RAIL SAFETY INVESTIGATION REPORT

DISABLED XPLORER SERVICE NP23

MUSWELLBROOK

2 December 2016

Released under the provisions of
Section 45C (2) of the Transport Administration Act 1988 and
Section 46BBA (1) of the Passenger Transport Act 1990

Investigation Reference 04753
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EXECUTIVE SUMMARY

At approximately 1310\(^1\) on 2 December 2016, NP23, the NSW Trains’ Sydney to Armidale/Moree Xplorer passenger service, with in excess of 200 passengers on board, was brought to a stand near Muswellbrook after the fire suppression system activated on the fourth position car (EC2525). The activation of the fire suppression system shutdown the auxiliary engine on EC2525 and caused a loss of electrical power supply to it and the third position car.

Although an alternative power feed to the effected cars was available, the driver was unable to restore power and eventually lost power to the entire train, disabling it. As a result, the passengers were stranded without working air conditioning, ventilation and toilet facilities for approximately four and a half hours. During this time, the outside ambient temperature was reported as a maximum of 39ºC.

Planning had commenced for rescue locomotives to propel (push) NP23 clear of the section as well as replacement buses however, these plans were hampered due to a number of factors.

A maintenance technician was able to restore power to NP23 at 1705. The train was then driven to Muswellbrook station under its own power.

Upon arrival at Muswellbrook station, the passengers were transferred to busses to complete their journeys. Three passengers attended hospital for treatment to heat related conditions.

The investigation found that the fire suppression system activated on the auxiliary engine of EC2525 when the main starter motor cable on the auxiliary engine chafed on the metal conduit of an electrical harness and short circuited. The auxiliary engine on this car had an approved maintenance deferral in place for its 7500hr service.

The investigation also found that NSW Trains needed to review its driver training curriculum including communications to and from a disabled train. The investigation found that Sydney Trains needed to assess all likely failure modes when considering changes to maintenance intervals.

The full details of the Findings and Recommendations of this rail safety investigation are contained in Parts 3 and 4 respectively.

\(^1\) All times referred to in this report are in Australian Eastern Daylight-saving Time (UTC+11 Hours).
PART 1 FACTUAL INFORMATION

Incident Location and Track Information

1.1 The incident occurred near Muswellbrook. Muswellbrook is a township located in the NSW Hunter Valley, approximately 286 kilometres north of Sydney by rail. It is also the junction between the Main North and the Ulan rail lines.

1.2 Muswellbrook is located in rail territory leased by the Australian Rail Track Corporation (ARTC) from the NSW Government. Under the terms of the lease, ARTC is responsible for track maintenance and train control functions.

1.3 Train movements on the line were controlled under ARTC Network Rule ANSY 500 *Rail Vehicle Detection System* with signalling and points operated remotely from the Network Control Centre North (NCCN) at Broadmeadow.

1.4 The line through Muswellbrook supports the movement of passenger and freight trains. It is classified as Class 1XC\(^2\) track.

![Figure 1: Curve and Gradient chart for incident location](image)

\(^2\) Class 1XC track is constructed using 60kg/m rail fixed to concrete sleepers.
Train Information

General

1.5 Train Number NP23 was an Xplorer type diesel multiple unit (DMU) train consisting of six cars on the day of the incident. Xplorer consists can run in various configurations, although generally as a 5 car set. All cars provide tractive effort.

1.6 The Xplorer rolling stock entered service in 1993 to operate passenger services from Sydney to Canberra and the northwest regions of NSW (Armidale and Moree). The trains are serviced at the Eveleigh Maintenance Centre (EMC) at Eveleigh in Sydney.

1.7 NP23 departs Sydney daily to the northwest regions as a single train but divides into two separate train portions at Werris Creek. One portion continues to Armidale while the other continues to Moree. The Armidale portion retains the train number NP23, the Moree portion is called NP43.

Propulsion Engine

1.8 Each car provides propulsion to the train. Each car is powered by a 383kW Cummins diesel propulsion engine through a hydraulic-mechanical transmission system that is coupled to one drive bogie on each car. The propulsion engine can be started and stopped remotely from the driver's cab.

Auxiliary Power Engine

1.9 The auxiliary power engine unit comprises a 135 kW Cummins diesel engine coupled to an alternator. The unit produces electrical power for the train's air conditioning units, air compressors, on board lighting and other auxiliary services such as refrigeration, buffet and toilet facilities.
1.10 In normal service, each auxiliary power engine unit on duty is generally set to feed power to two cars. Depending on the train size and power requirement, the configuration of which auxiliary power unit is set to duty or standby is determined and set by maintenance staff at the maintenance depot.

1.11 In the event that a duty auxiliary engine unit fails in service, in most cases the standby unit can be started remotely from the driver’s cab. The activation of the standby auxiliary engine unit will restore the electrical supply to the related cars. However, in certain situations the setup configuration must be manually switched by the driver to restore the power supply to the cars. In this incident, no manual changes to the switch configuration were required.

Train Crew

1.12 NP23 carried a crew of six – a driver, two Passenger Service Supervisors (PSSs) and three Passenger Attendants (PAs).

1.13 The driver was responsible for train operations, in-service fault-finding, safety communications with network controllers, and safeworking protection for the train and passengers.

1.14 The cabin crew were responsible for managing the safety and comfort of the passengers. The PSS had an additional role in assisting the driver with safeworking protection of the train when required.

Synopsis

1.15 At some time prior to 1310 on 2 December 2016, the driver of NSW Trains’ Sydney to Armidale/Moree Xplorer service NP23, received a fire alarm on the driver’s annunciator panel when the automatic fire suppression system activated and shut down the auxiliary engine on car EC2525. EC2525 was the fourth car in a six car train consist.

1.16 At 1310 the driver brought NP23 to a stand approximately three kilometres south of Muswellbrook (288.7kms). NP23 was carrying over 200 passengers at this time.

1.17 The auxiliary engine unit in EC2525 also supplied auxiliary electrical power to the adjacent car (EB2515). Both of these cars lost power due to the engine
shut down. An alternate power supply was available from the auxiliary engine on EB2515. The driver reported making numerous attempts to restore electrical power to the two cars without success.

1.18 Due to the auxiliary engine fire alarm, the driver additionally pushed the propulsion engine “Fire Extinguish” button in the driver’s cab to ensure the fire was extinguished. However, this system only shuts down and discharges the extinguishers on the propulsion engines where a fire had been detected by the system.

Figure 3: Annunciator and switch panels in drivers cab.

1.19 After reporting the incident to the NCCN in Newcastle, the driver continued to attempt various methods to overcome the problems caused by the fire. However, the methods used eventually caused all propulsion and auxiliary engines to shut down. As a result, the electrical supply was lost on the entire train, disabling it. Electrical supply, air conditioning, ventilation and functioning toilet facilities were not available.

1.20 In telephone communications between the technician at the EMC and the driver, there were many attempts to restore power to NP23. The driver
confirmed the fire was extinguished however the driver and the EMC were unable to restore power.

1.21 At 1530, an off-duty Broadmeadow Maintenance Centre (BMC) technician was deployed from Newcastle and arrived at the train at 1705. The technician was able to reset and restart the auxiliary engines on NP23 to restore the electrical supply throughout the train. The technician then went on to reset and restart the traction engines by 1715.

1.22 At 1745, NP23 was moved into Muswellbrook station under its own power, arriving at 1755. Here, NP23 was terminated and its passengers transferred to replacement bus services to complete their journeys. Ambulance Services of NSW conveyed one passenger to hospital for treatment of heat-related conditions. Two other passengers later attended hospital for treatment of similar heat-related conditions.
Weather Conditions

1.23 Bureau of Meteorology (BOM) records for the area indicated that ambient temperatures reached a maximum of 39°C. The records also indicated that light winds and low relative humidity prevailed on the day.
PART 2 ANALYSIS

Auxiliary engine fire suppression system

2.1 EC2525’s auxiliary engine fire suppression system was likely activated after the engine’s main ‘positive’ starter motor cable chafed on a metal engine harness conduit and short-circuited. Due to the resulting damage from the fire it was difficult to confirm the root cause of the fire (Refer to Figure 5).

2.2 The auxiliary engine was 17 months overdue for its 7500hr service. There was a maintenance deferral lodged and approved for this exceedance to the maintenance schedule. It is probable the chafed cable may have been identified and rectified had the 7500hr service occurred when scheduled.

 Communications

2.3 The EMC initially contacted the driver by train telephone at 1345. The driver was unable to interpret the technical instructions resulting in the inability to assimilate past training into actions that would remedy this situation.
2.4 The BMC based technician was delayed when locating NP23 due to insufficient information being provided at time of callout. The technician could have called his management to gain further information on the location of NP23. This resulted in delays to the rescue of NP23.

Training and competency

BMC Technician

2.5 The BMC technician was a multi-skilled mechanical tradesman with nine years’ experience in rolling stock maintenance. This experience was predominantly with Endeavour and Hunter type DMU sets. The Endeavour fleet is similar to the Xplorer fleet in the sense that they utilise the same power systems.

Driver

2.6 Although NP23 had sufficient tractive power to continue on the downhill grade into Muswellbrook, the driver chose to stop and inspect the set because the fire alarm activated and the PSS reported smoke odours present in the passenger compartment.

2.7 The driver received training in OSP 10 (Dealing with fires on trains and in the Rail Corridor) and TWP 164 (Responding to an on-train pax or fire alarm). However, at the time of the situation, the driver did not follow these instructions. OSP10 (pg 2, item 3) states ‘If possible, continue to the next station if it is nearby’. Muswellbrook station was approximately three kilometres from the site where the driver chose to stop the train.
2.8 Personnel and training records indicated that in 2015, the driver transferred from driving electric trains in Sydney to the NSW Trains depot at Werris Creek to drive Xplorer services.

2.9 The driver underwent the ‘conversion’ course for the operation of Xplorer trains. The driver was assessed as competent.

**Routine Maintenance and Inspection**

2.10 The maintenance schedule for Xplorer trains is based on a combination of both elapsed time (i.e. monthly, 6-monthly, annual) and engine usage (i.e. 1000 hrs, 2500 hrs, 7500 hrs).

2.11 Maintenance history records for EC2525 indicated the auxiliary engine unit was overdue for a 7500 hr service. To clarify, the 7500 hr threshold was reached approximately 17 months prior to the incident date. The 7500 hr service required the unit to be removed from the car and returned to Cummins (the manufacturer) to conduct the service.
2.12 The 7500hr service had been deferred on a number of cars by the EMC due to a backlog of bogie changes and other out of course repairs. Engineering staff at the EMC sought approval for the continued operation of the cars with overdue auxiliary engine services.

2.13 Approval was given for the continued operation of cars under certain provisions. This included scheduled equal time inspections and weekly oil analysis to monitor internal engine wear and the mechanical condition of the engines.

2.14 The approval did not identify any other potential risks or failures, particularly with the electrical equipment or wiring, as this failure mode had not occurred previously.

2.15 The delay in conducting 7500hr services of the Xplorer cars had manifested as a result of transmission and water pump failures which required preferential attention.

2.16 Had the 7500hr service been conducted on EC2525 as scheduled, it is probable the chafing of the starter motor cable may have been detected.

2.17 Although the inspection of the starter motor cable and its connection was not a specific item on the service schedule, a general examination of all cabling was required at each service.

2.18 A thorough examination of the starter motor cable and its connection to the starter motor during inspection was restricted due to its accessibility within the auxiliary unit casing.

2.19 The most opportune time to examine the starter motor cabling and conduits was when the auxiliary engine is removed from the car, which would occur because of either a component failure or to conduct the 7500hr service.

**Emergency Preparedness**

2.20 At 1402, the ARTC Train Transit Manager (TTM) proposed that locomotives from nearby freight trains be used to clear NP23 from the section. However, while NSW Trains had arrangements in place with some freight operators, special considerations are required for passenger train services and, in this
instance, NSW Trains did not have an operational agreement with the nearby rail operator.

2.21 As part of its emergency preparedness process, NSW Trains has a ‘Decision Flow Procedure for Customer Detrainment’ for trains that are unable to proceed in either direction due to train or network failures.

2.22 The procedure documented the requirements before initiating a controlled detrainment of customers. It required the Shift Supervisor at the NSW Trains Daily Operations Continuity Centre (DOCC), to resolve, or arrange to have resolved, the problem causing the delay of the train. Alternatively, the Shift Supervisor of DOCC could initiate assessment of the situation to determine if it is appropriate to commence the customer detrainment procedure with relevant Network Control Officer (NCO) authorisation.

2.23 At 1401, approximately 50 minutes after NP23 had stopped, the ARTC TTM directed the Shift Supervisor at DOCC (DOCC SS) not to evacuate the passengers as there were live running lines next to the train. When it became apparent that options such as hook and pull rescue and/or technician attendance would take longer than 30 minutes, activities commenced to put a block on passing trains and the doors were opened to improve passenger comfort.

2.24 At 1432, the DOCC SS conferred with the ARTC TTM about the use of buses for evacuation of the passengers. The TTM advised that no passengers be detained as planning and negotiations had commenced for the use of locomotives to clear NP23 from the section.

2.25 At this time of the incident, the buses were directed to Muswellbrook Station because this was deemed to be the best location to transfer passengers. It was not known at this time of the incident whether the hook and pull solution would be initiated hence the passengers remained on the train.

2.26 With many locations over the NSW regional rail network unable to be accessed by road, there was no register or database available for operators or emergency services to locate the access points to the track.

2.27 In this incident, the BMC technician was delayed trying to find access to NP23. As access to the rail network in NSW is required by many rail
operators, maintainers and emergency services, there is value in a system being developed and maintained that:

- Identifies the nearest roads, access gate points and relevant GPS coordinates for access to track, and
- Is readily accessible to all operators, maintainers, and emergency services.

2.28 In accordance with the NSW Trains’ SMS, the Incident Management Framework (IMF) was initiated and staff at Muswellbrook station arranged the logistics of recovery, location for buses, ambulance services, and the SES.

2.29 However, in this case, the DOCC encountered a situation where the entire train became disabled. The DOCC relied on the EMC to provide technical advice to the driver directly in an attempt to rectify the situation. The decision to call a technician from the BMC was made by the EMC after it appeared the hook and pull rescue might take longer to arrange. Given the circumstances of this incident, it was imperative that maintenance staff attend to the train as soon as practical. The BMC technician, who was on leave at the time, agreed to attend NP23.

**Passenger Comfort**

2.30 The ambient temperature was 39ºC.

2.31 For the passengers’ safety, the driver decided to keep the doors closed as passing trains were still likely there was no safe access to a safe place.

2.32 The temperature inside the carriages escalated beyond 39ºC as time passed while waiting for assistance.

2.33 With all engines shut down, and the air compressors stopped, NP23 lost all air pressure on the train. As a result, none of the air operated toilets or automatic doors would operate. Without operating toilets, the crew had to set up buckets in various driver compartments as temporary toilets.

**Incident Reporting**

2.34 Although the incident falls under a Category A notifiable occurrence in accordance with Section 57 of the Rail Safety National Law regulations, the
incident was not reported to the Australian Transport Safety Bureau by NSW Trains.
PART 3  FINDINGS

3.1 The investigation found that this incident was likely initiated by a fire that resulted from a short circuit between the main starter motor cable on the auxiliary engine and a metal conduit of car EC2525.

3.2 The insulation around the main starter motor cable was worn away due to chafing from being in contact with a metal conduit. The fire was detected by the on-board system which automatically initiated the fire suppression process on the auxiliary engine of car EC2525. The driver was notified of this event via the fire alarm warning light on the driver’s cab annunciator panel.

3.3 The train driver made a decision to stop the train three kilometres from Muswellbrook station.

3.4 The train driver disabled the train via pushing the emergency fire extinguish button on the drivers’ control panel which shut down all engines.

3.5 The train driver and the EMC helpdesk were unable to rectify the problem.

3.6 The subsequent disabling of NP23 for four and a half hours in hot weather conditions exposed the passengers and crew to uncomfortable conditions inside the train.

3.7 The BMC technician had difficulty finding the location of NP23, which lengthened the delay before recovery.

3.8 The BMC Technician was able to rectify the problem quickly once he arrived at the site of the disabled NP23.

Contributing Factors

3.9 The driver made a decision to stop the train three kilometres from Muswellbrook station which escalated the risk to the all on board the train.

3.10 The driver did not follow NSW Trains Procedures OSP 10 and TWP 164.

3.11 The auxiliary engine on car EC2525 was 17 months overdue for removal and the scheduled 7500 hour service.
3.12 The telephone support from EMC was not effectively interpreted by the train driver.
PART 4 RECOMMENDATIONS

The following recommendations are made in relation to matters identified in the course of this investigation.

NSW Trains

4.1 Review its driver training curriculum and processes to ensure its trainees:

- receive relevant information regarding equipment and operation of the rolling stock,
- are properly assessed in the handling of the rolling stock in all operating conditions as appropriate inclusive of normal, abnormal, degraded and emergency situations,
- receive adequate reference material that is available at all times as appropriate, and
- have access to discuss rolling stock or operational issues with a standards officer or other Subject Matter Expert (SME) as appropriate.

4.2 Review the current procedure(s) to ensure strict control of communications to and from disabled trains.

Sydney Trains

4.3 Review its maintenance systems and procedures to identify all the conditions that may be introduced should the maintenance window be exceeded, are identified and actioned in a timely manner.
PART 5 ACKNOWLEDGED UPDATES SINCE THIS INCIDENT TO IMPROVE SAFETY

5.1 NSW Trains has reviewed its Emergency Management Framework. The revised suite of documents were released in July 2017. The applicable documents are as follows:

- NSCC Guide
- Detrainment Decision Flow

5.2 NSW Trains has introduced a Competency Database (interim) to ensure training for all employees is adequate, appropriate and monitored. This is kept on a SharePoint database that all Line Managers can access to ensure the adequacy and currency of staff competence. This interim database is being used until Equip is fully implemented.

5.3 The NSW TrainLink Emergency & Evacuation Facilitator Guide has been updated, with the most recent version being released in March 2018. This updated training will be rolled out across 2018-19.

5.4 NSW Trains have recently released NSW Trains OSPs (Operator Specific Procedures) rather than operating under Sydney Trains OSPs. The OSPs that are particularly applicable to this incident are as follows:

- NTOSP9 Spoken Communication with Passengers
- NTOSP10 Dealing with fires on trains and in the Rail Corridor
- NTOSP11 Train evacuation and detraining when not at a station
5.5 In addition to the OSPs, multiple documents have recently been released around the Operation & Management of Diesel Trains and Train Working Procedures.

5.6 A Quick Reference Guide for fault finding and rectification has been reviewed. The guides are now on all driving cars.

5.7 Sydney Trains confirm the manufacturer of the auxiliary engine has rerouted the cable run to minimise cable chafing during service.

5.8 Sydney Trains has amended its rollingstock maintenance deferral procedure to ensure all conditions that may be introduced, if maintenance is deferred, are identified and actioned, which addresses OTSI recommendation at paragraph 4.3 of this report.
PART 6 APPENDICES

Appendix 1: Sources and submissions

Sources of information

- NSW Trains
- Sydney Trains
- The driver and crew members of NP23

Submissions

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

- NSW Trains
- The driver and crew members of NP23
- The technician
- Office of the National Rail Safety Regulator
- Transport for NSW
- Sydney Trains
- ARTC

Responses were received from various DIPs and were taken into consideration in finalising the Report.