occurring on the Down Main South at 305.650km on 23 January 1998 and 26 January 1994. The root causes of these misalignments were determined to be due to:

- Curve pull-in since lining and stabilising to correct curve pull-in together with creosote sleepers near the misalignment site in a pattern of 3:4 (23 January 1998).
- Alignment error (26 January 1994).

4.11.2 Rail Infrastructure Corporation Historic Misalignment Records

Rail Infrastructure Corporation also maintains a consolidated register of misalignments dating back to 1992.

A review of this database revealed the following.

- 44% of recorded misalignments occur on tight radius curves less than 400m.
- 67% of recorded misalignments occur on curves less than 800m.
- 74% of misalignments, where the track has been disturbed within 1 month following the disturbance, are associated with track surfacing/tie and track surfacing works.[22]
- 76% of recorded misalignments occur with an ambient temperature above 30°C.

Misalignment records dating back to January 1994, that detailed the ambient misalignment temperatures for the Yass area, were reviewed against daily temperatures for the same period. This review enabled the number of misalignments at their ambient temperatures to be normalised against the number of calendar days where these misalignment temperatures were recorded.

This review confirmed that the probability of a misalignment occurring increases as ambient temperature increases above 34°C, where this limit is consistent with the 35°C WOLO Limit applied within Rail Infrastructure Corporation's WOLO standard[23]. Refer to Figure 4.24 depicting the average number of misalignments per day against corresponding daily maximum temperatures.

[22] This value is calculated from 26 misalignments over a total of 35 misalignments, where the track has been disturbed within 0-1 month (Jan 1996 and Nov 2002). These misalignments are a subset of 461 misalignments recorded in the Rail Infrastructure Corporation misalignment database between January 1996 to November 2002.

[23] Temporary "WOLO" Speed Restrictions for Welded Track Under Extreme Weather Conditions C2513 Version 3.0 November 2001, Page 7.

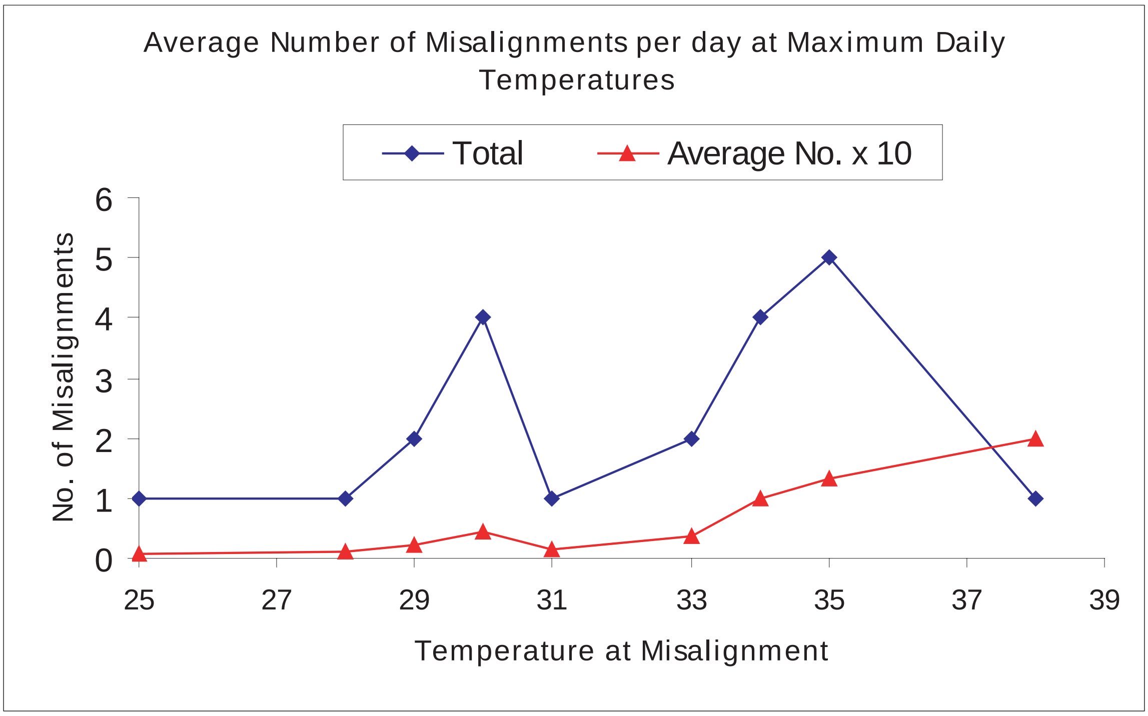


Figure 4.24 Misalignments in the Yass Area at Particular Temperatures averaged against the Number of Days at the Corresponding Ambient Temperature.

4.11.3 **Reported Steel Train Misalignments**

On 16 December 2002 and 17 December 2002, 10 misalignments were detected on the Main South in the Cootamundra area following the passage of Pacific National steel trains 2SP2 (6 misalignments detected) and 3WP2 (4 misalignments detected) respectively.

In response to these incidents the investigation attempted to determine whether there was any link between the misalignments that occurred in December 2002 and the misalignments (and subsequent derailments) that occurred on 7 November 2002 (Pacific National train 4YN2) at Rocky Ponds and 19 November 2002 (G9821). The process undertaken in order to assess any potential link consisted of the following.

- The investigation was provided with train consist information detailing the vehicles on each of those trains involved in the multiple misalignments. This train consist information was cross checked against:
  - The train consist information for 4YN2 and G9821, and
  - Pacific National steel traffic that preceded the derailed trains on 7 November 2002 and 19 November 2002 over a period of 24hrs prior to both derailments.
- A maintenance history review (post 7 November 2002) of those common wagons identified from the cross checking exercise was then undertaken to assess if any of these wagons may have had the potential to contribute to a misalignment. This assessment was based on a review of the repairs conducted on each of the common vehicles identified.

Essentially this review was conducted in order to assess the likelihood that a potentially defective wagon on the steel trains of 16 and 17 December may have preceded those vehicles which derailed on 7 November 2002 and 19 November 2002. Whilst this review may be considered speculative, the investigation sought to eliminate the possibility of identifying a common vehicle that underwent major vehicle ride stability repairs, where such a vehicle would then have had the potential to contribute to either one of the misalignments. In retrospect, if all of the vehicles that preceded the derailed vehicles had been inspected at the incident site, any potential rolling stock contributing factors would have been either identified or eliminated at that point without the need to conduct additional rolling stock investigations.

The train consist cross-check results are provided in the following table.

	7PW4	4YN2	3WP2	3NY3	G9821	2SP2	3WP2
	06-Nov-02	07-Nov-02	19-Nov-02	19-Nov-02	19-Nov-02	16-Dec-02	17-Dec-02
Common Rolling Stock ID	23:00 – Up Main South – Harden	16:50 - Up Main South - Misalignment - Derailed Train - Rocky Ponds	06:59 - Down Main South - Yass	13:53 - Down Main South - Yass	15:10 - Down Main South - Misalignment - Derailment - Yass	Multiple Misalignments identified behind train	Multiple Misalignments identified behind train
ROOX02265J	1		1				1
ROKX02168R	1		1				1
RQMF03059B	1						1
ROKX03014J	1						1
ROKX03002G	1						1
ROKX02920P	1		1				
ROKX02626C			1				1
ROKX02542V	1		1				
ROKX02283S			1			1	
RKLY85159G	1					1	

Table 4.10 Pacific National Train Consist Cross Check

Based on the cross check results identified above the investigation has determined:

- There were no common vehicles identified between the trains that actually derailed on 7 and 19 November 2002 and the Pacific National steel trains involved in multiple misalignments that occurred on 16 and 17 December 2002.
- Where there were common vehicles identified on those preceding trains of 7 and 19 November 2002 and the Pacific National steel trains of 16 and 17 December 2002, these preceding trains traversed the misalignment sites at least 8hrs prior to both derailments.

A review of the maintenance history of these common wagons, following the derailment dates, did not sufficiently identify any significant vehicle repairs that would be consistent with major ride stability problems.

A review of the Rail Infrastructure Corporation misalignment database records detailing the multiple misalignments identified behind the two Pacific National steel trains on 16 and 17 December 2002 revealed a mixture of factors believed to have contributed to these misalignments. Those factors included extreme ambient temperatures, poor track structure, track disturbance, suspect heavy steel train and hunting traffic.

Based on the train consist cross check results and a review of the reported causes of those multiple misalignments that occurred on 16 and 17 December, the investigation could not identify any factual link between:

- Potential rolling stock misalignment contributing factors from Pacific National steel vehicles, and
- The misalignments that occurred on 7 and 19 November 2002.

4.12 Relevant Safety Regulations

The NSW Rail Safety Act 1993 applies to the matters under investigation by virtue of the savings provisions of the NSW Rail Safety Act 2002 Schedule 5 Clause 12.

4.13 Emergency Response To The Occurrence

The following observations are made relating to the Emergency Response to this incident.

4.13.1 Incident Detection

The initial detection of this incident occurred within a couple of minutes. This fast detection time was due to the Driver keeping a close vigilance on how the train was handling, where the Driver initially detected a train handling abnormality and subsequently looked back at the train noting an unusual amount of dust. Once the reason for this abnormality was detected the Driver gained confirmation from the Observer that there was something wrong with the train's rear and immediately applied the automatic air brake bringing the train to a stand. The Driver's response to the incident was appropriate.

4.13.2 Incident Notification

The Observer notified Control of the suspected derailment shortly after G9821 came to a stand at 311.700km. The incident notification to Train Control was considered appropriate and occurred within minutes after determining that the train had derailed.

4.13.3 Safeworking Response

On notification of the incident Train Control arranged for all trains to be held at Yass. The fore and rear of G9821 was then protected.

The train crew were breath tested by the Area Operations Manager Network Control, both producing negative results.

Jerrawa Signal Box was switched in at 17:50 and Yass Junction Local Panel switched in at 19:38.

Pilot Staff Working was introduced over the Up Main between Jerrawa and Yass Junction at 19:45.

Pilot Staff Working between Jerrawa and Yass Junction was cancelled at 22:45. Jerrawa Signal Box was switched into Automatic working at 23:30 and Yass Junction Local Panel was switched into remote working at 00:38.

4.13.4 Track Maintenance Response

The Down Main Line was certified fit for traffic with a 10km/h speed restriction from 305.500km at 22:45 by the Yass Team Manager.

4.13.5 Rolling Stock Recovery Response

The Pacific National First Response Coordinator arrived on site at 17:20. The Cootamundra Emergency Unit arrived on site at 18:30. NGPF 26065Y was rerailed at 18:40, NGPY 36106M at 19:30, NGPF 36102P at 19:55, NGPF 35943Y at 20:40 and NGPF 35978Y at 21:30.

G9821 departed the derailment site under a 40km/h speed restriction at 22:10 and arrived at Yass Junction at 22:25 where the 5 derailed vehicles were detached into Yass Junction Yard for further examination and repairs.

4.14 Human Factors - Fatigue

The train crew's rosters have been analysed for worker fatigue using the Fatigue Audit InterDyne (FAID) evaluation software. These rosters have also been reviewed against the operator's accreditation fatigue management requirements.

FAID calculates a fatigue rating using four factors that have emerged from research into shiftwork and fatigue over the last few decades. The specific formulae for this program has been developed and validated by the Centre for Sleep Research at the University of South Australia. The specific determinants of work-related fatigue as used in the FAID model are:

1. The time of day of works and breaks
2. The duration of work and breaks
3. Work history in the preceding seven days
4. The biological limits on recovery sleep.

Fatigue scores below 80 are considered satisfactory, 80 to 100 suggest a risk assessment of the working should be conducted, and scores in excess of 100 are considered problematic.

4.14.1 **Train Crew's Shift Roster – Two Weeks prior to Incident**

The train crew's shift rosters for two weeks prior to the incident are tabled below. All shifts were determined to be within the Rail Safety Act 2002[24] fatigue management schedule.

Driver's Roster - 1 Fortnight Prior To Incident						
		RAIL SAFETY ACT 2002 - SCHEDULE 2*		FAID		
Shift Start	Shift End	Hours Worked	Hours Between Shifts	Shift ^FS	Work	Rest
05 Nov 02 07:00	05 Nov 02 15:00	08:00		11.6	8	
06 Nov 02 00:00	06 Nov 02 08:00	08:00	9.0	43.6	8	9.0
07 Nov 02 02:30	07 Nov 02 12:30	10:00	18.5	57.1	10	18.5
11 Nov 02 10:00	11 Nov 02 15:00	05:00	93.5	19.3	5	93.5
12 Nov 02 00:00	12 Nov 02 08:00	08:00	9.0	49.5	8	9.0
15 Nov 02 00:50	15 Nov 02 08:00	07:10	64.8	43.8	7.2	64.8
15 Nov 02 18:00	16 Nov 02 01:00	07:00	10.0	43.6	7	10.0
16 Nov 02 13:00	16 Nov 02 23:00	10:00	12.0	48.8	10	12.0
17 Nov 02 13:30	17 Nov 02 23:00	09:30	14.5	53.1	9.5	14.5
19 Nov 02 13:40	19 Nov 02 22:40	09:00	38.7	45.1	9	38.7

Observer's Roster - 1 Fortnight Prior To Incident						
		RAIL SAFETY ACT 2002 - SCHEDULE 2*		FAID		
Shift Start	Shift End	Hours Worked	Hours Between Shifts	Shift ^FS	Work	Rest
05 Nov 02 12:30	05 Nov 02 22:30	10:00		15.6	10.0	
08 Nov 02 07:00	08 Nov 02 17:00	10:00	56.5	18.3	9	57.5
09 Nov 02 09:00	09 Nov 02 19:00	10:00	16.0	25.310	10	16
10 Nov 02 13:30	10 Nov 02 23:00	09:30	18.5	42.58	9.5	18.5
11 Nov 02 11:00	11 Nov 02 19:00	08:00	12.0	36	8	12
12 Nov 02 21:00	13 Nov 02 07:00	10:00	26.0	78.5	10	26
14 Nov 02 07:00	14 Nov 02 15:00	08:00	24.0	56.4	8	24
15 Nov 02 00:00	15 Nov 02 08:00	08:00	9.0	88.4	8	9
16 Nov 02 08:00	16 Nov 02 16:00	08:00	24.0	55.3	8	24
19 Nov 02 13:40	19 Nov 02 22:40	09:00	69.7	31.8	9	69.7

Table 4.11 Driver and Observer Work Roster 2 Weeks prior to 19th November 2002

[24] **Rail Safety Act 2002- Schedule 2 is identical to the operator's accreditation requirements that specifies:**

1. Working hours for railway employees driving freight trains

The following conditions of work apply to railway employees who drive freight trains:

(a) In the case of a 2 person operation, the **maximum shift length to be worked is 12 hours.**

(d) There is to be a **break of at least 11 continuous hours** between each shift worked by a railway employee where the employee ends a shift at the home depot.

(e) There is to be a **break of at least 7 continuous hours** between each shift worked by a railway employee where the railway employee ends a shift away from the home depot and the break is taken away from the home depot.

The following fatigue plots and risk level category allocation have been calculated using the above roster information.

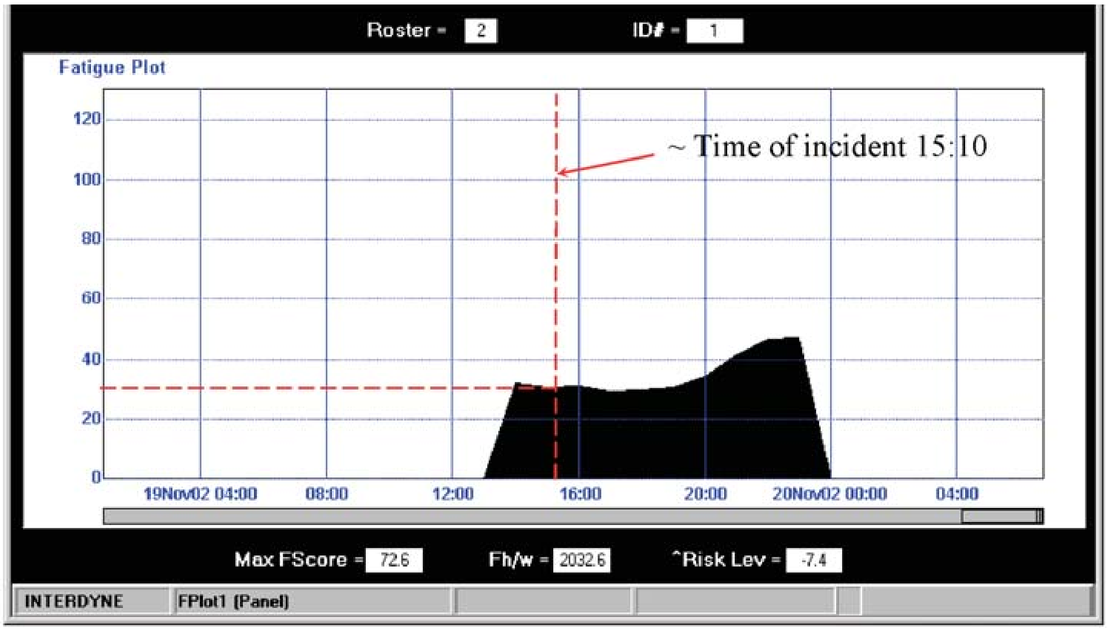
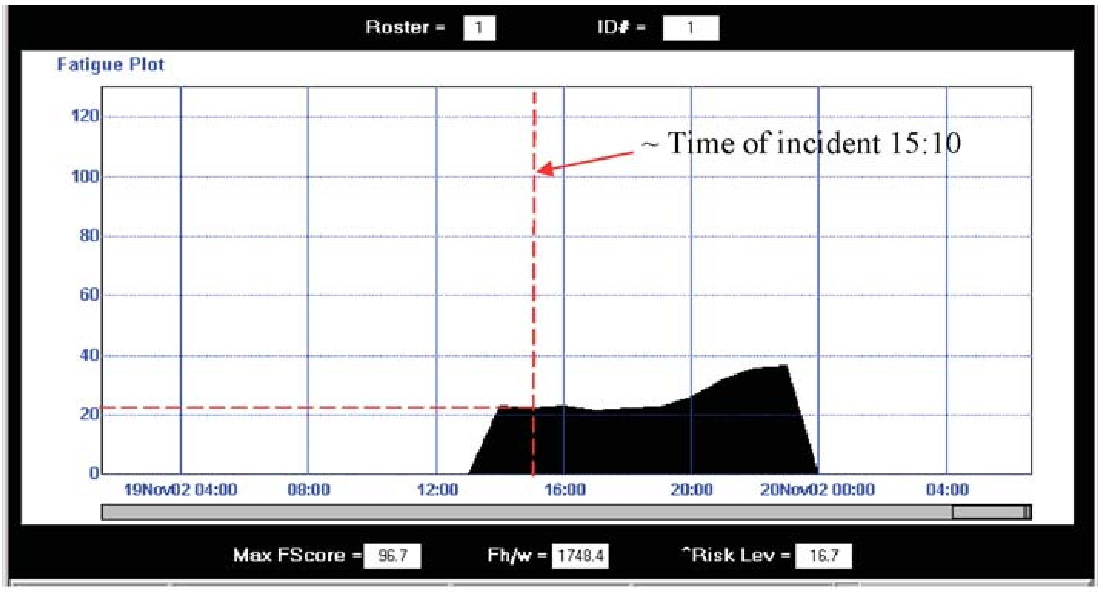


Figure 4.25 Driver's Roster Fatigue Plot ~ Fatigue Score at 15:10 ~ 30.3



Shift Max Risk Level by Category

Roster	#Very Low	#Low	#Mod	#High	#Very High	Total	%Very Low	%Low	%Mod	%High	%Very High
1	6	1	0	0	2	9	66.7	11.1	0	0	22.2
2	9	1	0	0	0	10	90	10	0	0	0

Figure 4.26 Observer's Roster Fatigue Plot ~ Fatigue Score at 15:10 ~ 22.5

Figure 4.27 Observer's Roster Fatigue Plot ~ Maximum Fatigue Score over roster on 15 November 2002 = 88.4

Based on the Rail Safety Act 2002 fatigue management review described in Table 4.12, the incident date FAID fatigue plots shown in Figures 4.25 and 4.26 and the fortnightly fatigue plots depicted in Appendix 9.13, the Driver and Observer fatigue results can be summarised as:

Description	Fatigue Score	FAID Rating	R.S.A 2002
Driver Fatigue Score at 15:10 on 19 November 2002	30.3	Very Low	
Maximum Driver Fatigue Score for Staff Roster one fortnight prior to and including 19 November 2002	57.1	Low	
Accreditation conditions working hours and shift breaks on 19 November 2002			9 hrs work 38.7hrs break
Accreditation conditions working hours and shift breaks for fortnight			no non-compliances
Observer Fatigue Score at 15:10 on 19 November 2002	22.5	Very Low	
Maximum **Observer** Fatigue Score for Staff Roster one fortnight prior to and including 19 November 2002	88.4	Very High	
Accreditation conditions working hours and shift breaks on 19 November 2002			9 hrs work 38.7hrs break
Accreditation conditions working hours and shift breaks for fortnight			no non-compliances

Table 4.12 Summary Fatigue Scores for Driver and Observer

5.0 ANALYSIS

The following investigation analysis has been derived from the evidence documented in Section 4.0 and corresponding appendices.

5.1 Infrastructure Location Factors

Those location factors, albeit only minor, that are believed to have impacted on the mechanism of a misalignment occurring at 305.650km can be listed as:

- The section of track on which the misalignment site is located is on a long descending grade where trains are forced to brake in order to maintain track speed.
- The Down Main South track at 305.650km has traffic in one direction only. Under both of these conditions tangent rail creep is typical, although at 305.650km the tangent creep associated with train operations was assessed to be of a minor nature.
- The misalignment site was situated on a 322m radius curve where the configuration of a curve less than 400m by nature presents additional risks to the maintainer in managing the prevention of misalignments.
- The potential exists for trains to speed over the misalignment site at 305.650km by virtue of the section of track being on a long descending grade. Rail Infrastructure Corporation has raised concerns of trains speeding through this section of track, and the associated concern of long term track degradation, however no documented evidence could be provided to the investigation in support of these concerns. It is noted however that G9821 was determined to have been travelling within the designated line speed at the time of the incident.

5.2 Track Structure

The following substandard track structure components were identified within the misalignment curve, where these components may have had the potential to contribute to a loss of track stability, albeit only in a minor way, and ultimately assist in the mechanism of a misalignment at 305.650km.

5.2.1 Sleeper Condition

The sleeper condition at the misalignment curve was identified as "poor" within the misalignment report compiled by Rail Infrastructure Corporation. Creosote sleepers were also identified within the misalignment curve, where although the condition of these sleepers can appear acceptable on a visual inspection, they are known to cause track stability problems. These problems occur if the creosote leaches from the sleeper to effectively reduce the interlocking frictional properties of the sleeper and ballast, thereby reducing the timber sleeper lateral stability.

5.2.2 Ballast Condition

Foul ballast was identified within the misalignment curve, as evident in Figures 4.9 & 4.10, where the presence of this type of ballast effectively reduces the interlocking properties of the sleeper to ballast interface. Foul ballast also reduces ballast compaction, which again reduces the track's lateral stability. The misalignment curve was also known to contain nattery ballast, where this type of ballast is renowned to break down into a fine particle size and eventually into a type of foul ballast. Foul ballast was noted to be more evident on the Down Main in comparison to the Up Main at 305.650km.

5.2.3 Fastener Mechanism Condition

Round holed sleeper plates without dog spikes and single sided sleeper plates were identified at various locations within the misalignment curve. This type of fastener mechanism and condition of the fastener mechanism is more likely to allow the rail to move laterally when the rail is in a state of compression. Under these conditions, at these fastener points, it is possible for the rail to flex laterally and initiate a misalignment.

5.3 Tangent Rail Creep

5.3.1 Train Operations

A number of skewed sleepers were identified throughout the misalignment curve as depicted in Figure 4.14. Whilst these sleepers provide an indication that tangent rail creep has occurred due to train operations, the investigation has ruled out the possibility of this type of rail creep being prevalent at the time of misalignment on the basis that:

- WTSA creep measurements taken 3 months prior to the misalignment identified a relatively small amount (35mm Up Rail & 5mm Down Rail) of net tangent rail creep within the 500m section, and
- WTSA rail adjustments were conducted in the misalignment curve on two prior occasions where at least 40mm of rail had been removed in order to address tangent rail creep within the 500m section.
- The 500m section was checked for correct rail adjustment on 20 November 2002 and again in December 2003 where it was determined that the Down Main in the relevant 500m section was in correct adjustment.

The investigation has therefore concluded that the tangent rail creep influenced by normal train operations, which was indicative of those skewed sleepers identified at 305.650km, most likely occurred prior to the last WTSA rail adjustment carried out on 8 December 2000. As this creep was effectively removed from the respective 500m section prior to 19 November 2002, the effect of tangent rail creep, as would be indicative of this sleeper skewing, is considered to have been minimal.

5.3.2 Track Resurfacing

Tack resurfacing work was conducted 35 days prior to the misalignment in order to address curve alignment concerns in the adjoining 500m section of track. These track resurfacing works finished 10m past the point of misalignment (305.650km). The potential therefore existed for localised tangent rail creep to have occurred up to this point (305.660km) as a result of the track resurfacing machine transferring rail stresses in the down direction towards the track resurfacing end point. The extent of rail creep associated with the track resurfacing, if any, could not however be quantified or discounted by the investigation.

5.4 WTSA Track Maintenance Procedures

Some general observations in relation to the management of WTSA were identified by the investigation that could be considered for review by Rail Infrastructure Corporation and the Yass Maintenance Team, as listed below.

5.4.1 Rail Adjustment Competency

The rail adjustments performed in the vicinity of 305.650km were carried out by, or under the supervision of, infrastructure workers with the relevant rail adjustment qualification of PW3. This qualification however does not require a competency re-certification assessment after a defined period. In contrast, other infrastructure track examination and track maintenance qualifications are subject to competency reassessment after a defined period. Such qualifications include aluminothermic welding (QWE 46, 1 year re-certification period) and track examination systems (PW52 & PW53, 3 year re-certification period). Considering that maintaining correct rail adjustment is essential in the management of misalignment prevention, Rail Infrastructure Corporation should consider reviewing the issue of PW3 re-certification.

5.4.2 Rail Adjustment Post Misalignment

The rail adjustment records taken post misalignment adjustment can be referenced in Appendix 9.9. Rail Infrastructure Corporation's standards do not explicitly define the documentation requirements for recording rail adjustment under the scenario when rails are checked for adjustment following a misalignment and converted from Continuously Welded Rail (CWR) to Jointed Welded Rail (JWR). In this instance there is no specific requirement to use the recording and reporting requirement for checking rail adjustment as detailed in Rail Infrastructure Corporation's procedure RAP 5391. Under this procedure all rail adjustment records are to be recorded for CWR track. Refer to Appendix 9.15 for the reporting requirements of RAP 5391.

5.4.3 WTSA Track Stability Calculation for Non Standard Track Configurations

The calculation of WTSA track stability is defined by Rail Infrastructure Corporation standard C2443 Track Examination: Calculation of Welded Track

Stability from Field Information. This standard allows for a maximum of 10% stability loss due to foul ballast, pumping joints[25] or poor formation.

The track stability calculated at the time of misalignment was 21%, where had the addition of foul ballast been added to this calculation the WTSA calculation would have equated to 24%. No direct assessment of the condition or type of fastener mechanism is carried out within the WTSA calculation. An indirect assessment is made however of the fastener mechanism condition by virtue of the track condition index (TCI) assessment. Considering the curve at 305.650 misaligned on the 19 November 2002 and the WTSA stability loss at the time of misalignment was as a worst case 24%, there would seem to be either:

- Additional infrastructure factors not considered within the WTSA algorithm, that in this instance would have raised the WTSA stability loss had these potential factors been incorporated into the WTSA algorithm, or
- The WTSA algorithm does not adequately produce a representative stability loss when considering the combined effects of substandard track structure components.

5.4.4 Dynamic Stabiliser

As identified in Section 4.7.6 the dynamic stabiliser was not utilised to finish off track resurfacing works carried out on the misalignment curve on 15 October 2002. Whilst the track stability loss would not have changed markedly at the time of misalignment, had the dynamic stabiliser been used, the problem of this machine not being made available to the Yass Maintenance area is of concern.

Rail Infrastructure Corporation should determine if there is a need for additional dynamic stabiliser machinery to be made available to infrastructure maintainers considering:

- The use of a dynamic stabiliser is recommended by Rail Infrastructure Corporation Civil Standards, and
- Of those misalignments that have occurred within one month of the track being disturbed, 74% of these misalignments are associated with surfacing tie and surfacing works.

5.5 WOLO Speed Restriction Application and Communications

In accordance with the Yass Maintenance Team's Hot Spot speed restriction process in place on 19 November 2002 a WOLO was created between Breadalbane (248.500km) and Bowning (330.000km) at 14:00. G9821 could therefore not be provided with a hard copy of this WOLO prior to the train's departure at Goulburn (13:55). The notification of this WOLO to G9821 could also not be carried out through the use of WB radio and CountryNet train radio communications.

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[25] A pumping joint denotes the vertical movement (greater than approximately 10mm) of the track at a mechanical rail joint as rail traffic passes over the joint.

The communication failure of this WOLO notification, where the WOLO was complied after the recommended 10:00 deadline, highlights the unreliability of the notification system if applied outside the recommended guidelines.

As a consequence of the misalignment at 305.650km, the Yass Team Manager revised the local WOLO process to apply Hot Spot Speed restrictions at a forecasted ambient temperature of 30˚C instead of 35˚C. This change in process thereby allowed the application of Hot Spot speed restrictions at a reduced ambient temperature instead of having to intently monitor the daily temperature and apply a WOLO where the actual temperature is predicted to reach above 35˚C on each respective day.

5.5.1 WB Radio Coverage

At present there is approximately 88kms of main line track between Joppa Junction and Yass Junction that has no WB radio coverage. Goulburn Signal Box cannot therefore communicate with trains in this track region via WB radio. Should Goulburn Signal Box be required to contact a train in this region they must relay their message to Junee Control where the message would be relayed via Junee Control's CountryNet train radio.

5.5.2 Train Radio Communications

Only one train radio communication attempt was made by the Train Controller to B9821. The possibility of both the Driver and Observer not noticing the visual and audible train radio notification would be higher than if successive calls had of been made to B9821. The likelihood of a train radio connection being made would have also increased had the Train Controller made a general broadcast call of WOLO conditions and required all locomotives within the affected area to contact Control to acknowledge receipt of the WOLO advice.

Currently the train radio system does not provide an indication for the Driver and Observer under the scenario when an incoming train radio communication has been attempted by Control and not responded to by the train crew. The system at present relies on the train crew responding to an incoming alert. If train radio communication attempts made by Control to a locomotive, are not responded to, the train crew currently have no knowledge of the attempted calls being made by Control.

As a register of the incoming train radio call is stored within the locomotive's train radio system it is conceivable that a modification to the current visual and or audible alarm could be made to advise the train crew of an attempted call. This alarm could then prompt a response on behalf of the train crew to contact Control in order to be advised of the Train Controller's communication.

5.5.3 WOLO Safeworking Rules

In the change from the previous Safeworking Unit Safeworking rules (SWU 722) to the new Network Rules (NGE 210) the specific requirements concerning

the application of WOLOs also changed. The extent of this change related to the removal of the requirement for Network Control Officers to ensure contact is made with train crews that have already entered the "affected portion of line". The removal of this specific requirement from the Network Rules and Network Procedures has not been subsequently transferred to any State Rail Operator Specific Procedure. Network Control Officers do not currently have any supporting procedures to assist them in the application of WOLO notifications.

5.6 Climatic Conditions

As shown in Figure 4.20 the maximum ambient temperature on 19 November 2002 was recorded as the hottest ambient temperature in the Yass area in the two months leading up to the incident date.

The rail temperature recorded shortly after the misalignment registered at 51°C. It is possible for the rail temperature to have been between 3-5°C above this temperature at the time of misalignment due to the increase in rail temperature experienced as G9821 passed over the misalignment site. Effectively, the rail temperature could have been between 54°C and 56°C at the time of misalignment. This rail temperature would then equate to between 19°C to 21°C above a correctly adjusted rail neutral temperature of 35°C. Under these conditions the rail would have been in a state of compression as G9821 traversed the misalignment site.

5.7 Train Management

All train management actions of the Driver were determined to comply with the Operator's train management standard requirements.

The train's load was also verified to be within approved limits in terms of each vehicle's maximum gross tonnage allowance and the marshalling of loaded and unloaded vehicles throughout the train.

5.8 Train Condition

5.8.1 Post Derailment Inspection

The mainline derailment inspection processes within Pacific National do not explicitly specify the inspection and reporting requirements of a train involved in a mainline derailment. Pacific National's Safety Health & Environment (SHE) Manual Section 5.1 (Page 11 of 34) requires the following to be documented **"For Serious Incidents":**

- Photographs
- Relevant notes
- Diagrams
- Data logger down loads

- Locomotive, wagon and vehicle registration numbers

Rail Infrastructure Corporation's Derailment Investigation Manual at **Section 4.1.5 Examine the Vehicles** notes the following with relation to a misalignment incident.

> *"In the case of misalignment of track occurring under the train, then all vehicles ahead of the derailed vehicles must be examined prior to the release of that portion of the train. The examination in this case need not include detailed depot examination if the bogie conditions, such as wheels and bolster gib wear, can be assessed on site."*

No specific examination document was provided by Pacific National specifying that an inspection of those vehicles ahead of the derailed vehicle had taken place in order to assess and confirm that no relevant rolling stock components were identified as faulty. A number of specific mechanical faults within any one of the vehicles traversing a potential misalignment site could significantly contribute to initiating the mechanism of a misalignment.

Such rolling stock mechanical conditions may include:

- Side bearer condition (critical for speeds greater than 80km/h)
- Snubber wear
- King/Queen casting wear and security
- Axle box jamming
- Excessive axle box clearances
- Wheel flats
- Spring condition
- Vehicle overload

Whilst the majority of these items are inspected as a part of the Full Mechanical Inspection as defined within Rail Infrastructure Corporation's Train Operating Conditions Manual, the capture and certification of such an inspection following a main line derailment is not required within either the Pacific National or Rail Infrastructure Corporation Derailment Investigation procedures. The level of competence required of the rail safety worker that conducts such an inspection is also not specified.

5.8.2 Train Condition Review Against Additional Misalignment Incidents

On 16 and 17 December 2002 10 misalignments were detected on the Main South in the Cootamundra area following the passage of Pacific National steel trains 2SP2 (6 misalignments detected) and 3WP2 (4 misalignments detected) respectively.

The investigation subsequently reviewed available train manifest and maintenance documentation of 16 and 17 December 2002 steel trains against the G9821 train consist and other train consists that preceded G9821 on 19 November 2002. The train consist information of 16 and 17 December 2002 was also cross-checked

against the Pacific National train 4YN2 which derailed subject to a misalignment on 7 November 2002 at Rocky Ponds/Harden (Up Main South 377.960km). Based on the cross-check results identified above, the investigation determined:

- There were no common vehicles identified between the trains that derailed on 7 and 19 November 2002 and the Pacific National steel trains involved in multiple misalignments that occurred on 16 and 17 December 2002.
- Where there were common vehicles identified between those preceding trains of 7 and 19 November 2002 and the Pacific National steel trains of 16 and 17 December 2002, these preceding trains traversed the misalignment sites at least 8hrs prior to both derailments.

A review of the maintenance history of these common wagons, following the derailment dates, could not sufficiently identify any apparent vehicle repairs that would be consistent with major ride stability problems.

5.9 Combined Misalignment Track Analysis Review

Based on the analysis and evidence identified within this report the investigation has concluded that the track at 306.560Km misaligned under G9821 which inturn led to the train derailing.

Those factors considered to have contributed to the mechanism of misalignment include:

- Track resurfacing works which took place on the misaligned curve 35 days prior to the misalignment date, where these works are considered to have weakened the lateral stability of the track structure, albeit only to a minor extent.
- The track resurfacing works conducted 35 days prior to the misalignment were noted to have finished 10m past the point of misalignment (305.650km). The potential therefore existed for localised tangent rail creep to have occurred up to this point (305.660km) as a result of the track resurfacing machine transferring rail stresses in the down direction towards the track resurfacing end point. The extent of rail creep associated with track resurfacing, if any, could not however be quantified or discounted by the investigation.
- The temperature at the time of misalignment was the hottest temperature at the location since the track was resurfaced, indicating the influence of thermal stresses being prevalent at the time of misalignment.
- Foul ballast was identified at the misalignment site albeit this factor may be regarded as a minor contributor.
- Poor sleeper condition was identified at the misalignment site albeit this factor may be regarded as a minor contributor.
- Poor fastener mechanism condition and substandard types of fastener mechanisms including round holed sleeper plates without dog spikes and single sided sleeper plates were identified at the misalignment site, albeit these factors may be regarded as minor contributors.

- Due to an inability to relay WOLO information the train speed exceeded the WOLO speed in force at 14:00, where had the train successfully received the WOLO notification prior to the misalignment at 15:10 the train would have been restricted in speed from 75km/h to 65km/h.

Although the investigation was not able to identify a major causal factor the occurrence of this incident highlights the increased risk of misalignment on track configuration that is not configured to standard requirements.

6.0 CONCLUSIONS

6.1 Findings

The investigation determined that Pacific National train G9821 derailed at 305.650km, whilst travelling on the Down Main South, due to a severe track misalignment. This misalignment was determined to have occurred under the train.

The investigation did not identify a major incident causal factor. Although a number of the track structure components such as ballast, fastener and sleeper condition may have been identified as substandard, the condition of these items were not considered to have caused the incident in either isolation or as a combination of factors. An extensive track adjustment review was also conducted by the investigation in order to determine if track adjustment contributed to the misalignment. This review confirmed that the track was in correct adjustment prior to the misalignment, thereby discounting this as a potential causal factor.

The investigation identified the possibility that track resurfacing machinery may concentrate internal rail stresses at the machineries rail exit point. Although this issue was identified as a potential contributing factor in this incident the investigation could not quantify the extent if any of its contribution.

The occurrence of this type of incident highlights the increased risk of misalignment on track configuration that is not configured to standard requirements. Rail Infrastructure Corporation therefore must ensure that adequate ongoing maintenance and inspection is applied to this type of track configuration in order to compensate against the reduction in track structure stability.

6.2 Contributing Factors

The following contributing factors, in addition to those described above, were also considered to have played a part in the occurrence of this incident:

- Track resurfacing work had taken place on the misaligned curve 35 days prior to the misalignment date. This track resurfacing work would have effectively reduced the lateral track stability at the time of misalignment, albeit only to a minor extent.
- The ambient temperature recorded at the misalignment site shortly after the incident was 35°C. This temperature was the hottest temperature recorded in the Yass area since the track resurfacing work was carried out on 15 October 2002, on the basis of the daily maximum temperatures at the closest weather station.
- A WOLO notification compiled at 14:00 on 19 November 2002, covering the misalignment site at 305.650km was not received by G9821 prior to the misalignment at 15:10. G9821 was travelling 8.5 km/h above the WOLO

speed in force at the time of misalignment as the train crew were unaware of the applicable WOLO speed restriction. G9821 could not be advised of this speed restriction due to the late application of this WOLO and the fact that G9821 could not be contacted by WB radio or CountryNet train radio prior to 15:10.

- Attempts made by the Signaller at Goulburn Signal Box to contact G9821 via the WB radio were unsuccessful as G9821 was positioned past the WB radio coverage limit (229.200Km) in the south direction. This WB coverage however is re-established again in the vicinity of Yass Junction (317Km) to provide Goulburn Signal Box with WB radio communication surrounding the signalling system of the junction in which the signal box remotely controls.
- The Train Controller made a single attempt to contact the train crew of G9821 to warn the train of the approaching WOLO conditions. This attempt was unsuccessful and was not attempted again. The failure to provide the WOLO notification was a breach of the WOLO safeworking Rule SWU 722 current at the time of the incident.
- The train crew did not respond to the single incoming call from Junee Control at approximately 14:02, where this call was made with the intent on communicating to the train crew of the approaching WOLO conditions between Breadalbane (248.500km) and Bowning (330.00km).
- The Train Controller did not attempt to contact G9821 using a train radio general broadcast that has the ability to contact all trains equipped with the train radio system over a section or sections of track selected by the Train Controller.
- Once a train radio communication ringing call from Control to a train is disconnected, and not answered, there is no indication on the locomotive train radio to advise of the missed call.
- RailCorp do not have Operator Specific Procedures in place to assist train controllers in the process of issuing WOLO notifications.

6.3 Related Findings

The investigation has determined the following related findings:

6.3.1 Train Management and Operations

- The Driver and Observer's rostered fatigue ratings met recommended FAID levels on the incident date. The operator's fatigue management accreditation requirements were also met on incident date.
- The train speed, train load and train braking management were all determined to be within standard operating requirements.
- The train crew were breath tested and both train crew returned negative results.
- There were no common vehicles identified between those trains that derailed subject to misalignments on 7 and 19 November 2002 and the Pacific National steel trains involved in multiple misalignments that occurred on 16 and 17 December 2002.

6.3.2 Track Maintenance

- The management of tangent and curve rail creep with respect to correct adjustment practices over 500m rail lengths was considered to meet the required standard.
- Ballast shoulder and crib profiles were considered to meet standard requirements.

6.4 General Safety Related Findings

The investigation found that the following matters did not contribute to the incident, but had the potential to affect rail safety.

- The Observer's rostered FAID fatigue rating indicated a very high level of fatigue for 1 of the 14 days assessed prior to the incident date.
- Rail Infrastructure Corporation's Derailment Investigation Manual and Pacific National's Incident Investigation Manual do not explicitly define the expected rolling stock inspection reporting criteria required following a misalignment related derailment. The level of competency required to carry out such an inspection is also not specified.
- The current rail adjustment qualification of PW3 does not require a competency re-certification assessment after a defined period. In contrast, other infrastructure track examination and track maintenance qualifications are subject to competency reassessment after a defined period.
- There is no specific requirement within Rail Infrastructure Corporation's standards or procedures that defines the acceptable reporting requirements for carrying out rail adjustment when rail is converted from CWR to JWR.
- The new Network Rule NGE 210 does not specifically require a Network Control Officer to ensure, where possible, that trains are advised of WOLO conditions when the train has, at the time of the WOLO notification, already entered the "affected portion of line".
- The requirement to ensure WOLO notifications are advised to Train Control prior to 10:00 on the day of their application is no longer contained in the current Network Rule NGE 210.

7.0 POST MISALIGNMENT SAFETY ACTIONS CARRIED OUT BY RAIL INFRASTRUCTURE CORPORATION

The Yass Maintenance Team initiated the following safety actions in an effort to improve the track structure stability at 305.650km following the incident.

7.1 Interim Track Configuration Change from CWR to JWR

Immediately post misalignment the Yass Maintenance Team converted the track from CWR to JWR in order to provide an interim measure of reducing the influence of tangential rail stresses associated with high temperatures.

7.2 Reduction in Application Temperatures for Hot Spot Speed Restrictions and WOLO Telegrams

The Yass Team Manager modified the process for applying speed restrictions at locations with a history of track stability problems (Hot Spot locations). This process was effectively amended to require the following.

- On days forecasted at a maximum temperature of 30°C (previously 35°C) Hot Spot speed restrictions would be applied at all Hot Spot locations.
- On days where the temperature is monitored by the Yass Civil Maintenance Team and predicted to reach 30°C (previously 35°C) or above, a WOLO telegram would be issued to cover the section of track bounded by the Hot Spot location extremities.

7.3 Rail Painting with Solar Radiation Inhibitor Paint

All rails of the Up and Down Main South track at the misalignment site, and other Hot Spot locations, were painted with a radiation reducing white paint in order to reduce the rail temperature experienced during high ambient temperatures. This painting program was finalised at 305.650km and a number of other locations by the end of January 2003.

7.4 Low Profile Concrete Re-Sleepering

Low profile concrete sleepers in a 1 in 4 pattern have been installed at Hot Spot locations and tight radius curves in the Main South Yass Maintenance Team area. This program started in July 2003 and was finalised in September 2003.

7.5 Rail Profile Grinding

Profile grinding of the rail to remove defects that have the potential to increase vertical displacements and in turn reduce lateral track stability was undertaken throughout the Yass Maintenance Team area. This program was completed in conjunction with the concrete sleepering program in September 2003 and covered the misalignment site at 305.650km.

8.0 SAFETY RECOMMENDATIONS

8.1 Direct Safety Recommendations

As of 1 July 2004 RailCorp was vested with safety management responsibility for the safety management of Rail Infrastructure Corporation. The safety recommendations of this investigation have therefore been amended to reflect this change. In addition to those safety actions already undertaken by Rail Infrastructure Corporation, the following safety recommendations are made in order to avert the occurrence of similar misalignment incidents.

8.1.1 Review of Ballast, Fastener Mechanism and Sleeper Condition at 305.650km and other Hot Spot Locations

It is recommended that the RailCorpYass Maintenance Team ensure the following track structure components meet the current maintenance standard requirements at 305.650km following the programmed concrete re-sleepering program and in preparation for the summer of 2004/2005.

- Ballast condition.
- Fastener type and conditional.
- Sleeper condition.

8.1.2 Review of WTSA Algorithm Considering Ballast Condition and Non Standard Track

It is recommended that RailCorp review and amend where necessary the lateral stability calculation within the WTSA algorithm with respect to assessing the impact of a combination of track structure factors being prevalent as opposed to the straight addition of these factors. In particular the review should consider the combination of ballast condition and non standard track

The calculation of WTSA track stability is defined by RailCorp standard C2443 Track Examination: Calculation of Welded Track Stability from Field Information. This standard allows for a maximum of 10% stability loss due to foul ballast, pumping joints or poor formation.

Considering the curve at 305.650km misaligned on the 19 November 2002 and the WTSA stability loss at the time of misalignment was as a worst case 24%, there would seem to be either:

- Additional infrastructure factors not considered within the WTSA algorithm that in this instance would have raised the WTSA stability loss had these potential factors been incorporated into the WTSA algorithm, or
- The WTSA algorithm does not adequately produce a representative stability loss when considering the combined effects of substandard track structure components.

8.1.3 Further research required into the potential transfer of internal rail stresses by track resurfacing machinery at the machineries track resurfacing exit point.

It is recommended that RailCorp conduct further research into the potential transfer of internal rail stresses by track resurfacing machinery at the point at which the machinery exits the track structure. This research should attempt to quantify if this potential contributing factor is likely to play any significant role in initiating a misalignment. RailCorp should then determine and implement corrective actions to address any concerns raised from the research.

8.1.4 Further research required into the potential reduction of track stability associated with Nattery ballast.

It is recommended that RailCorp conduct further research into the potential reduction of track structure stability associated with Nattery ballast. This research should attempt to quantify if this potential contributing factor is likely to play any significant role in initiating a misalignment over more standard types of ballast composition. RailCorp should then determine and implement corrective actions to address any concerns raised from this research.

8.1.5 Ensuring adequate levels of ongoing maintenance and inspection of non standard track configurations.

The occurrence of this type of incident highlights the increased risk of misalignment on track configuration that is not configured to standard requirements. It is therefore recommended that RailCorp ensure adequate ongoing maintenance and inspection is applied to this type of track configuration in order to compensate against its reduction in track structure stability.

8.1.6 Ensuring WOLO heat related speed restrictions are applied in compliance with Network Rule Requirements,

It is recommended that RailCorp ensure WOLO notifications are compiled and applied, where possible, prior to the 12:00 application time. It is also recommended that RailCorp consider specifying within the Network Rules a recommended time in which WOLO notifications should be provided to Train Control for their distribution to operators.

8.1.7 CountryNet Train Radio missed call alert improvement

It is recommended that RailCorp consult with rail operators on improving the locomotive train radio call alert system to provide train crews with the ability to identify that an incoming call has taken place and has not been answered.

8.1.8 Signal Box to train communication review

It is recommended that RailCorp review the radio communication infrastructure currently available to Signal Boxes in order to determine if this infrastructure is

adequate to facilitate the rail safety communication requirements of signallers. Should this communication infrastructure be determined unsatisfactory, RailCorp are recommended to improve the infrastructure in order to meet the rail safety communication requirements of signallers.

8.1.9 Train Control Operator Specific Procedures for the application of WOLO notifications

It is recommended that RailCorp create WOLO notification Operator Specific Procedures for Train Controllers to assist in the training and execution of these notifications via train radio. Those procedures developed in response to this recommendation could be emphasised in RailCorp's safety management system training prior to the summer months.

8.1.10 Improved Driver vigilance of incoming Train Radio calls

It is recommended that Pacific National ensure their train crews are vigilant in their recognition and response to incoming train radio calls.

8.2 General Safety Recommendations

The following safety recommendations are made to RailCorp and Pacific National management in order to improve upon rail safety management as identified within this misalignment investigation.

8.2.1 Improvements required in the reporting of misalignments and track restoration processes

It is recommended that RailCorp formalise their track restoration civil technical note requirements into a standard, where this standard would identify the key processes that must be carried out when reinstating misaligned track. In particular, the requirement to carry out a check of rail adjustment during the rectification works should be formalised within this standard along with the rail adjustment and misalignment reporting requirements.

At present there is no specific requirement within RailCorp's standards or procedures that defines the acceptable reporting requirements for carrying out a post incident rail adjustment analysis when rail is converted from CWR to JWR.

8.2.2 Rail adjustment competency re-certification

It is recommended that RailCorp specify a recertification period for the rail adjustment (PW3) qualification.

Other infrastructure track examination and track maintenance qualifications are subject to competency reassessment after a defined period. Considering that maintaining correct rail adjustment is essential in the management of misalignment prevention, RailCorp should consider requiring an ongoing competency assessment process is associated with this qualification.

8.2.3 Review of dynamic stabilisation resources available to maintainers following track resurfacing works

It is recommended that RailCorp determine if there is a need for additional dynamic stabiliser machinery to be made available to the maintenance areas considering:

- Immediate track stability improvements are gained from stabilisation
- That the use of a dynamic stabiliser is recommended by the RailCorp Civil Standards where alignment is difficult to maintain, and
- That RailCorp maintenance areas, in particular within the southern country region, prefer to use this machinery but have not been able to do so since 1998.

8.2.4 RailCorp train speed monitoring

It is recommended that RailCorp carry out an appropriate level of operator train speed monitoring to gauge each operator's compliance with approved track speeds. RailCorp could then effectively advise the operators of trains that may be exceeding the design track speed or speed restrictions in place.

8.2.5 Mandatory inspection of vehicles involved in Main Line derailments

It is recommended that RailCorp produce a mandatory inspection criteria for vehicles involved in main line derailments. Such an inspection criteria should assist the Operator in identifying the rolling stock components requiring inspection, depending on the type of derailment and the potential contributing factors identified at the time of derailment.

The level of competence required by a rail safety worker to carry out such an inspection should also be specified together with the requirement for the inspection to be carried out prior to the train departing the incident site.

It is recommended that Pacific National ensure all vehicles involved in main line misalignment derailments are inspected against applicable RailCorp minimum operating standards for rolling stock. This inspection should determine, where practicable, if the rolling stock has played a contributory role in the misalignment.

8.2.6 Review of the Safeworking Network Rules concerning WOLO notifications

It is recommended that RailCorp review the applicable Network Rules governing the application of WOLO notifications to ensure there is no ambiguity of the Network Control Officer's responsibility to communicate, where possible, WOLO conditions to trains that have entered the "affected portion of line".
It is also recommended that RailCorp review whether there still exists a requirement, within the applicable Network Rules/Network Procedures/Operator Specific Procedures/Infrastructure Standards to recommend a target time for when infrastructure maintainers should notify Network Control of WOLO notifications.

9.0 APPENDICES

9.1 Track Configuration Review

Kilometreage	Steel Sleeper	Thermit Weld	Closure?	Glued Joint?	Rail	Lubricator	Other
305.5530							Start of cutting.
305.5544		Yes	Yes		Dn		
305.5546	Yes						
305.5575		Yes	Yes		Dn		
305.5654	Yes						
305.5695	Yes						
305.5713	Yes						
305.5735	Yes						
305.5748	Yes						
305.5790	Yes						
305.5815	Yes						
305.5859	Yes						
305.5909	Yes						
305.5992	Yes						
305.6052	Yes						
305.6072	Yes						
305.6146	Yes						
305.6185	Yes						
305.6188		Yes	Yes		Dn		
305.6221	Yes						
305.6241		Yes	No		Dn		
305.6249	Yes						
305.6258							Misalignment 23.01.98
305.6294	Yes						
305.6312		Yes	No		Dn		
305.6349					Dn		New mechanical joint
305.6349							Misalignment 19.11.02
305.6373	Yes						
305.6421	Yes						

Kilometreage	Steel Sleeper	Thermit Weld	Closure?	Glued Joint?	Rail	Lubricator	Other
305.6421							First damaged sleeper
305.6595	Yes						
305.6663		Yes	Yes		Dn		
305.6692		Yes	Yes		Dn		
305.6739	Yes						
305.6781	Yes						
305.6799	Yes						
305.6819	Yes						
305.6833	Yes						
305.6869							End of cutting.

9.2 G9821 Train Consist Information

ional Rail Corporation   TMS - ATR - Train Consist Report   Page 2 of 6
Run Date: 19/11/2002

dication: CONFIRMED   Train Id: G9821A   Origin Date: 19/11/2002
ain Type: SEGRAIN   Location: GOULBURN
igin: INNER HARBOUR   Destination: DUBBO

****

co: 1 8160   ST: A   Loco Phone No: GT13
2 8155   A
Crew: 1340hrs   Home Depot: GUL
1340hrs   GUL

tal Wagons: 40   Total Dangerous Goods: 0   Tonnes per Operative Brake: 21
ain Weight: 840   Total Out of Gauge : 0   HP per trailing tonne : 5.33
ain Length: 614.4   EOTM Id : 9999   Air Brake Test Certificate: 92610
Air Brake Cut Out Vehicles: 0

cation out of which consist is confirmed : INNER HARBOUR
C Phone No:

****

LLINGSTOCK

G OOG	Seq	Rollingstock	Length	Mass	ST	Cond Freight	Orig	Att	Consignee	Dest
	1	8160	21.2		A		IHB	IHB		DBO
	2	8155	21.2		A		IHB	IHB		DBO
	3	NGPF36074N	14.3	21	E		IHB	IHB		DBO
	4	NGPF36145F	14.3	21	E		IHB	IHB		DBO
	5	NGPF36173L	14.3	21	E		IHB	IHB		DBO
	6	NGPF36179T	14.3	21	E		IHB	IHB		DBO
	7	NGKF35889J	14.3	21	E		IHB	IHB		DBO
	8	NGPF35901K	14.3	21	E		IHB	IHB		DBO
	9	NGPF36184F	14.3	21	E		IHB	IHB		DBO
	10	NGPF35993X	14.3	21	E		IHB	IHB		DBO
	11	NGPF36044M	14.3	21	E		IHB	IHB		DBO
	12	NGPF36196X	14.3	21	E		IHB	IHB		DBO
	13	NGPF35902T	14.3	21	E		IHB	IHB		DBO
	14	NGPF36100U	14.3	21	E		IHB	IHB		DBO
	15	NGKF35899R	14.3	21	E		IHB	IHB		DBO
	16	NGPF36052C	14.3	21	E		IHB	IHB		DBO
	17	NGPF36043D	14.3	21	E		IHB	IHB		DBO
	18	NGPF35967U	14.3	21	E		IHB	IHB		DBO
	19	NGPF35977F	14.3	21	E	G	IHB	IHB		DBO
	20	NGPY36197B	14.3	21	E		IHB	IHB		DBO
	21	NGPF35956D	14.3	21	E		IHB	IHB		DBO
	22	NGPF36188S	14.3	21	E		IHB	IHB		DBO
	23	NGPY35944H	14.3	21	E		IHB	IHB		DBO
	24	NGPF36128Q	14.3	21	E		IHB	IHB		DBO
	25	NGPF36065Y	14.3	21	E		IHB	IHB		DBO
	26	NGPF36155N	14.3	21	E		IHB	IHB		DBO
	27	NGPY36106M	14.3	21	E		IHB	IHB		DBO

sername: Commercial in confidence

ional Rail Corporation TMS - ATR - Train Consist Report

Page 3 of 6
Run Date: 19/11/2002

lication: CONFIRMED Train Id: G9821A Origin Date: 19/11/2002

ain Type: SEGRAIN Location: GOULBURN

igin: INNER HARBOUR Destination: DUBBO

****

LLINGSTOCK

OOG	Seq	Rollingstock	Length	Mass	ST	Cond	Freight	Orig	Att	Consignee	Dest
	28	NGPF36102P	14.3	21	E			IHB	IHB		DBO
	29	NGPF36085H	14.3	21	E			IHB	IHB		DBO
	30	NGPF36187J	14.3	21	E			IHB	IHB		DBO
	31	NGPF35948N	14.3	21	E			IHB	IHB		DBO
	32	NGPF35943Y	14.3	21	E			IHB	IHB		DBO
	33	NGPF36029S	14.3	21	E			IHB	IHB		DBO
	34	NGPF35960D	14.3	21	E			IHB	IHB		DBO
	35	NGPF36003R	14.3	21	E			IHB	IHB		DBO
	36	NGKF36213B	14.3	21	E			IHB	IHB		DBO
	37	NGPF36198D	14.3	21	E			IHB	IHB		DBO
	38	NGPF35903F	14.3	21	E			IHB	IHB		DBO
	39	NGPF36081R	14.3	21	E			IHB	IHB		DBO
	40	NGPF35953W	14.3	21	E			IHB	IHB		DBO
	41	NGPF36045V	14.3	21	E			IHB	IHB		DBO
	42	NGPF35978Y	14.3	21	E			IHB	IHB		DBO

****

NGEROUS GOODS

nt No	Seq	Wagon Id	UN NO	Class	Shipping Name	Sub Risk	Mass	PKGS	QTY	PKG GRP

****

ANNED ENROUTE WORKING

ntermediate Loc	Plan	Actual	Dest	Attach	Detach	Planned Date/Time
NER HARBOUR	40	42	DBO	ATTACH		19/11/2002 09:40 EAST
JBBO	42	0	DBO		DETACH	20/11/2002 00:48 EAST

****

EFECTS

ollingstock Id	Rollingstock Status	Defect Description
GPF35977F	G	BODY DAMAGE (DEFINE)

****

NTAINERS

q	Wagon Id	Transit Leg	Container Id	Container T/Leg	Mass (Tonnes)	DG Class	Commodity

ername: Commercial in confidence

9.3 NGPF NGKF Wagon Details from the Train Operating Conditions standard

General Instruction Pages — **Locomotive and Rolling Stock Data**

P

❐ Pacific National – *Freight Rolling Stock*

CODE	DESCRIPTION	CLASS	MAX GROSS MASS TONNES	TARE TONNES	LENGTH METRES	DRAW CAPACITY MN	BRAKE TYPE	NOTES See Page 1
Grain Hoppers								
NGCX	Grain	C	57	17	12.3	0.90	B2	
NGDX	Grain	C	73	17	14.3	0.90	B3	l
NGFF	Grain	C	76	22	14.6	0.75	B2	
NGGF	Grain	A	78	21	14.3	1.80	B3	l
			81	21	14.3	1.80	B3	**l, e.**
NGHF	Grain	C	76	18	14.4	1.80	••B4	
NGIF	Grain	C	76	20	15.1	0.75	B4	
NGLF	Grain	C	73	17	14.3	0.90	B2	
NGKF	Grain	A	78	21	14.3	1.80	••B3	l
			81	21	14.3	1.80	B3	**l, e.**
NGMA	Grain	D	68	22	11.9	0.75	B2	
NGMF	Grain	D	68	22	11.9	0.75	B2	
NGNF	Grain	C	73	17	14.3	0.75	B2	l
NGOF	Grain	C	73	17	14.3	0.75	B2	l
NGPF	Grain	A	78	21	14.3	1.80	••B4	l
			81	21	14.3	1.80	••B4	**l, e.**
NGPY	Grain	A	78	21	14.3	1.80	••B4	l
			81	21	14.3	1.80	••B4	**l, e.**
NGQF	Grain	A	78	21	14.3	1.80	B3	l
			81	21	14.3	1.80	B3	**l, e.**

General Instruction Pages — **Locomotive and Rolling Stock Data**

EXPLANATION OF NOTES:

FOR LOCOMOTIVE AND ROLLING STOCK DATA

a These vehicles when loaded beyond their published gross mass up to a maximum of 80 tonnes are restricted to routes and speeds as follows when so loaded:

At a maximum speed of 80 km/h	At a maximum of 70 km/h	At a maximum of 60 km/h
Sydney – Brisbane Sydney - Broken Hill Sydney – Albury Sydney - Port Kembla – Moss Vale Maitland - Muswellbrook - Gulgong Orange – Dubbo	Gulgong - Merrygoen – Dubbo Dubbo - Narromine - Parkes Cootamundra - Stockinbingal - Parkes Stockinbingal - Griffith	Joppa Junction - Queanbeyan

b These vehicles must operate on Class 1, 1C or 1XC only, when loaded to **92 tonnes** (for 4 axles) gross or 23 tonnes per axle at a maximum speed of **80 km/h**. Wheel tread hollowing shall not exceed 2mm.

c These vehicles must operate on Class 1, 1C or 1XC only, when loaded to **84 tonnes** (for 4 axles) gross or 21 tonnes per axle at a maximum speed of **100 km/h**.

d These vehicles are permitted to operate at a maximum gross mass of **92 tonnes** on the Class 2 line Cootamundra to Griffith via Temora at a maximum speed of **60 km/h**, also a maximum speed of 15 km/h is to be observed for these vehicles Cootamundra North to Cootamundra West and Cootamundra to Cootamundra West.

e When loaded from **78** up to a maximum of **81** tonnes gross mass **Class E** speeds will apply.

f When loaded with coke to count as 80 tonnes

g Maximum speed when loaded to maximum gross mass-
Class 1 track 65 km/h, **Class 1C track** 65 km/h, **Class 1XC** track 80 km/h Maximum speed when empty 80 km/h

h Not permitted to run on Classes 2,3,4,5 track.

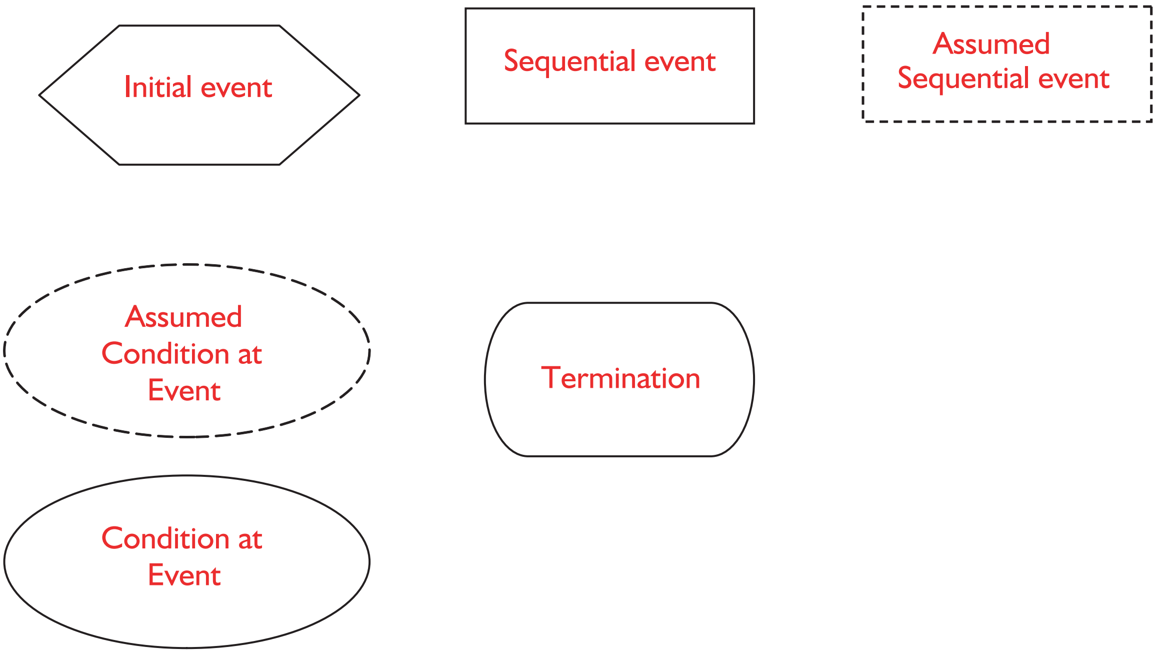
i When loaded to a gross mass of 80 tonnes Class 'C' speed classification can be used.

j Fuel/oil tanks 70 km/h unless stencilled for 80 km/h

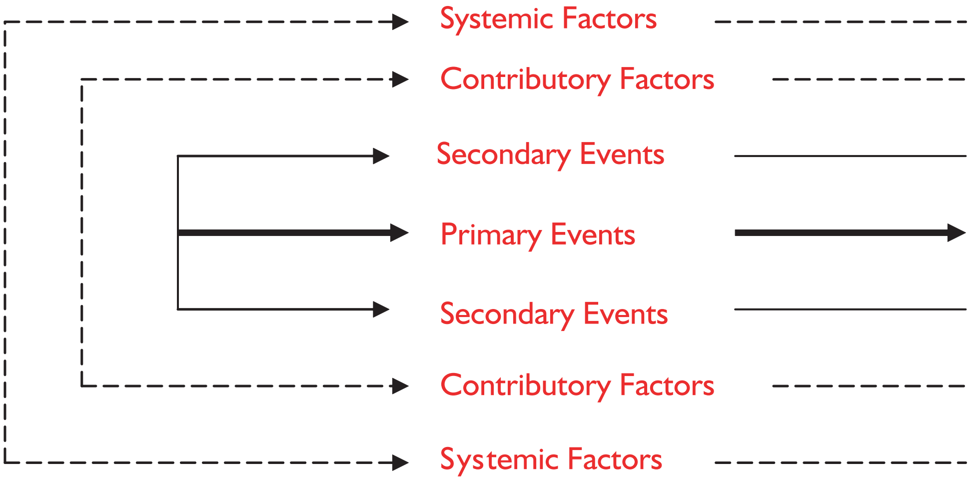
k Bogie tank wagons – maximum gross mass and length. Individual vehicles may vary. The following NTAF wagons only have a rivetted underframe and must therefore be classified as Low DRAW CAPACITY (0.75) when calculating trailing loads :- Nos. 5193, 5194, 6006, 6010, 6011, 6019, 6034, 6046, 6055, 6063, 6065, 6066, 6069, 6073, 7276.

l These wagons are not allowed to pass sheep and cattle races, loading platforms, loading banks, stages and other structures erected at platform clearances to heights exceeding 1.372 metres above rail level. They are not permitted to pass through enclosed goods sheds and sheds or buildings erected over hoppers in private sidings or be placed in sidings or on other tracks where the track centres and clearances are known to be restricted.

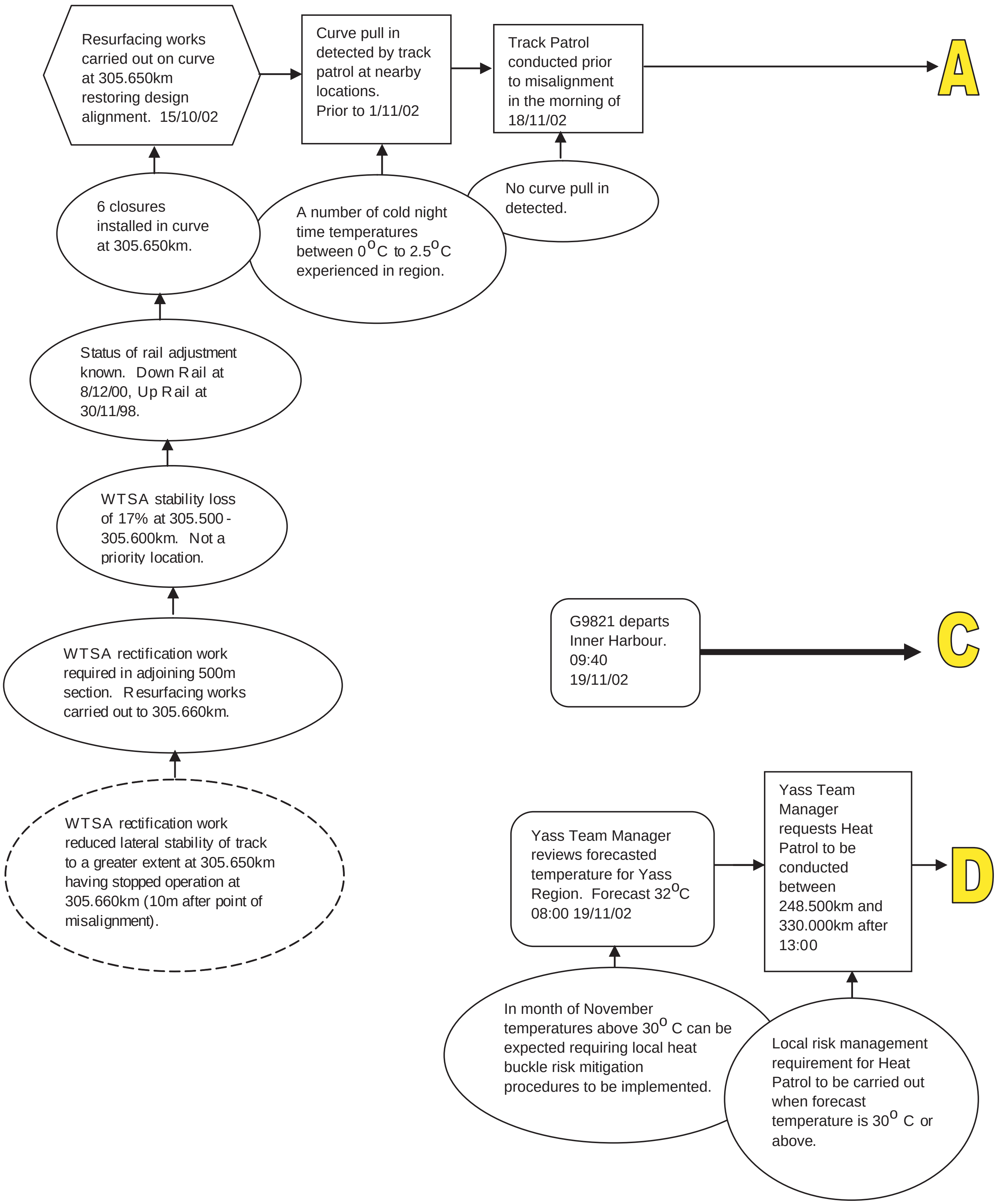
9.4 Events and Conditions Chart Symbols & Meanings

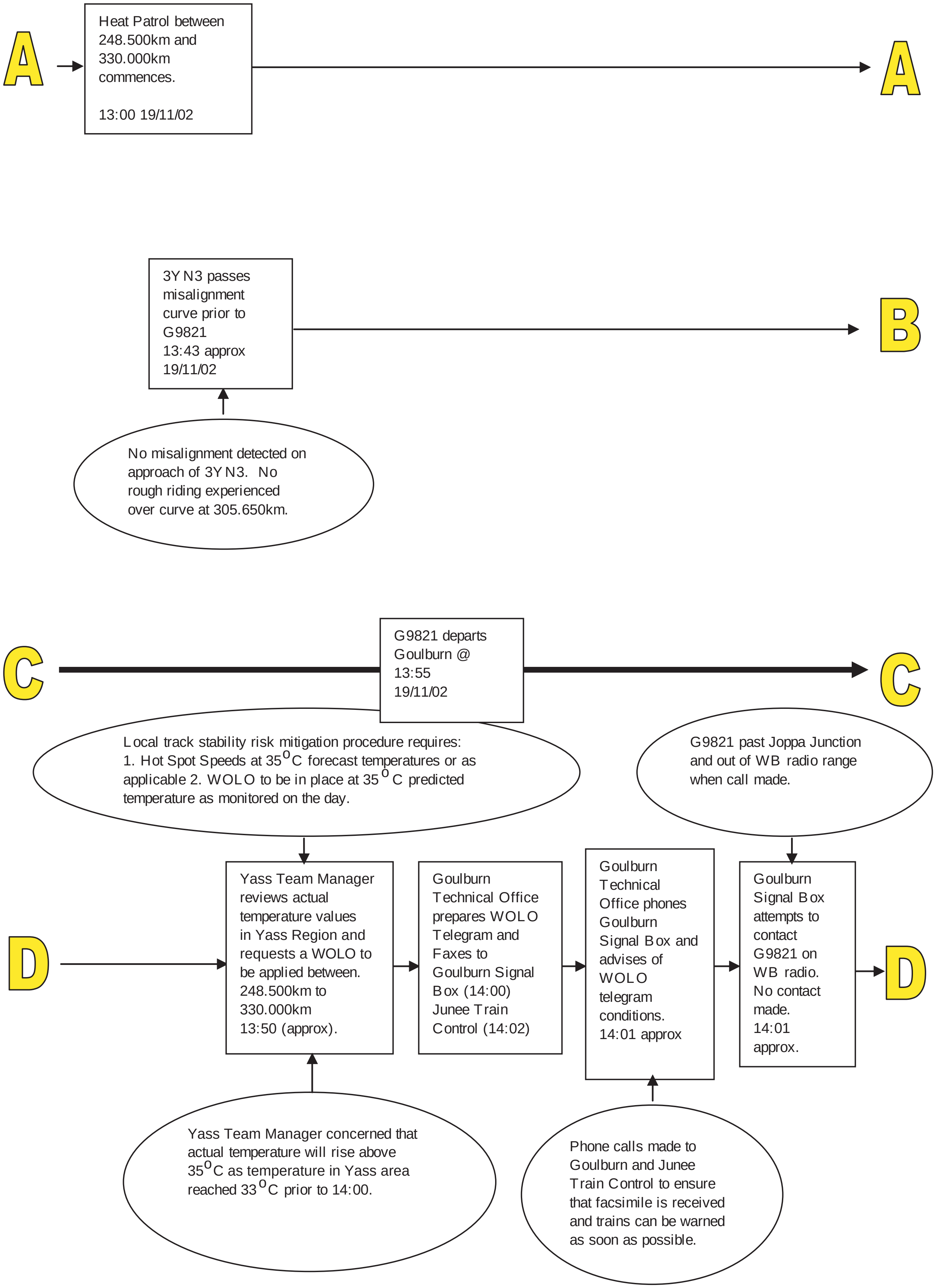


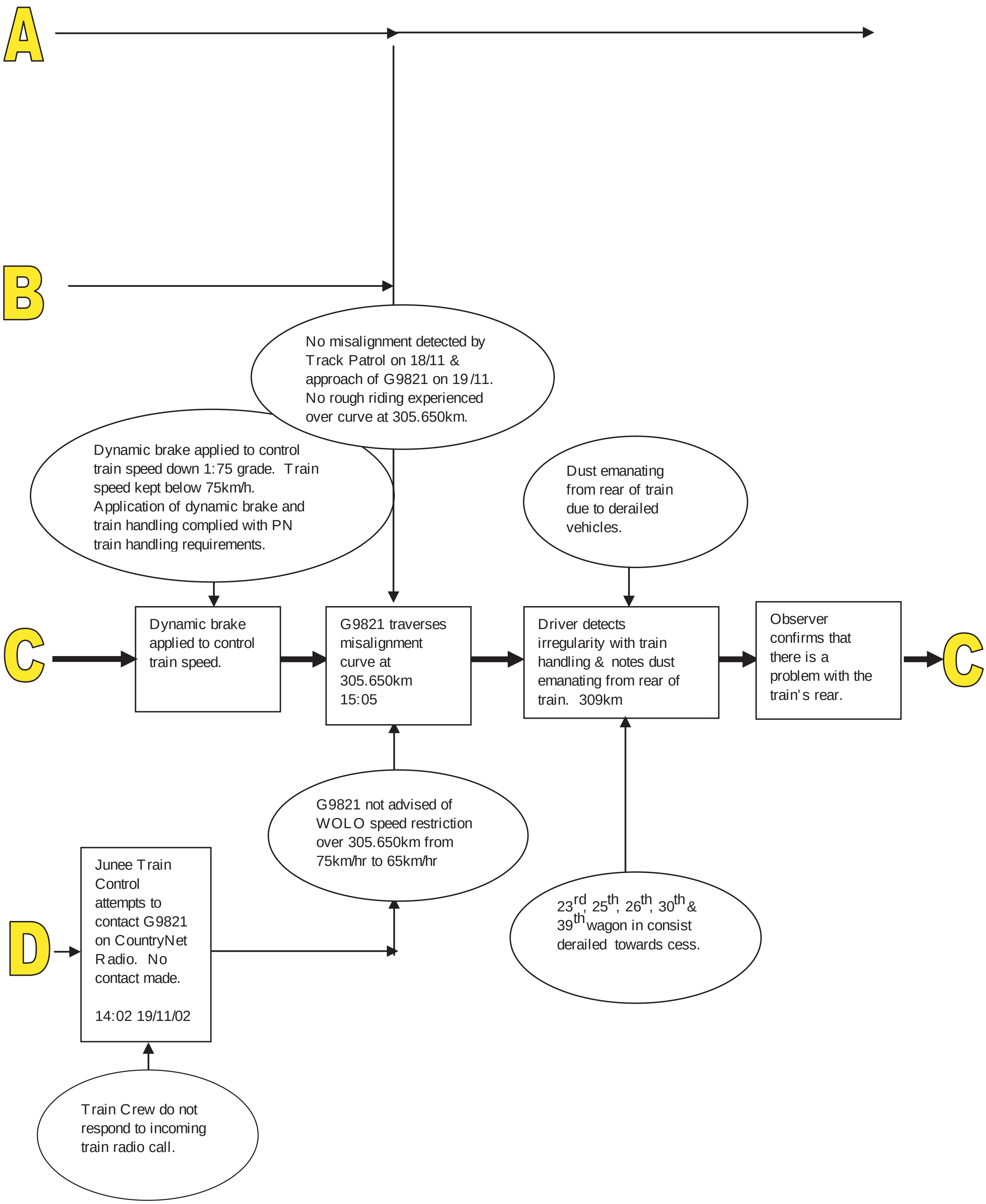
Events and Causal Factors Relationships

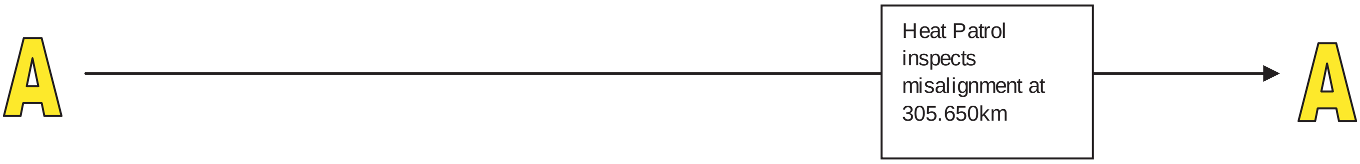


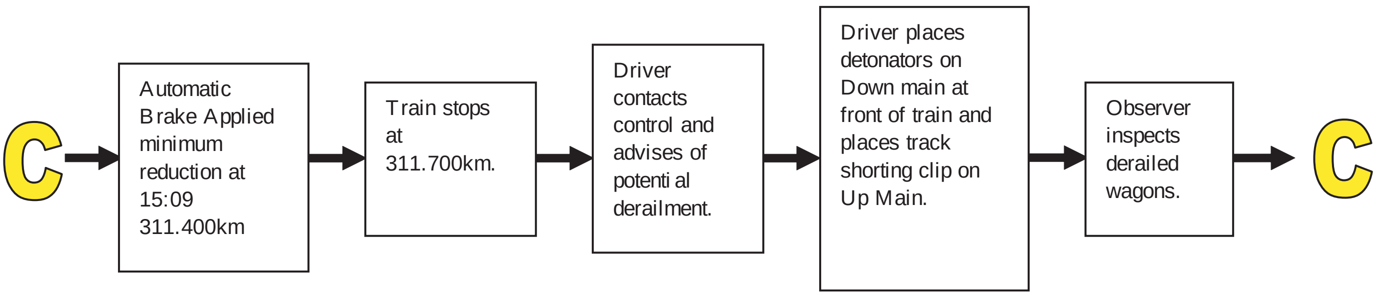
9.5 Events and conditions chart – Yass Junction Derailment subject to Misalignment on 19 November 2002



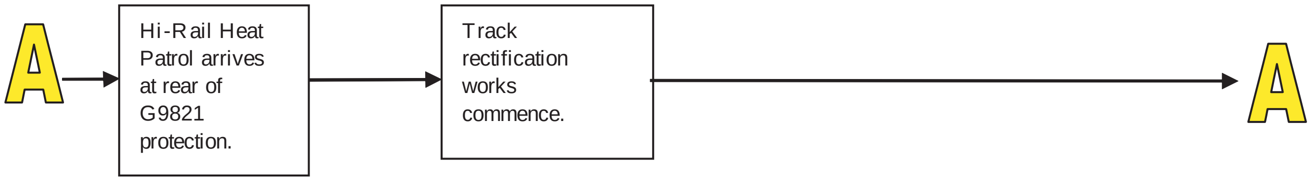

A
Heat Patrol between 248.500km and 330.000km commences.
13:00 19/11/02
A
3Y N3 passes misalignment curve prior to G9821
13:43 approx 19/11/02
B
No misalignment detected on approach of 3Y N3. No rough riding experienced over curve at 305.650km.
C
G9821 departs Goulburn @ 13:55 19/11/02
C
Local track stability risk mitigation procedure requires: 1. Hot Spot Speeds at 35^{O}C forecast temperatures or as applicable 2. WOLO to be in place at 35^{O}C predicted temperature as monitored on the day.
G9821 past Joppa Junction and out of WB radio range when call made.
D
Yass Team Manager reviews actual temperature values in Yass Region and requests a WOLO to be applied between. 248.500km to 330.000km 13:50 (approx).
Goulburn Technical Office prepares WOLO Telegram and Faxes to Goulburn Signal Box (14:00) Junee Train Control (14:02)
Goulburn Technical Office phones Goulburn Signal Box and advises of WOLO telegram conditions. 14:01 approx
Goulburn Signal Box attempts to contact G9821 on WB radio. No contact made. 14:01 approx.
D
Yass Team Manager concerned that actual temperature will rise above 35^{O}C as temperature in Yass area reached 33^{O}C prior to 14:00.
Phone calls made to Goulburn and Junee Train Control to ensure that facsimile is received and trains can be warned as soon as possible.

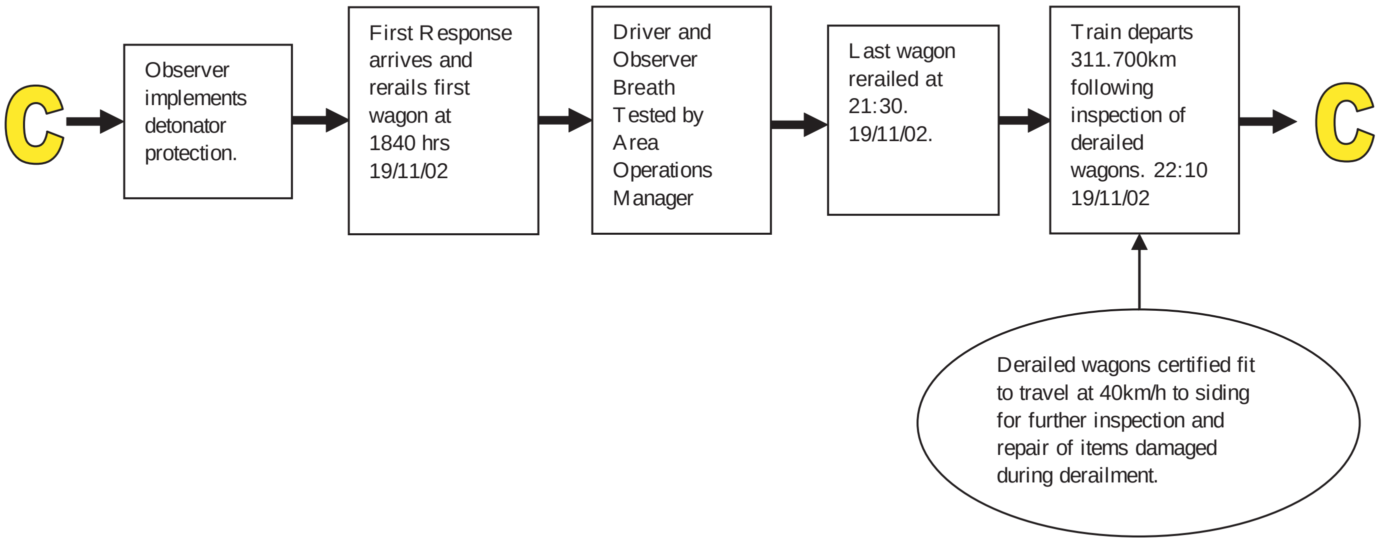

A
B
No misalignment detected by Track Patrol on 18/11 & approach of G9821 on 19/11. No rough riding experienced over curve at 305.650km.
Dynamic brake applied to control train speed down 1:75 grade. Train speed kept below 75km/h. Application of dynamic brake and train handling complied with PN train handling requirements.
Dust emanating from rear of train due to derailed vehicles.
C
Dynamic brake applied to control train speed.
G9821 traverses misalignment curve at 305.650km 15:05
Driver detects irregularity with train handling & notes dust emanating from rear of train. 309km
Observer confirms that there is a problem with the train's rear.
C
G9821 not advised of WOLO speed restriction over 305.650km from 75km/hr to 65km/hr
Junee Train Control attempts to contact G9821 on CountryNet Radio. No contact made. 14:02 19/11/02
D
23rd, 25th, 26th, 30th & 39th wagon in consist derailed towards cess.
Train Crew do not respond to incoming train radio call.

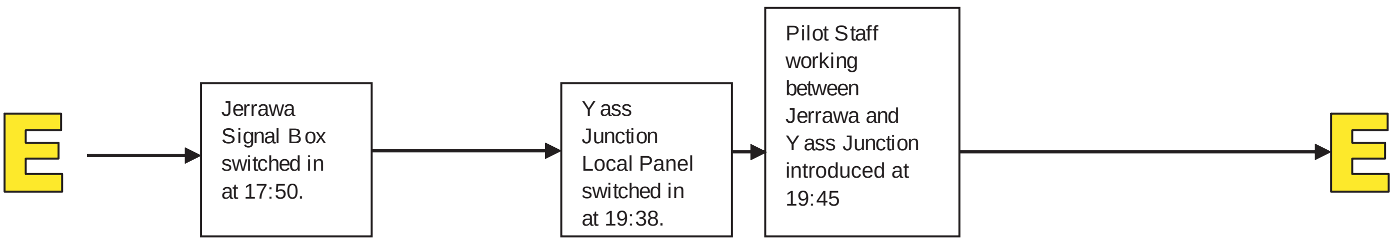

A
Heat Patrol inspects misalignment at 305.650km
A

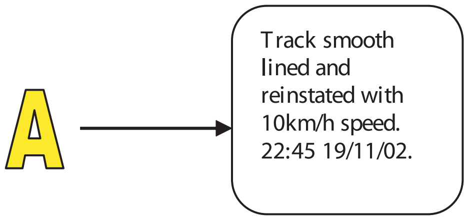

C
Automatic Brake Applied minimum reduction at 15:09 311.400km
Train stops at 311.700km.
Driver contacts control and advises of potential derailment.
Driver places detonators on Down main at front of train and places track shorting clip on Up Main.
Observer inspects derailed wagons.
C

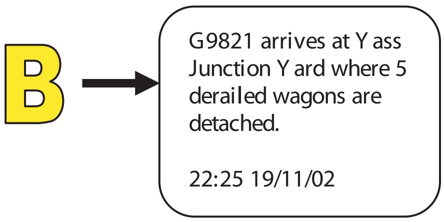

Control requests train to be inspected and protection laid out.
E

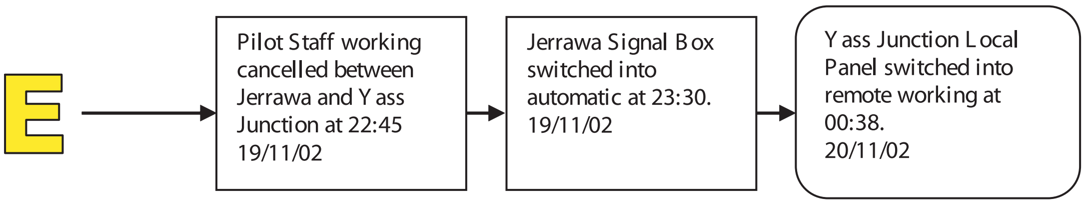

A
Hi-Rail Heat Patrol arrives at rear of G9821 protection.
Track rectification works commence.
A


C
Observer implements detonator protection.
First Response arrives and rerails first wagon at 1840 hrs 19/11/02
Driver and Observer Breath Tested by Area Operations Manager
Last wagon rerailed at 21:30. 19/11/02.
Train departs 311.700km following inspection of derailed wagons. 22:10 19/11/02
C
Derailed wagons certified fit to travel at 40km/h to siding for further inspection and repair of items damaged during derailment.


E
Jerrawa Signal Box switched in at 17:50.
Yass Junction Local Panel switched in at 19:38.
Pilot Staff working between Jerrawa and Yass Junction introduced at 19:45
E


A
Track smooth lined and reinstated with 10km/h speed. 22:45 19/11/02.


B
G9821 arrives at Yass Junction Yard where 5 derailed wagons are detached.
22:25 19/11/02


E
Pilot Staff working cancelled between Jerrawa and Yass Junction at 22:45 19/11/02
Jerrawa Signal Box switched into automatic at 23:30. 19/11/02
Yass Junction Local Panel switched into remote working at 00:38. 20/11/02