Transport Safety
Bulletin

INDEPENDENT TRANSPORT SAFETY REGULATOR

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www.transportregulator.nsw.gov.au

Focus on signals passed at danger

This bulletin is dedicated to signals passed at danger (SPADs), an occurrence whereby a train passes a signal displaying a stop indication without the authority to do so.

About SPAD events

The NSW rail network consists of the Metropolitan Rail Area network (MRA), the Defined Interstate Rail Network (DIRN), the Hunter Valley network and the Country Regional Network (CRN).

There are four principal safeworking systems used in NSW to manage the movement of rail traffic to ensure adequate separation of trains and prevent conflicting movement. An integral part of each of these systems is a means to authorise the movement of a train from one portion of track to another.

For the MRA and a majority of the DIRN and Hunter Valley, the authority for a train to proceed to occupy a defined section in the network is given by a signal indication. For much of the CRN and the western section of the DIRN, an authority to proceed is given via the issue of a written or verbal authority or by the train drivers taking possession of some form of token, for example, a metal rod (staff).

Analysis of SPAD events helps improve safety

Train drivers pass many tens of thousands of signals every year uneventfully. In a very small percentage of cases, a SPAD may result. In many of these instances, there are other protections for the train. Only a small percentage of SPADs result in a serious accident such as a collision or derailment. However many SPAD events provide a warning known as an accident precursor (close call) that could have resulted in injuries, damage to equipment, property and the environment – but did not.

Accident precursors serve as warning signs of failures or deficiencies in safety risk controls employed by rail transport operators. They are particularly important in providing insight into the underlying risks of infrequent but serious accidents.

The actual risk associated with a SPAD depends on many factors, including whether the infrastructure and rolling stock are equipped with engineering defences that automatically stop a train, how far the train has travelled into another block and whether that block was occupied by another train. In most cases, there is an 'overlap' beyond a signal at stop which is guaranteed to be free of obstructions.

This means that a dangerous situation should not arise unless a train passes the signal at stop and proceeds beyond this overlap.

The most frequent type of SPAD is a technical SPAD. This occurs when the signal returns to a stop aspect as the train approaches due to a technical fault or technician's intervention. Freight trains may be over 1000 metres long when fully loaded and can take more than a kilometre to stop. Loaded passenger trains can respond more quickly but the distance travelled after the brakes are applied is still substantial. Thus a signal returning to stop as a train approaches may not give the driver sufficient time to stop the train. These are also referred to as *returned in face of driver* (RIFOD) SPAD events. These typically do not pose a collision risk as the route ahead of the signal has already been cleared for the train.

The most frequent type of non-technical SPAD involves driver judgement. This can include the driver misreading the information displayed by signals, misjudging when or how hard to brake, or failing to see the signal. Factors such as the condition of the train, infrastructure design, signal positioning and operational conditions may contribute to these errors. The driver's training, experience, mental state, fatigue and alertness can also contribute to driver errors that result in SPAD events. Often there are multiple contributing factors that require a rigorous investigation process to determine the appropriate action to correct any issues. Once contributing factors to a SPAD event are identified the process of identifying and implementing improvements can begin.

Some factors associated with SPAD events may only become evident by analysing data over time to look for trends.

SPAD data

This bulletin presents data on SPAD frequency, SPAD severity and multi-SPAD signals on the NSW rail network. The data presented is predominantly based on occurrence notification records. These records are the initial written report of a safety occurrence that a rail transport operator must submit to the Independent Transport Safety Regulator (ITSR) in accordance with the *Rail Safety Act 2008*.

Data in this bulletin reported as non-technical SPAD events represents combined data from the categories *driver misjudged, completely missed* and *starting against signal*. These categories are from the national incident categorisation of the *Guideline for the top event classification of notifiable occurrences: Occurrence classification guideline one (OC-G1).*

Trends in SPAD events by network

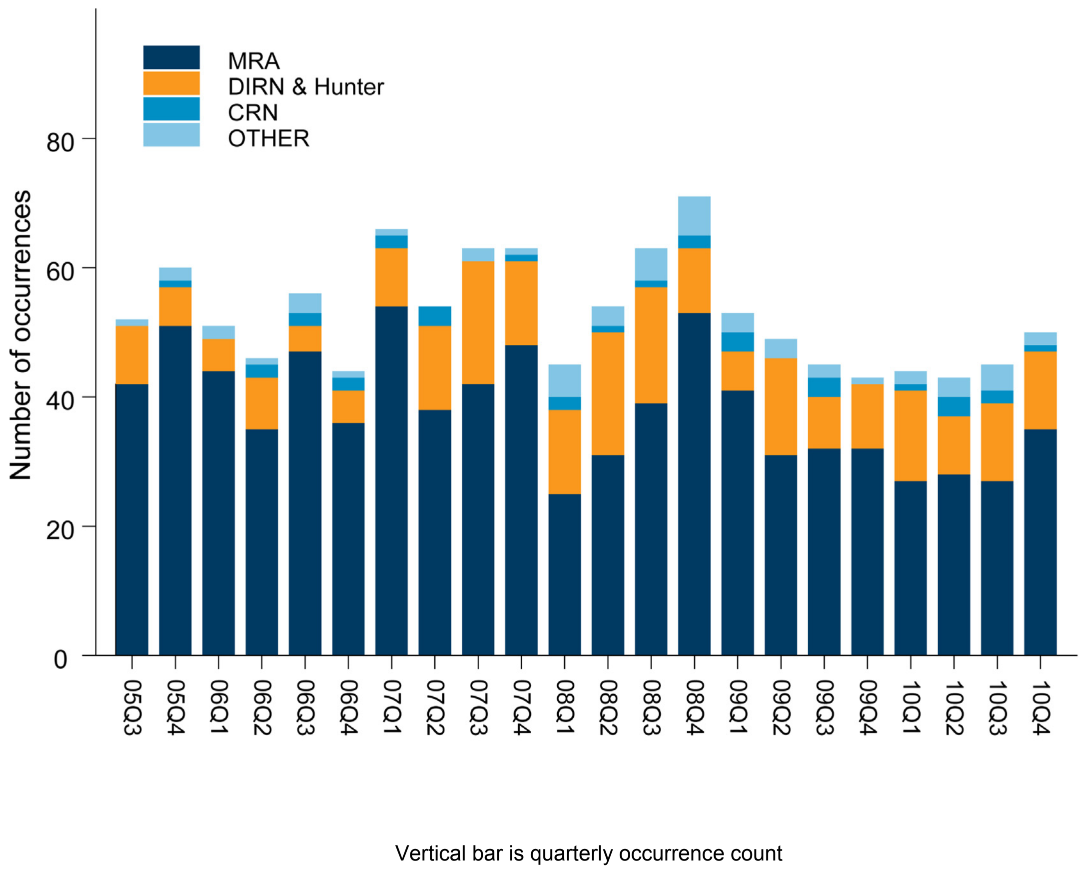

Figure 1: Non-technical SPAD events on the NSW rail network, 1 July 2005 to 1 January 2011

SPAD events occur more frequently on the MRA because of the higher volume of traffic and higher signal density than the other networks. Figure 1 shows there has been an overall decrease in the number of SPAD events on the MRA over time. This occurred despite an increase in train movements on this network over the same period. The number of SPAD events on the other networks shows no significant trend over the period.

Trends in SPAD events by type of train

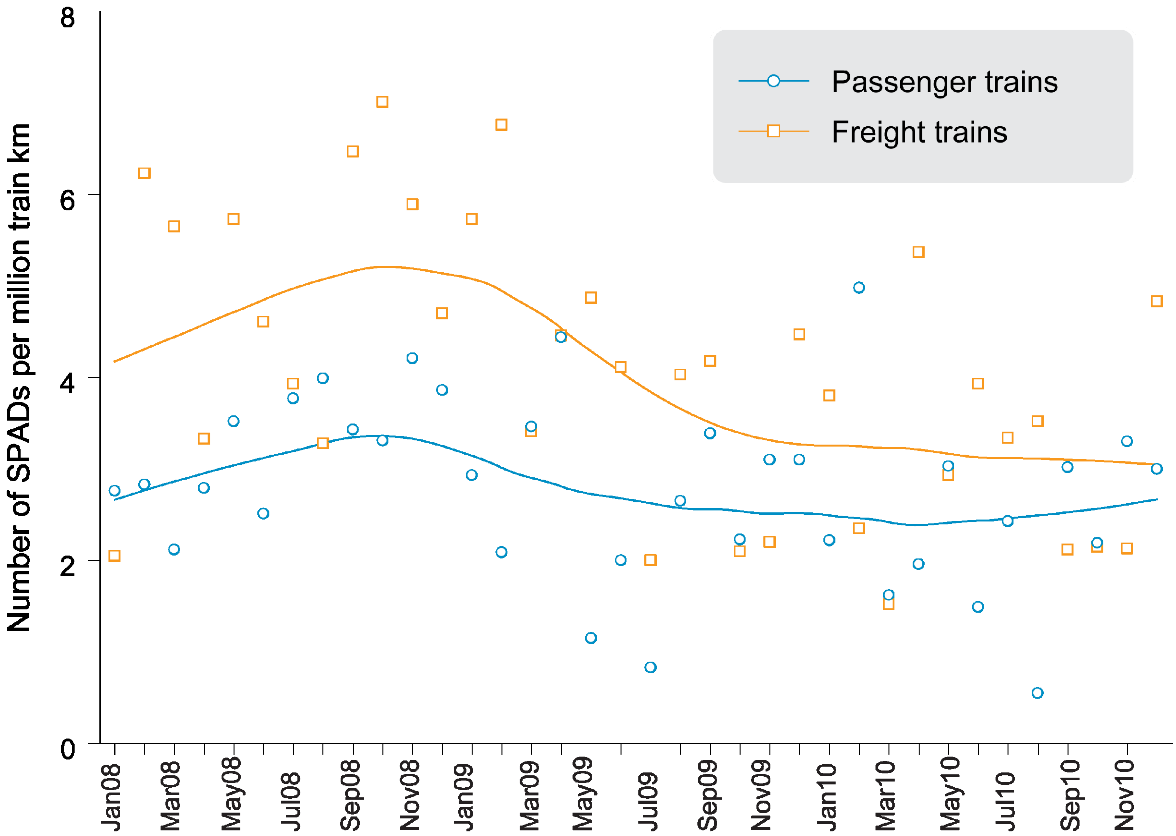

Figure 2: Non-technical SPAD rate (count per million km) by train type on the NSW network for the three years to December 2010.

Figure 2 shows the rate of non-technical SPAD events (that is, RIFODs excluded) per million kilometres for passenger and freight trains. The SPAD rate for freight trains was about 50% greater than passenger trains for the period up to July 2009. However the difference in SPAD rates between freight and passenger trains has decreased over time. In 2010 the rate for freight trains was about 30% higher than passenger trains (3.2 and 2.5 SPAD events per million train km respectively).

Some potential contributing factors to a higher rate of freight train SPAD events include increased braking distance of freight trains and differing mental workload conditions associated with the freight and passenger train driving task.

An assumption of the analysis is that passenger and freight trains have an equal probability of encountering a signal at stop. This information is not currently extracted or available from train control systems for the network. If available, this data would provide a more effective means of normalisation enabling actual difference in SPAD rate to be determined.

SPAD severity

There were 991 SPAD events (of which 591 were RIFODs) in the two year period from January 2009 to December 2010 on the NSW rail network. Figure 3 shows that most are low severity with only about 1.6% (16 SPAD events) resulting in a serious incident such as collision or derailment.

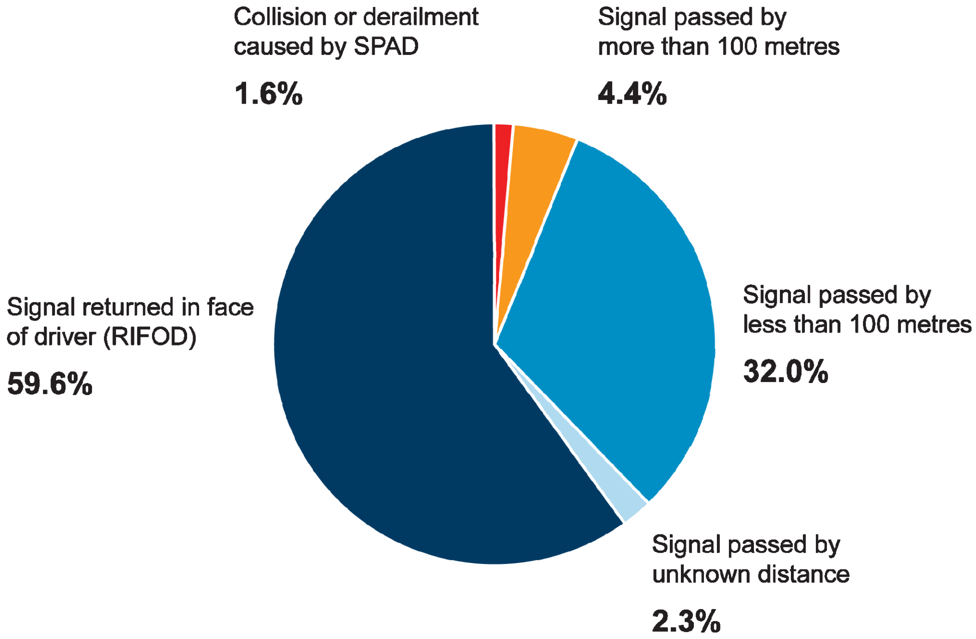

Figure 3: Severity of SPAD events on the NSW rail network for the two years to December 2010

The largest category of SPAD in Figure 3 is *signal returned in face of driver (RIFOD).* While these events typically do not pose a collision risk, they may result in passenger falls or load shift if rapid deceleration occurs due to emergency braking. The second largest category, *signal passed by less than 100 metres*, is also usually of a low severity because the train will typically remain within the signal overlap.

Analysis of SPADs for common contributing factors

Analysis of SPAD data to identify common contributing factors can be an effective way to implement controls for effective reduction of SPAD rates.

Multi-SPAD events

There are a number of aspects of railway operations that can be investigated to see if a particular aspect has a large number of SPADs attributed to it (multi-SPAD events). Such aspects can include signals, drivers, locations, operating scenarios, etc.

Analysis of SPAD data to identify signals where multiple SPAD events have occurred is a useful first step in identifying site and signal specific factors contributing to SPAD events. This relatively simple form of analysis can, in combination with other SPAD management initiatives, lead to effective improvements in SPAD rates when infrastructure problems are contributing to SPAD events.

Identifying multi-SPAD signals can be based on a statistical calculation that establishes how many SPAD events need occur at a particular signal beyond the point where the repeat events are likely to be due to chance. The analysis will identify signals with a SPAD rate higher than the general signal population. Depending on the detail of data available, analysis may also take account of uncertainty in estimating the expected rate as well as differences in exposure, for example signals on lines with a greater frequency of trains would tend to generate more SPAD events than signals on quieter lines.

Identifying multi-SPAD signals

The analysis of multi-SPAD signals was conducted for the MRA and the remainder of the NSW network separately. The review threshold adopted for the MRA was two or more SPADs in two years[1]. A threshold of two or more SPADs in three years was adopted for the remainder of the network.

Information on multi-SPAD signals is currently made available by RailCorp for all train drivers on the MRA. Such information is not yet made available by other network managers for areas outside the MRA.

The maps in Figures 4 and 5 show signals where two or more SPAD events have occurred on the DIRN, CRN and Hunter Valley network (Figure 4) and the MRA network (Figure 5). Tables 1 and 2 show more detailed information on the location and characteristics of the signals involved.

[1] RailCorp identify multi SPAD signals on the basis of two in five years but apply further criteria such as degree of protection

Table 1: Signals with two or more SPAD events for the three years to December 2010 on the DIRN, CRN and Hunter Valley network

Signal number	Signal type	Location	Line	Kilometrage	Date of latest SPAD	Number of SPADs 1/1/2008 to 31/12/2010
64	Absolute	Werris Creek	Northwest	416.440	29/06/2010	4
MV74	Shunting	Moss Vale	Down Main	146.060	02/02/2010	4
NFU2	Absolute	Kooragang	Kooragang	170.047	02/12/2010	3
IJ5	Absolute	Islington Jct	Down Relief	164.000	28/10/2010	3
MD203	Absolute	Maitland	Down Main	191.519	14/05/2010	3
CA28	Absolute	Cootamundra	Down Main	429.650	19/03/2009	3
M106.7	Absolute	Sandgate	Down Main	171.649	10/12/2010	2
G43	Shunting	Goulburn	Down Main	225.144	21/10/2010	2
JE76	Absolute	Junee	Main	488.619	03/07/2010	2
KE10	Absolute	Kerrabee	Ulan	363.500	02/06/2010	2
KL62	Absolute	Kooragang	Departure	174.996	23/04/2010	2
G50	Absolute	Goulburn	Up Main	224.737	22/03/2010	2
BJ87	Absolute	Berrima Jct	Down Main	141.100	03/02/2010	2
PW2	Absolute	Port Waratah	Arrival Road	164.950	21/12/2009	2
HN22	Absolute	Harden	Up Goods	385.345	11/12/2009	2
MD306	Absolute	Telarah	North Coast		22/09/2009	2
HJ164	Absolute	Hexham	Up Coal	174.192	25/06/2009	2
PW46	Shunting	Port Waratah	Arrival Road		26/04/2009	2
PW75	Shunting	Port Waratah		169.487	06/03/2009	2
PW70	Shunting	Port Waratah		167.079	24/02/2009	2
3	Absolute	Craven	Main	289.388	24/11/2008	2
MK23	Shunting	Muswellbrook	Down Main	288.047	08/11/2008	2
PW80	Shunting	Port Waratah	Departure		28/10/2008	2
CL1	Absolute	Camberwell	Down Main	243.301	03/09/2008	2
61	Absolute	Werris Creek	Branch	415.720	01/07/2008	2
18	Absolute	Grafton Yard	Storage Loop	699.000	26/06/2008	2

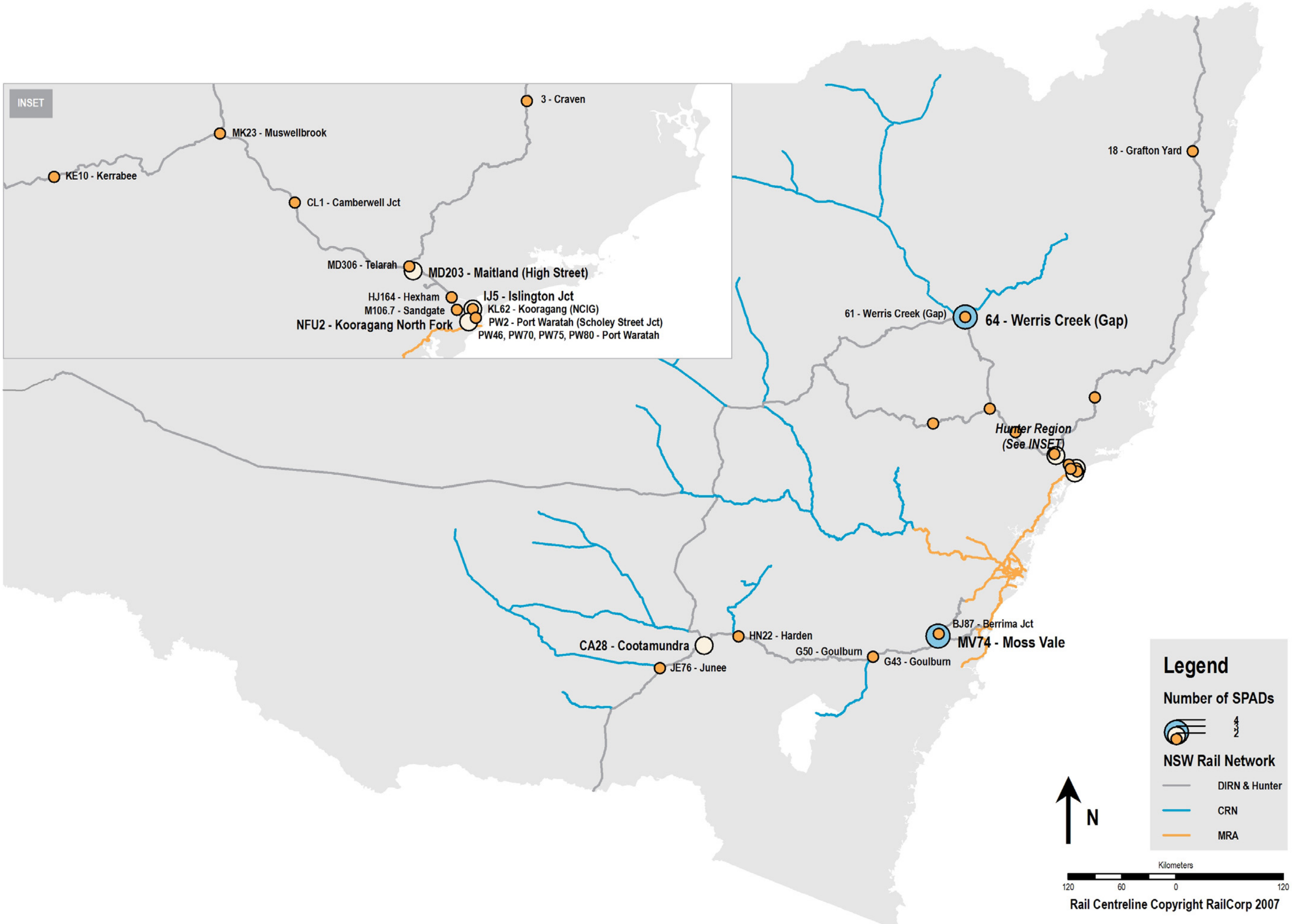

Figure 4: Signals with two or more SPAD events for the three years to December 2010 on the DIRN, CRN and Hunter Valley (inset) network

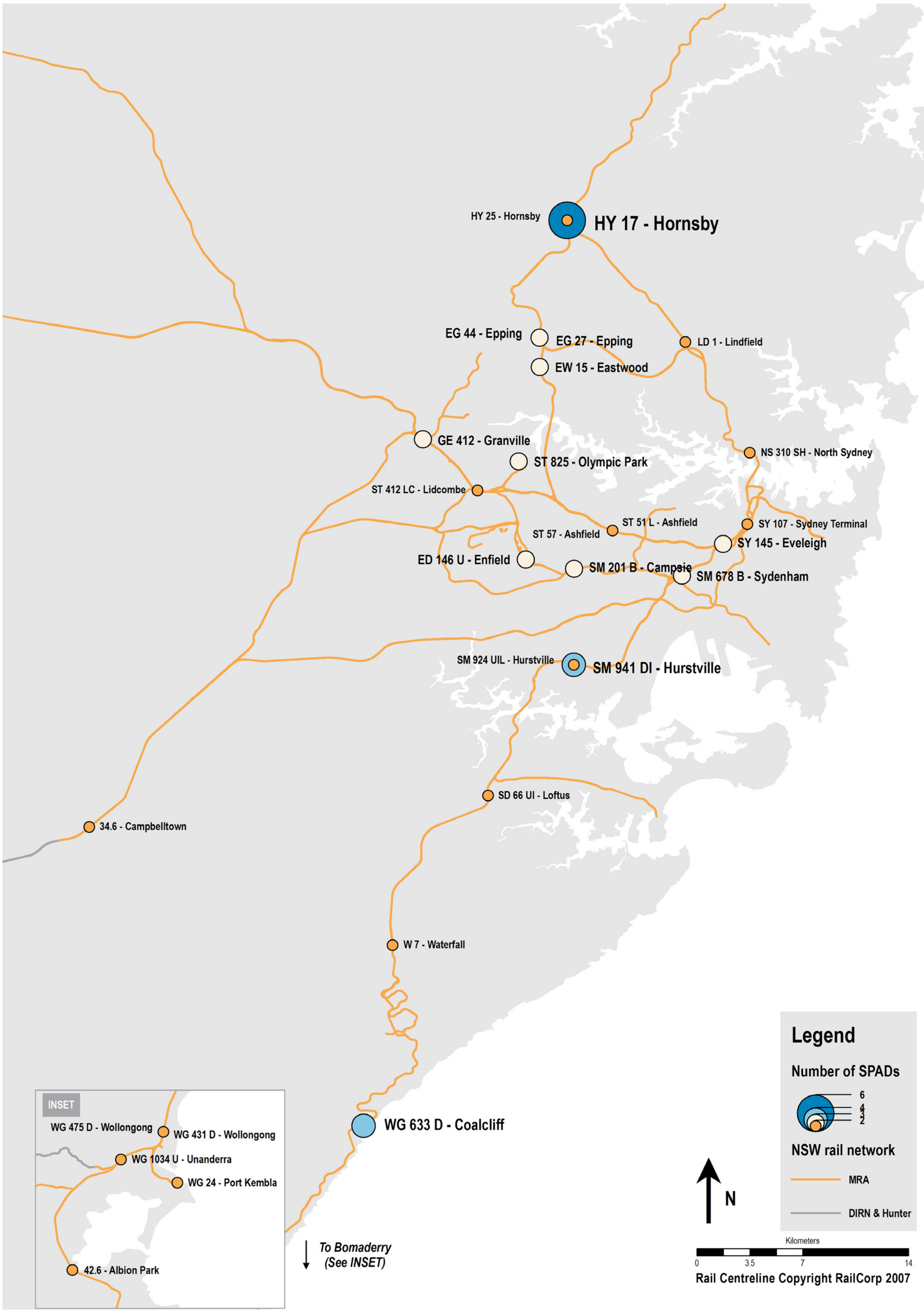

Figure 5: Signals with two or more SPAD events for the two years to December 2010 on the MRA network, including South Coast (inset)

Table 2 shows more detailed information on the location and characteristics of the signals displayed in the map at Figure 5.

Table 2: Signals with two or more SPAD events for the two years to December 2010 on the MRA network

Signal number	Signal type	Location	Line	Kilometrage	Date of latest SPAD	Number of SPADs 1/1/2009 to 31/12/2010
HY 17	Absolute	Hornsby	Down Main	32.642	15/10/2010	6
WG 633 D	Absolute	Coalcliff	Illawarra	60.220	17/06/2010	4
SM 941 DI	Absolute	Hurstville	Down	15.398	17/12/2009	4
ST 825	Absolute	Olympic Park	Down	16.930	18/12/2010	3
SY 145	Shunting	Eveleigh	Western	1.715	17/12/2010	3
SM 678 B	Absolute	Sydenham	Up	5.773	21/11/2010	3
EG 44	Absolute	Epping	Up Main	24.120	30/10/2010	3
EG 27	Absolute	Epping	Down Main	22.861	30/06/2010	3
ED 146 U	Absolute	Enfield	Up Main	14.940	21/06/2010	3
EW 15	Absolute	Eastwood	Down Main	20.550	14/05/2010	3
SM 201 B	Absolute	Campsie	Down	10.682	24/03/2010	3
GE 412	Absolute	Granville	Up West	21.925	10/12/2009	3
ST 57	Absolute	Ashfield	Down Local	8.462	13/12/2010	2
WG 1034 U	Absolute	Unanderra	Up	90.471	10/12/2010	2
SD 66 UI	Absolute	Loftus	Up Illawarra	25.761	04/12/2010	2
NS 310 SH	Absolute	North Sydney	Up Shore	5.605	12/11/2010	2
SY 107	Absolute	Sydney	Down	0.661	05/11/2010	2
WG 475 D	Absolute	Wollongong	Down	82.550	29/10/2010	2
34.6	Absolute	Campbelltown	Up Main	55.860	14/09/2010	2
ST 412 LC	Absolute	Lidcombe	Up Main	17.215	12/07/2010	2
SM 924 UIL	Absolute	Hurstville	Up Illawarra	14.698	11/07/2010	2
ST 51 L	Absolute	Ashfield	Down Local	8.280	03/04/2010	2
42.6	Absolute	Albion Park	South Coast	103.450	08/02/2010	2
LD 1	Absolute	Lindfield	Down Shore	14.053	20/09/2009	2
WG 431 D	Absolute	Wollongong	Down	83.250	18/08/2009	2
HY 25	Absolute	Hornsby	Down Main	33.415	17/06/2009	2
W 7	Absolute	Waterfall	Down	38.230	16/06/2009	2
WG 24	Absolute	Port Kembla	Port Kembla	89.733	08/04/2009	2

Note some signals have been reconfigured since the last recorded SPAD

RailCorp has these signals under active management. Mitigating actions taken include review of signal sighting and placement, signal redesign and replacement, installation of LED lights, signal repositioning and the removal of obstructions such as vegetation.

RailCorp has a range of programs in place to improve driver performance such as route knowledge risk assessments, multi-SPAD alert boards, professional driving technique training, DVD education programs and SPAD notices and briefings. RailCorp utilises a range of communication and stakeholder consultation strategies to enhance understanding of SPAD risks.

Action is needed to improve SPAD performance

At present SPAD management practices differ greatly within the rail industry and while SPAD rates appear to be improving in some areas of the network, SPAD rates remain high.

Action is required by all rail transport operators to improve SPAD performance and ensure greater consistency of investigation and data collection practices. Network managers can play an important role in making data and information available for rolling stock operators and promoting consistent practices.

ITSR is actively carrying out targeted inspections of rolling stock operators and rail infrastructure managers to ensure that SPAD-related risks are adequately managed and SPAD events are investigated.

Practical tools and further information to help improve SPAD performance

Education and promotion of better SPAD management practice is also a core part of ITSR's regulatory activities. ITSR has produced a number of checklist tools and better practice information that draw upon international examples. The tools are particularly beneficial in providing insights into the human factors that contribute to SPAD events, particularly the interaction between driver error and poor infrastructure.

The data presented in this bulletin appears in a revised edition of *Management of signals passed at danger*. This paper contains detailed information on better practice in the investigation, data collection and management of SPAD events. It contains a range of practical tools that are tailored to rolling stock operators and rail infrastructure managers.

Copies of *Management of signals passed at danger* and tools for SPAD investigation and sample mitigating measures can be found at http://www.transportregulator.nsw.gov.au.

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