20 June 2023

File Ref: OIAPR-1274023063-2712

[redacted]

Tēnā koe [redacted]

Request for information 2023-132

I refer to your request for information dated 22 May 2023, which was received by Greater Wellington Regional Council (Greater Wellington) on 22 May 2023. You have requested the following:

"I am requesting any information held by GRWC, that is either internal, or has been provided to contracted providers of public transport services within the Wellington Region, for example, but not limited to, Transdev, Tranzit, Mana Coach Services, NZ Bus, and any other succeeding operators, that relates to the performance and temperature settings of air conditioning controls on the bus or train services provided.

Please also provide any information relating to the guidance or operation of the air conditioning controls, such as but not limited to, operating temperatures, consideration of passenger numbers, the effect of CO2 exhalations warming up the transport service and any other guidelines or considerations that the public transport operator must consider when setting air conditioning controls."

Greater Wellington's response follows:

We conducted an initial search through all documents relating to air conditioning performance and temperature settings with our operators. This search returned 274,000 items.

On 2 June 2023 we contacted you to see whether you would narrow your scope to a certain timeframe to limit the number of items. You responded:

"Can this be from when the transport operator changeover started in mid 2018? Around the time of the "bustastrophe" and *"maybe further refinement is just correspondence from GWRC to the transport operators previously mentioned as it relates to the operation of and guidelines relating to air conditioning etc"*

We conducted a search of documents based on your narrowed request and found 4 email correspondence chains related to your request. These are attached below.

- **Attachment 1** – July 2022
- **Attachment 2** – January 2023
- **Attachment 3** – March 2023
- **Attachment 4** – March 2023

Information relating to the guidance or operation of the air conditioning controls

Air conditioning on bus

Our bus operators are required to comply with air conditioning performance as stated in the Requirements for Urban Buses (RUB). The exception to this, are our two-axle electric double decker buses which were given a dispensation to use open windows in lieu of air conditioning, due to the battery technology of these buses not allowing for air conditioning. However, our more recent axle electric double decker buses are fitted with air conditioning on the upper deck. The Requirements for Urban Buses can be found here: https://www.nzta.govt.nz/resources/requirements-for-urban-buses/.

The RUB performance requirements are not adjusted to take into account the impact passengers have on the temperature in the bus, as the system is designed for a full passenger load and will adjust to the temperature sensors fitted to the air conditioning system.

In accordance with our Partnering Agreement, the temperature within the saloon is to be maintained at a temperature of 22^{o}C +/- 4^{o}C. Our double decker vehicles have two temperature sensing zones, one for the upper deck and one for the lower deck.

Our electric vehicle bus fleet is fitted with an automatic thermostatically controlled heating and ventilation system which is capable of maintaining a saloon temperature range of 18-26^{o}c, independent of the driver adjusting settings, which provides adequate fresh air intake.

Please refer to **Attachment 5** which contains a report that summarises the results of CO2 monitoring onboard our bus network.

Please refer to **Attachment 6** which contains a copy of our letter to the Ministry of Health on this matter. The Ministry of Health replied to our letter on 17 May 2023 acknowledging the letter and advised us that they would be taking some time to consider the findings of the report and the questions we raised.

Air conditioning on rail

Please refer to **Attachment 7** which contains a report on CO, CO2, and NO2, on the Wairarapa passenger trains, completed December 2022.

In the rail carriages, air is heated using electrical heaters in the Heating, Ventilation, and Air Conditioning (HVAC) unit which is located underneath the carriage. The air is blown through the ducting, to the carriage.

All carriages have the same heating capacity, although some carriages have more under-the-seat electrical heaters and others are heated predominantly by the HVAC unit. This electrical energy is produced using diesel powered generators in the Generator carriage.

Heating is controlled with a four-position temperature switch and a three-position fan speed switch. These settings on the HVAC controller represent approximately 1-degree increments (18-21^{o}c).

The train manager manages the HVAC unit, which is turned on prior to passengers boarding.

Please refer to **Attachment 8, Attachment 9, and Attachment 10** which contain the Operational Manuals for the HVAC system on our carriages.

We have withheld information in Attachment 1, Attachment 2, Attachment 3, Attachment 4, Attachment 7, Attachment 8 and Attachment 9, under section 7(2)(a) of the Local Government Official Information and Meetings Act 1987 (the Act), in order to protect the privacy of natural persons, including that of deceased natural persons.

We have considered whether the public interest in the requested information outweighs Greater Wellington's need to withhold certain aspects of the requested information. As a result, we do not consider that the public interest outweighs Greater Wellington's reason for withholding parts of the document under the grounds identified above.

If you have any concerns with the decision(s) referred to in this letter, you have the right to request an investigation and review by the Ombudsman under section 27(3) of the Act.

Please note that it is our policy to proactively release our responses to official information requests where possible. Our response to your request will be published shortly on Greater Wellington's website with your personal information removed.

Nāku iti noa, nā

Fiona Abbott
Kaiwhakahaere Matua Waka-ā-atea | Acting Group Manager Metlink

From: [redacted]
To: Tristan Elder
Subject: FW: Bus Aircon Systems Audit
Date: Tuesday, 19 July 2022 6:25:41 pm
Attachments: image007.png
image263034.png
image415669.png
image177810.jpg
image574225.png

Tristan as below

Fresh air / outside air contains contaminants

TK recommend fitting Anion Generators as well

The fresh air intakes introduce about 10% fresh air

Im sure the doors cycling must allow a lot of fresh air in, which is then pulled though the return air and dispersed out.

Tranzit Group

[redacted] Tranzit Group
P: + [redacted] | **F:** + [redacted] | **M:** + [redacted]
E: [redacted] @tranzit.co.nz | **W:** www.tranzit.co.nz
310-330 Queen Street, Masterton | PO Box 116, Masterton 5840

Energy Excellence awards finalists

Please consider the environment before printing this email.

From: Tristan Elder <Tristan.Elder@gw.govt.nz>
Sent: Tuesday, 19 July 2022 1:42 pm
To: [redacted] <[redacted]@tranzit.co.nz>
Subject: Bus Aircon Systems Audit
Importance: High

Hi [redacted]

I'm pulling together information on the Air Conditioning units currently fitted to vehicles running Metlink services. Could you assist by answering a couple questions in the table below please?

Please can I have the data by 22/7/22.

Fleet No.	Vehicle Make	Vehicle Model	AC Make	AC Model	Does the AC unit have the capability to introduce fresh air?	If they do, is there a filter fitted to the fresh air intake?
55	BCI	Cityrider	Thermo King	KRS II Plus	Yes	Yes
28	BCI	DD	Thermo King	TDD-S	Yes	Yes
28	SCANIA	K320	Thermo King	CF1000	Yes	Yes
106	OPTARE	MetroCity	Thermo King	X500	Yes	Yes
11	TEG / Yangtse	ELVDD	Thermo King	E900LW	Requires body mods	Custom

Regards

Tristan Elder
Asset Engineer (Bus Fleet)
Metlink
Cell | 021 961 727
100 Cuba St, Te Aro, Wellington 6011 | PO Box 11646, Manners St, Wellington 6142
Follow us online: Facebook | Twitter
To find out how to plan your journey, go to metlink.org.nz

From: [redacted]
To: Tom Logan
Subject: RE: Driver demist / fresh air controls
Date: Tuesday, 17 January 2023 5:01:30 pm
Attachments: image001.png
image002.png
image003.jpg
image004.png
image005.png
image790864.png
image198225.png
image898909.jpg
image212492.png

Just quickly on that one Tom, Yip only outside air would be from the driver's window or/and the door being opened for passengers every 3-4 minutes.

Tranzit Group

[redacted] Tranzit Group
P: + [redacted] | F: + [redacted] | M: + [redacted]
E: [redacted]@tranzit.co.nz | W: www.tranzit.co.nz
316-330 Queen Street, Masterton | PO Box 116, Masterton 5840

From: Tom Logan <tom.logan@gw.govt.nz>
Sent: Tuesday, 17 January 2023 10:48 am
To: [redacted]@tranzit.co.nz>; [redacted]@tranzit.co.nz>
Subject: RE: Driver demist / fresh air controls

Thanks [redacted], I hope you had a great break.

Kia ora [redacted] thanks for any help you can offer. It seems that the only outside air to the driver comes from either an opening window or the demist system? (Unless the air conditioning is bring in some, but it looks like most systems are set up for 100% recirculation).

Regards,
Tom.

From: [redacted]@tranzit.co.nz>
Sent: Tuesday, 17 January 2023 10:44 am
To: Tom Logan <tom.logan@gw.govt.nz>; [redacted]@tranzit.co.nz>
Subject: RE: Driver demist / fresh air controls

HI Tom, Sorry I've been away from work.

I've attached [redacted] from Training she will have all the detail that the drivers have in regards to drivers manuals.

There's nothing from the manufacturers really.

Yes BCI has no side opening window all the others do.

[redacted] Tranzit Group
P: + [redacted] | **F:** + [redacted] | **M:** + [redacted]
E: [redacted]@tranzit.co.nz | **W:** www.tranzit.co.nz
316-330 Queen Street, Masterton | PO Box 116, Masterton 5840

Please consider the environment before printing this email.

From: Tom Logan <tom.logan@gw.govt.nz>
Sent: Wednesday, 21 December 2022 2:21 pm
To: [redacted] <[redacted]@tranzit.co.nz>
Subject: Driver demist / fresh air controls

Kia ora [redacted], I hope all is well with you.

I am doing some work for Paul Blane, and was wondering if you had operator / driver manuals / instructions for the driver area ventilation controls for the various buses you operate? I could pop into a depot to view them if that is possible, or if they are electronic could they be emailed to me?

It looks like all buses except BCI also have opening driver windows, is that correct?

Ngā mihi

Tom Logan (he/him) | Bus Projects Delivery Consultant

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M 021 2427629
100 Cuba St, Te Aro, Wellington 6011 | PO Box 11646, Manners St, Wellington 6142 | **metlink.org.nz**
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From: [redacted]
To: Tom Logan
Cc: [redacted]
Subject: RE: Fresh air into top deck of UT200RHDF with no air conditioning
Date: Thursday, 16 March 2023 12:10:54 pm
Attachments: image002.png
image004.png
image005.jpg
image006.png
image007.png
image001.png
image743737.png
image986513.png
image165359.jpg
image065496.png

The panto is on the back – maybe it would fit

Tranzit Group

[redacted] Tranzit Group
P: + [redacted] | **F:** + [redacted] | **M:** + [redacted]
E: [redacted]@tranzit.co.nz | **W:** www.tranzit.co.nz
316-330 Queen Street, Masterton | PO Box 116, Masterton 5840

From: Tom Logan <tom.logan@gw.govt.nz>
Sent: Thursday, 16 March 2023 7:15 am
To: [redacted]@tranzit.co.nz>
Cc: [redacted]@tranzit.co.nz>
Subject: Re: Fresh air into top deck of UT200RHDF with no air conditioning

I was thinking it might fit on the back, I have asked Valeo if that is possible. Or is there charging equipment in the way?

Get Outlook for Android

From: [redacted] <[redacted]@tranzit.co.nz>
Sent: Thursday, March 16, 2023 6:44:25 AM
To: Tom Logan <tom.logan@gw.govt.nz>
Cc: [redacted]@tranzit.co.nz>
Subject: RE: Fresh air into top deck of UT200RHDF with no air conditioning

Hi Tom, It would likely be ripped from the roof or pull lines down – the first DD's have hopper windows though.

[redacted] Tranzit Group
P: [redacted] | F: ± [redacted] | M: ± [redacted]
E: [redacted]@tranzit.co.nz | W: www.tranzit.co.nz
316-330 Queen Street, Masterton | PO Box 116, Masterton 5840

Please consider the environment before printing this email.

From: Tom Logan <tom.logan@gw.govt.nz>
Sent: Wednesday, 15 March 2023 10:02 am
To: [redacted] <[redacted]@tranzit.co.nz>
Cc: [redacted] <[redacted]@tranzit.co.nz>
Subject: Fresh air into top deck of UT200RHDF with no air conditioning

Kia ora [redacted],

You may have seen this in the news last year? Cost concerns scupper fresh air plans for Auckland buses | RNZ News GWRC have done some CO2 measuring as you might know also, and I have been asked to look at options for introducing fresh air into buses in the Wellington fleet. It looks like any with air conditioning can be programmed or modified to introduce fresh air, however the top deck of these buses without air conditioning will need a different solution. I was wondering if you could let me know if the Valeo unit below would fit into these 10 buses, and if so a cost estimate for them to be supplied and installed. They seem to be located at your Rongotai depot.

Valeo Thermal Bus (valeo-thermalbus.com)

I am putting some options together for Paul to consider, I have also suggested that if it is just COVID that is the issue an air purifier could be installed – again simpler on buses with air conditioning and ducting, but there are stand-alone units available.

I am open to any thoughts or discussion on this, or please let me know if there is someone else at your company I should be discussing this with.

Ngā mihi

Tom Logan (he/him) | Bus Projects Delivery Consultant

GREATER WELLINGTON REGIONAL COUNCIL
M 021 2427629
100 Cuba St, Te Aro, Wellington 6011 | PO Box 11646, Manners St, Wellington 6142 | **metlink.org.nz**

From: [redacted]
To:
Subject: Re: Air conditioning system on ADL E500 buses
Date: Tuesday, 14 March 2023 7:42:55 am
Attachments: image001.png
image001.png

Hi Tom
They only use internal air with no external vents
Cheers [redacted]

[redacted] | [redacted]
44 Newlands Road, Newlands, Wellington 6037
T [redacted] | **M** [redacted]
E [redacted]@manacoach.co.nz | **W**www.manacoach.co.nz

On 13/03/2023, at 3:11 PM, Tom Logan <tom.logan@gw.govt.nz> wrote:

Hi [redacted]

I understand that the E500 buses you have use Thermo King air conditioning units, are these able to have fresh air programmed in, or do the units not have vent flaps to outside air? Hoping you will know.

Ngā mihi

Tom Logan (he/him) | Bus Projects Delivery Consultant

GREATER WELLINGTON REGIONAL COUNCIL
M 021 2427629
100 Cuba St, Te Aro, Wellington 6011 | PO Box 11646, Manners St, Wellington 6142 |
metlink.org.nz
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image001.png

Pilot study: indoor air quality monitoring on Metlink buses

2022/23

For more information, contact the Greater Wellington Regional Council:

Wellington
PO Box 11646

T 04 384 5708
F 04 385 6960
www.gw.govt.nz

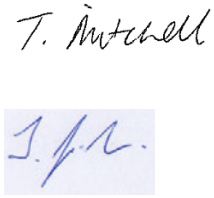
Masterton
PO Box 41

T 06 378 2484
F 06 378 2146
www.gw.govt.nz

GW/ESCI-T-23-6

April 2023

www.gw.govt.nz
info@gw.govt.nz

Report prepared by:	T Mitchell T Logan	Senior Environmental Scientist Air Quality Bus Projects Delivery Consultant	
Report reviewed by:	P Blane	Principal Advisor Bus Fleet	
Report approved for release by:	F Abbott R Morris	Manager, Assets & Infrastructure Acting Manager, Environmental Science	 **Date**: 28 April 2023  **Date**: 28 April 2023

The report may be cited as:

Mitchell T. & Logan, T. 2022. *Pilot study: indoor air quality monitoring on Metlink buses.* Greater Wellington Regional Council, Publication No. GW/ESCI-T-23-6, Wellington.

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Executive summary

Indoor CO_2 levels are an indicator of ventilation effectiveness, ie, ability to exchange stale indoor air with 'fresh' outdoor air. The purpose of ventilation is to avoid the accumulation of indoor-generated contaminants and odours and to maintain human comfort levels. Since the pandemic, there has been increased attention on improving ventilation and indoor air quality to reduce the risk of transmission of current and future airborne respiratory illnesses.

This pilot aimed to improve understanding of air quality and effectiveness of ventilation inside urban buses. Indoor air was monitored by Air Matters Ltd on eight in-service Metlink buses during October 2022 to provide information on the levels of CO_2 from passenger respiration. Sustained and elevated levels of CO_2 were found on 22% of monitored trips indicating inadequate ventilation for the bus occupancy level, which may pose an increased risk of transmission of respiratory infections and affect passenger comfort levels.

It is recommended that options to improve ventilation on the upper level of electric double decker buses are investigated and tested. There is no national policy or regulation for acceptable CO_2 levels for public transport environment and no ventilation specifications in the *Requirements for Urban Buses*. Public health advice is required to determine whether measured CO_2 levels pose a risk to passenger health.

1. Introduction

Metlink buses transport around 57,000[1] people per day to their destinations. We want people's journeys to be as comfortable and safe as possible within our available resources and what is technically achievable. The latest Quality of life survey (2022[2]) found 41% of survey respondents in the Greater Wellington region did not feel safe from catching COVID-19 or other illness from public transport and 27% agreed that it was safe. Because of COVID-19, 33% of respondents reported using public transport less often and 4% reported using more often.

Since the pandemic there has been increased international attention on improving ventilation in shared indoor spaces to reduce the chances of transmitting airborne respiratory infections, such as COVID-19 and seasonal influenza, and to provide better indoor air quality. In NZ, the Ministry of Education provides guidance for ventilation and CO_2 levels in classrooms to improve learning outcomes and lower the risk of viral transmission[3].

In 2022, University of Auckland found high levels of CO_2 on buses compared to other publicly used indoor environments and highlighted concerns about increased risk of viral transmission (Rindelaub, 2022). In response to these concerns, Metlink initiated a pilot monitoring study to assess the levels of in-cabin CO_2 on a sample of Wellington buses. The monitoring was carried out in October 2022 by Air Matters Ltd, who have expertise in occupational indoor air testing. The findings of the testing are summarised in this report, with the full Air Matters Ltd report attached as Appendix 2.

[1] Average daily bus passengers July 2022 to February 2023
[2] FINAL-QOL-8-City-Topline-Report_17-October-2022.pdf (qualityoflifeproject.govt.nz)
[3] https://temahau.govt.nz/covid-19/advice-schools-and-kura/ventilation-schools/ventilation-guidance

2. Background

2.1 Indoor ventilation requirements

The main source of indoor CO_2 is from exhaled breath. The NZ standard[4] for ventilation for acceptable indoor air quality recommends ventilation sufficient to keep CO_2 below 1,000 ppm (parts per million) for human 'comfort' levels. Indoor ventilation requirements are usually specified by the rate of *Air Change Per Hour* (ACH), ie, exchange of stale indoor air for 'fresh' outdoor air. Measuring ventilation directly is difficult, requiring specialised equipment and expertise. Therefore, measuring the sustained concentration of indoor CO_2 (arising from accumulation of exhaled breath) can be used as an indicator of ventilation effectiveness. Improving ventilation has been identified as one key mitigation for transmission of airborne infectious particles between people (World Health Organization, 2021; ASHRAE, 2022).

2.2 Ventilation on buses

Generally, buses in the Wellington public transport fleet either have opening windows for ventilation, or air conditioning with little or no fresh air entering as the air is recirculated within the cabin. Some air conditioning units installed on Wellington buses have no way of introducing fresh air (without modification), others have the ability, but this function is not activated. There is fresh air available via the windscreen demister system, which may help provide fresh air to the driver. Many, but not all, buses have an opening window next to the driver. Too much fresh air being introduced could overwhelm the capability of the air conditioning unit and/or cause condensation on the windows. Incidental air changes occur when opening/shutting of doors at bus stops and if the bus has opening windows at passenger discretion.

Requirements for heating, ventilation, and air conditioning (HVAC) listed in the *Requirements for Urban Buses* (Waka Kotahi, 2022) are limited to climate control, ie, maintaining a temperature of 20°C ± 2°C. The *Land Transport Rule Passenger Services 1999* states that if forced ventilation is the only means of ventilation, then the system must incorporate at least two fans capable of delivering within two minutes an air volume the same size as the passenger compartment (which equates to 30 air changes per hour). The air conditioning system for new urban buses with full climate control would struggle to achieve both ventilation requirements and maintain temperature specifications.

2.3 CO_2 monitoring to assess infection risk

Since the pandemic, numerous studies overseas and three primary schools in NZ (NIWA, 2022) have used CO_2 monitoring as an indicator of respiratory infection risk. The relative risk of viral transmission may scale with CO_2 concentration, as there is more chance of breathing in infectious particles, should a source be present. However, there is not a direct link between indoor monitored CO_2 levels and absolute infection risk, as risk of transmission depends on factors which vary independent of CO_2 concentration, for example,

[4] NZS 4303:1990 Ventilation for acceptable indoor air quality

community transmission rates, which affect the probability that infected people may be present (Eykelbosh, 2021).

Using CO_2 monitoring to assess ventilation and/or infection risk has been mostly applied to indoor spaces that are regularly occupied by the same group of people (eg, offices and schools). Indoor guidelines that exist for CO_2 are generally based on 'steady-state' concentrations, ie, when an equilibrium is reached between occupant-generated CO_2 and the rate of air exchange. Public transport environments, where occupancy changes over relatively short periods, can lead to fluctuating CO_2 levels. It is noted that CO_2 monitoring may not be an effective tool for evaluating infection risk in spaces that are transiently occupied by different people (UK SAGE-EMG[5]).

Air Matters Ltd assessed CO_2 levels against traffic-light bands for risk of viral transmission developed by the *Australian Safe Indoor Air Working Group* (OzSAGE[6]) for bars, restaurants and shops opening following the removal of COVID-19 restrictions. OzSAGE noted that shared vehicles, including public transport, are not currently subject to effective regulation of ventilation levels and that national standards should be developed and implemented. Although, the applicability of OzSAGE guidelines to the public transport environment is uncertain, they are a useful reference point for comparing the tested vehicles. Sustained CO_2 levels above 1500 ppm have been recommended as an indicator of poor ventilation for indoor occupied workspaces (UK HSE Health and Safety Executive[7], UK SAGE-EMG[8]).

2.4 CO_2 monitoring to assess direct health effects

Breathing high levels of CO_2 can result in headaches, tiredness and impacts on cognitive performance. If such effects occur, they are generally reversible with fresh air. Consensus on appropriate health-based thresholds for short-term non-occupational indoor exposure to CO_2 is not available and existing evidence for impacts on health, wellbeing, learning outcomes and work performance is inconsistent (ASHRAE, 2022).

For occupational exposure, the NZ Workplace Exposure Standard for CO_2 is 5000 ppm (averaged over an 8-hr working day) and a short-term limit of 30,000 ppm (15-minute average).

[5] EMG: Role of ventilation in controlling SARS-CoV-2 transmission, 30 September 2020 - GOV.UK (www.gov.uk)
[6] OzSAGE Safe Indoor Air (ventilation) recommendations. Version 1.02. 6 September 2021. https://ozsage.org/working_group/safe-indoor-air-ventilation/

[7] HSE Ventilation in the workspace. https://www.hse.gov.uk/ventilation/using-co2-monitors.htm#understanding
[8] EMG: Role of ventilation in controlling SARS-CoV-2 transmission, 30 September 2020 - GOV.UK (www.gov.uk)

3. Monitoring strategy

Air Matters Ltd installed two CO_2 sensors in each bus level (mid and back of the cabin). There were two monitors per single deck bus and four per double deck bus. Between 18-20 October 2022, eight in-service buses were monitored each day representing a total of 64 trips (Table 3.1). The monitors used were personal CO_2 meters (SAN-10), which use non-dispersive infrared (NDIR) technology.

Table 3.1: Buses monitored and their ventilation systems

Vehicle ID	Engine Type	Drivers' window	Opening windows	Air conditioning	Demist system with fresh air	Capacity Adults	Outside air from Air conditioning	Comment
3701	Electric DD	Yes	Yes	No	Yes	74	No	Fresh air via windows.
3710	Electric DD	Yes	Lower	Upper only	Yes	90	No	Fresh air via windows on lower deck, upper deck will require modification to achieve fresh air.
3523	EURO VI DD	No	No	Yes	Yes	102	No	Fresh air is possible
5083	EURO V DD	Yes	No	Yes	Yes	101	No	Up to 20% fresh air is possible
3433	EURO VI	No	No	Yes	Yes	75	No	Fresh air is possible
3452	EURO VI	No	No	Yes	Yes	75	No	Fresh air is possible
5738	Electric	Yes	No	Yes	Yes	75	Unknown	Up to 20% fresh air possible.
5747	Electric	Yes	No	Yes	Yes	75	Unknown	Up to 20% fresh air possible.

4. Key findings

4.1 Representativeness of sampled buses and passenger loadings

The eight buses selected for the study were a combination of bus types (DD electric, DD diesel, LV diesel and electric) operating on a variety of routes, including the bus corridor through the Golden Mile and outer suburbs of Wellington City. As such, the bus sample is broadly representative of the fleet operating in Wellington.

Buses were monitored during the morning and afternoon peaks to capture maximum passenger loadings. The maximum passenger numbers on the monitored buses were compared to the annual school term time distribution of daily maximum passengers recorded on each trip. Over half the monitored bus trips had maximum passenger loadings that were between the 75th and 100th percentile of typical maximum loadings in 2022.

4.2 CO_2 results

The CO_2 monitoring devices used in the study were 'personal' occupational health monitors and are therefore not optimised to measure indoor air quality but were considered the most practical devices readily available for the pilot study.

There were problems with readings from two devices drifting significantly from their calibrated value resulting in unrealistically low readings. Measurements below expected minimum outdoor CO_2 concentrations (413 ppm) were subsequently invalidated. Nevertheless, we have confidence in the monitoring data for showing general patterns and relationship between passenger occupancy and CO_2 levels.

4.2.1 Risk bands for viral transmission

Figure 4.1 shows the percentage of time monitored CO_2 levels (as a 30-second average) occurred in the OzSAGE relative risk banding levels for each vehicle monitored, including rest breaks and repositioning. Poor ventilation conditions, indicated by CO_2 above 1500 ppm, ranged from 0.3% of the time (Bus 5738) to 28% of the time (Bus 3433).

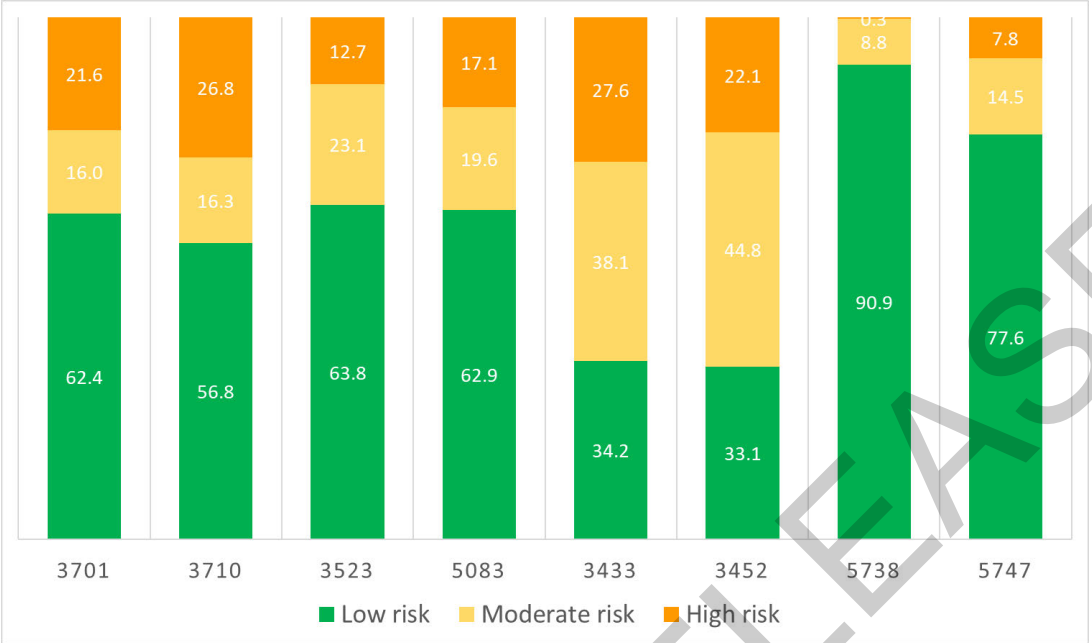

Figure 4.1: Percentage of time all CO_2 ppm (30 second averages) were in OzSAGE risk of viral transmission categories by vehicle tested. Includes rest breaks and bus repositioning. Low risk = < 800 ppm, Moderate risk = > 800 and < 1500 ppm, High risk = > 1500 ppm

Although it is not possible to use these CO_2 monitoring results to directly assess risks of respiratory infection transmission, the results suggest that measures to improve on-board ventilation should be further investigated and public health advice sought. It is noted that that ventilation provides a continuum of protection against infection risk, but there is no threshold level of ventilation for zero risk (NIWA, 2022).

4.2.2 CO_2 average by bus type and trip duration

GW Environmental Science averaged the CO_2 30-second data from the two sensors on each bus level and then aggregated the data by individual bus trips. Rest breaks and repositioning time were excluded so the analysis was focused on passenger exposure. A bus trip represents a segment of a route with specified bus stops. For example, trip 1160 (on Route 7) has 20 stops between Kingston and Wellington railway station. Total maximum passenger numbers for each route-trip were compared with 'typical' passenger occupancy during term in 2022.

Table 4.1. shows the double decker vehicle CO_2 monitoring results averaged for each route-trip combination and the percentile of maximum passenger loadings for the year. Typically, the upper decks recorded higher CO_2 levels than the lower deck, particularly for the electric buses. Table 4.2 shows the single deck vehicle CO_2 monitoring results for each individual route-trip and the percentile of maximum passenger loadings for the year. Across all monitored buses, there were 14 route-trips that had average CO_2 above 1500 ppm.

The summary distribution for all 30-second CO_2 readings by vehicle route-trip is attached in Appendix A1.

Table 4.1: Double deck vehicle route-trips. Route-trips where average CO_2 was greater than 1500 ppm are shaded orange.

Vehicle	Route	Trip	Duration	Departure	Stops (n)	Max pax	Max pax percentile*	CO_2 mean (ppm)	
								Lower deck	Upper deck
3701	7	1000	00:24:48	06:00	19	25	0.84	761	933
	HX	1020	00:09:40	06:25	2	8	0.92	736	1067
	39	1900	00:37:09	06:50	24	44	0.97	1005	2171
	7	1160	00:33:33	07:55	20	56	0.61	1613	3993
	1	1840	00:57:45	12:15	22	25	0.88	575	509
	7	1700	00:26:06	13:50	12	13	0.98	572	NA
3710	1	1010	00:58:26	05:40	32	28	0.83	1054	1167
	1	1180	01:19:04	07:05	32	80	0.89	2484	5756
	23	1100	00:43:01	08:40	26	27	0.77	1360	2871
	29	1140	01:01:38	10:14	12	12	0.71	629	1025
	29	1470	01:02:11	11:42	13	13	0.97	574	716
	29	1460	00:54:52	12:44	14	8	0.62	433	508
	29	1510	00:46:38	13:42	17	16	0.94	469	685
3523	1	1030	00:58:41	06:00	23	32	0.89	687	868
	24	1080	01:08:05	07:20	37	51	0.79	972	1166
	24	1110	01:02:55	08:23	21	18	0.67	617	775
	7	1790	00:29:45	15:15	18	26	0.32	625	785
	HX	1050	00:16:02	16:08	5	18	0.88	539	633
	7	1930	00:31:27	16:45	19	57	0.94	968	1306
	23	1350	00:40:26	17:44	18	34	0.8	691	897
5083	36	1120	00:55:18	08:00	26	105	1	2100	3026
	83	2090	00:42:45	09:20	12	10	0.29	821	708
	83	1200	01:15:36	11:05	21	37	0.95	842	726
	753	1010	00:21:55	15:26	2	62	0.56	1992	2243
	31x	1090	00:43:07	16:10	17	29	0.72	1189	1405
	36	1150	00:42:34	17:45	27	55	0.95	1199	1681

*The percentile of the 2022 daily maximum passengers onboard during the CO2 monitoring period

Table 4.2: Single deck vehicle route-trips. Route-trips where average CO_2 was greater than 1500 ppm are shaded orange.

Vehicle	Route	Trip	Trip duration	Departure	Stops (n)	Max pax	Max pax percentile*	CO_2 mean (ppm)
3433	24	1010	01:10:39	06:10	30	23	0.86	1252
	680	1000	00:28:34	07:50	16	47	0.87	1668
	24	1170	01:15:28	10:10	21	13	0.68	690
	24	1700	01:16:34	12:15	22	18	0.95	737
	24	1750	01:06:12	13:40	30	34	0.97	1443
	685	1010	00:38:58	15:15	16	33	0.68	2228
	7	1890	00:28:55	16:25	21	34	0.64	1679
	7	1960	00:30:02	17:05	13	10	0.79	987
	7	2030	00:36:46	17:35	23	56	0.86	2208
3452	HX	1000	00:09:51	06:10	2	5	0.78	761
	25	1030	00:27:43	06:48	11	7	0.59	768
	25	1080	00:31:47	07:35	21	26	0.35	1330
	25	1150	00:56:39	08:30	22	29	0.93	1660
	25	1220	00:32:38	09:30	15	12	0.66	1376
	17	1200	00:28:30	11:10	2	1	0.10	639
	17	1110	00:09:18	11:40	4	4	0.44	710
	17	1220	00:17:22	12:10	2	1	0.05	733
	17	1130	00:25:28	12:40	9	11	0.86	858
	17	1240	00:23:34	13:10	5	3	0.30	710
	17	1150	00:28:00	13:40	14	10	0.60	903
	17	1260	00:15:33	14:10	5	3	0.36	676
	7	1750	00:35:13	14:45	21	31	0.79	1298
	673	1010	00:29:44	15:40	9	33	0.49	2297
	19	1930	00:23:45	16:41	9	12	0.82	1525
	24	1420	01:12:38	17:15	26	24	0.69	1113
5738	2	1210	00:54:59	07:27	25	20	0.28	733
	2	1380	00:59:48	08:37	32	57	0.95	843
	2	1750	00:57:01	10:15	28	24	0.61	513
	2	2060	00:52:36	12:52	26	13	0.33	549
5747	2	1170	00:52:36	07:11	30	61	1	1389
	2	1320	00:58:54	08:15	31	72	1	1260
	2	1610	00:54:19	09:27	28	24	0.62	612
	2	1860	01:01:24	11:37	26	27	0.82	515
	2	2150	00:53:50	12:45	24	22	0.57	495
	2	2260	00:54:47	14:07	21	18	0.38	560
	2	2550	01:06:08	15:15	38	47	0.93	976
	2	2660	01:07:24	16:37	41	60	1	898
	2	2950	00:55:20	17:46	28	33	0.75	871

*The percentile of the 2022 daily maximum passengers onboard during the CO_2 monitoring period

4.2.3 Relationship between CO_2 and passenger occupancy

Passenger numbers onboard between bus stops were estimated using the difference between number of passengers alighting and passengers disembarking as recorded by snapper and gold card data. Although, in general CO_2 peaks temporally coincided with peaks in passenger numbers (Air Matters Ltd Appendix B: CO_2 time series graphs), there was considerable variability in the relationship between CO_2 and passenger numbers. Passenger numbers onboard and average CO_2 levels between each stop are shown for single deck buses (Figure 4.2) and by deck for double decker buses (Figure 4.3).

Figure 4.2 shows that on single deck buses average CO_2 levels above 1500 ppm between stops were found across the range of passenger numbers (0 to 72) except for bus 5738. Figure 4.3 shows at times high CO_2 concentrations between stops on the upper decks across the entire range of passenger numbers. The highest upper deck CO_2 concentrations were found on the two electric double decker buses (3701 and 3710). Although it was not possible to identify the spilt between passenger numbers on the upper and lower levels, the higher CO_2 concentrations found upstairs were probably due to the smaller upstairs cabin volume and slower decay rate of CO_2 (emitted by previous passenger) as there was less fresh air introduced upstairs compared to downstairs when bus doors open for passengers to board and disembark.

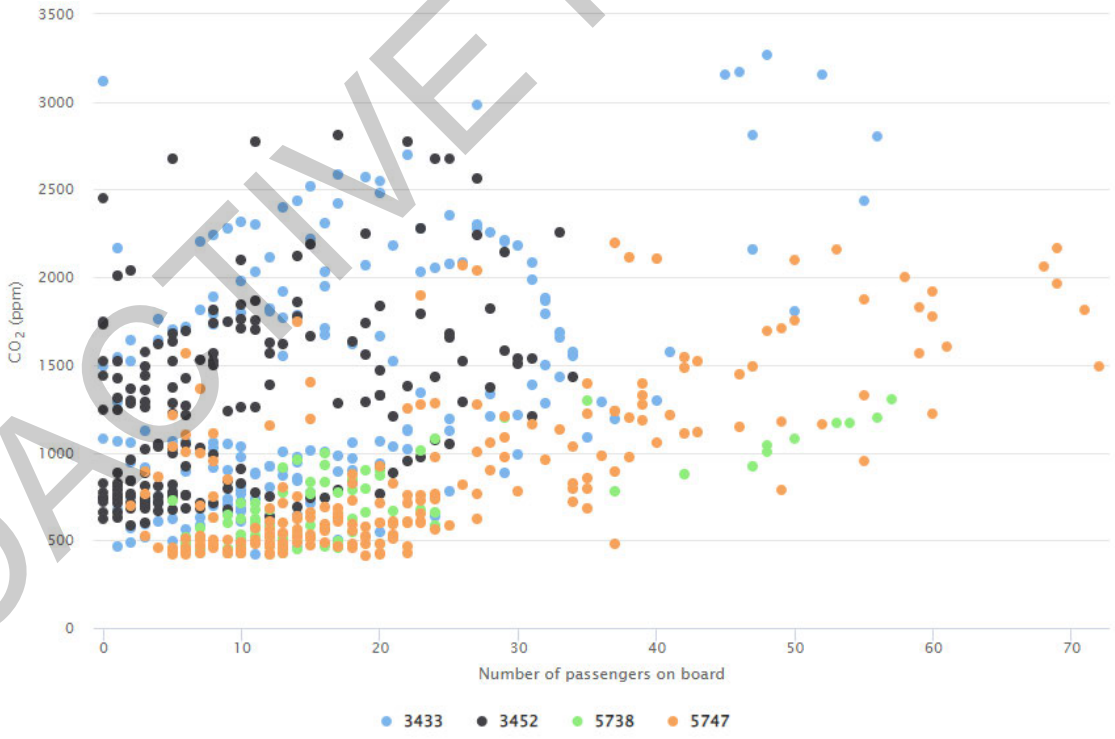

Figure 4.2: Single deck buses. Average CO_2 ppm vs number of passengers on board between bus stops by vehicle ID.

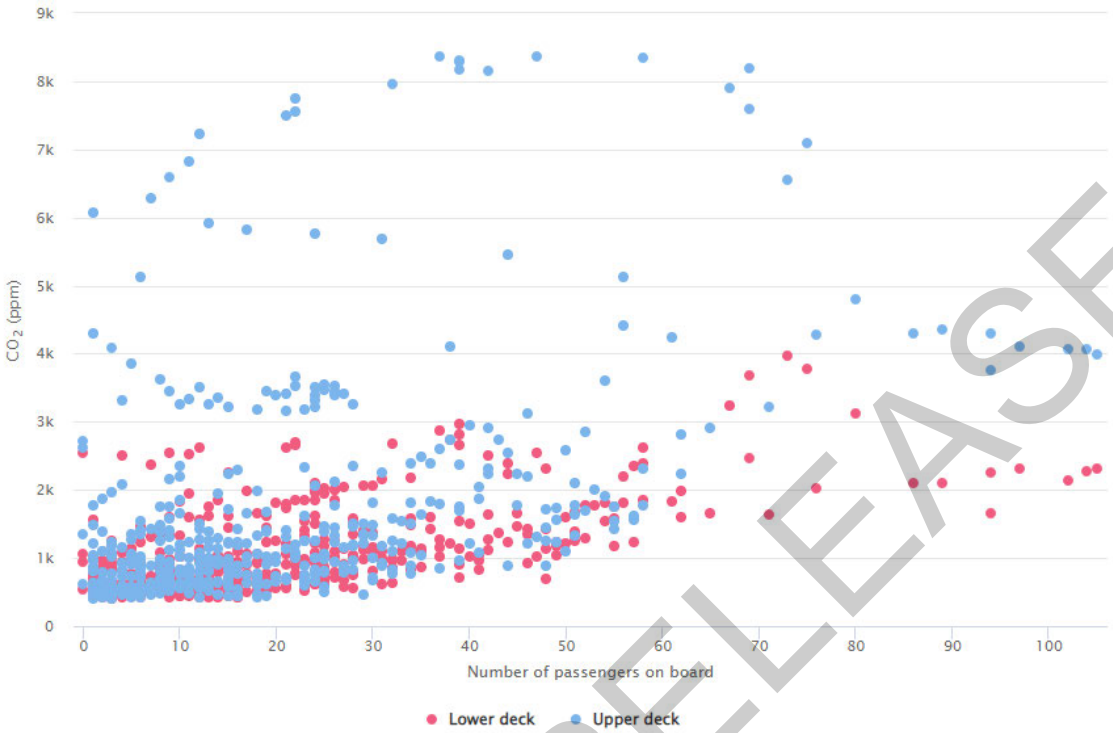

Figure 4.3: Double decker buses. Average CO_2 ppm vs number of passengers on board between bus stops by upper and lower deck.

4.2.4 Monitoring results summary

CO_2 concentrations are a function of many factors: passenger numbers, duration of the trip, CO_2 accumulated from previous passengers onboard, bus airflow and ventilation systems and potentially individual variations in passenger CO_2 generation rate.

The monitoring found that most buses experienced periods when CO_2 levels exceeded high risk guidelines for viral transmission, particularly the upper decks of double decker buses. Due to the small sample size, and inability to track any ventilation controls in use, this study was not able to identify reasons for differences in CO_2 concentrations between buses.

4.3 Direct health effects for passengers and drivers

The maximum average CO_2 concentration measured between two bus stops was 8404 ppm. At this level passenger comfort is likely to be affected. As there are no short-term non-occupational health guidelines for CO_2 exposure, further research and/or guidance from public health authorities is needed, particularly to assess whether there might be potential impacts on passengers with underlying vulnerabilities or health conditions.

When averaged over the entire day's monitoring (including re-positioning), CO_2 concentrations were well below the 8-hr and 15-minute Workplace Exposure Standard for occupational exposure to CO_2, designed to protect healthy adult workers. Driver exposure to CO_2 may be lower than in other areas on the bus due to driver control of personal air flow control settings and proximity to door opening. Personal monitoring is the best way to assess occupational exposure in this instance.

4.4 Outdoor air pollutants inside buses

Air Matters monitoring devices did not detect any traffic exhaust gases (ie, carbon monoxide and NOx) on board. GW Environmental Science carried out a very limited black carbon (ultrafine soot from combustion) monitoring trial on some buses and found varying levels of ultrafine combustion particulate most likely from traffic sources entering through open doors and windows. This has implications for increasing outdoor air intake along routes through highly trafficked areas which may increase the levels of polluted outdoor inside the bus but may also enhance air exchange which can flush out air pollutants that become 'trapped' inside the bus. More investigation and expert advice are required to understand this issue.

5. Recommendations

- Agree with Air Matters Ltd finding that priority should be given to understanding the factors influencing elevated levels of CO_2 on the upper levels of double decker buses.

- Investigate feasibility of improving ventilation on upper decks of double decker buses, and test effectiveness of any identified achievable modifications, such as adding fresh air through the air conditioning system.

- Seek advice from Ministry of Health on appropriate levels of CO_2 for public transport to protect health of all passengers.

Acknowledgements

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Appendix 1: CO_2 summary results by vehicle and route-trip

Table A1.1: Summary of distribution of CO_2 ppm 30-second measurements on double decker buses by route-trip, excluding bus repositioning and driver rest breaks.

Vehicle	Level	Route-Trip	Min	25th percentile	Median	Mean	75th percentile	Max
3701	Lower	7-1000	443	604	753	761	931	971
	Lower	HX-1020	528	586	762	736	892	937
	Lower	39-1900	507	786	1011	1005	1115	1623
	Lower	7-1160	1022	1131	1652	1613	2036	2272
	Lower	1-1840	413	509	554	575	637	761
	Lower	7-1700	425	502	547	572	630	775
	Upper	7-1000	522	763	917	933	1151	1366
	Upper	HX-1020	827	911	1088	1067	1210	1358
	Upper	39-1900	789	1355	2260	2171	2906	3514
	Upper	7-1160	1844	2492	3998	3993	5545	6064
	Upper	1-1840	415	456	484	509	580	647
	Upper	7-1700	NA	NA	NA	NA	NA	NA
3710	Lower	1-1010	464	957	1017	1054	1228	1454
	Lower	1-1180	455	1952	2565	2484	3000	4342
	Lower	23-1100	425	885	1382	1360	1815	2131
	Lower	29-1140	434	547	609	629	697	866
	Lower	29-1470	415	477	594	574	673	705
	Lower	29-1460	432	433	433	433	434	434
	Lower	29-1510	421	429	475	469	504	516
	Upper	1-1010	413	941	1214	1167	1386	1768
	Upper	1-1180	883	4586	6273	5756	7807	8405
	Upper	23-1100	1563	2441	2950	2871	3399	4421
	Upper	29-1140	538	857	1040	1025	1250	1542
	Upper	29-1470	535	616	719	716	810	878
	Upper	29-1460	455	495	504	508	527	576
	Upper	29-1510	419	558	681	685	818	912
3523	Lower	1-1030	414	572	626	687	814	990
	Lower	24-1080	421	833	872	972	1223	1504
	Lower	24-1110	451	539	585	617	701	804
	Lower	7-1790	417	525	629	625	740	781
	Lower	HX-1050	413	438	543	539	625	688
	Lower	7-1930	532	754	1043	968	1173	1314
	Lower	23-1350	443	561	618	691	842	982
	Upper	1-1030	541	654	826	868	1084	1252
	Upper	24-1080	561	680	1223	1166	1535	1833
	Upper	24-1110	550	696	754	775	881	968
	Upper	7-1790	416	606	793	785	991	1021
	Upper	HX-1050	538	556	598	633	710	804

Vehicle	Level	Route-Trip	Min	25th percentile	Median	Mean	75th percentile	Max
	Upper	7-1930	643	1023	1382	1306	1633	1780
	Upper	23-1350	523	674	863	897	1142	1264
5083	Lower	36-1120	1531	1825	2147	2100	2317	2812
	Lower	83-2090	641	722	801	821	927	1041
	Lower	83-1200	418	494	841	842	1095	1650
	Lower	753-1010	588	1503	2340	1992	2492	2719
	Lower	31x-1090	770	1024	1182	1189	1351	1570
	Lower	36-1150	604	919	1106	1199	1588	1805
	Upper	36-1120	429	1955	3573	3026	4105	4407
	Upper	83-2090	493	565	672	708	806	1152
	Upper	83-1200	428	524	742	726	892	1061
	Upper	753-1010	458	2150	2471	2243	2626	2722
	Upper	31x-1090	1040	1332	1416	1405	1518	1630
	Upper	36-1150	554	1172	1889	1681	2228	2403

Table A1.2: Summary of distribution of CO_2 ppm 30-second measurements on single deck buses by route-trip, excluding bus repositioning and driver rest breaks.

Vehicle	Route-Trip	Min	25th percentile	Med	Mean	75th percentile	Max
3433	24-1010	415	1077	1277	1252	1564	1814
	680-1000	438	935	1611	1668	2395	3121
	24-1170	435	579	704	690	806	928
	24-1700	415	551	751	737	933	1025
	24-1750	668	787	1483	1443	2043	2299
	685-1010	1305	2203	2301	2228	2420	2597
	7-1890	955	1495	1755	1679	1962	2093
	7-1960	881	913	984	987	1056	1132
	7-2030	1028	1679	2259	2208	2822	3309
3452	HX-1000	639	748	768	761	800	840
	25-1030	630	687	792	768	841	859
	25-1080	626	827	1371	1330	1816	1867
	25-1150	1208	1288	1623	1660	2026	2289
	25-1220	1255	1279	1363	1376	1466	1533
	17-1200	559	613	631	639	658	742
	17-1110	693	701	708	710	718	738
	17-1220	696	725	734	733	744	766
	17-1130	678	707	874	858	989	1043
	17-1240	683	694	707	710	720	760
	17-1150	748	767	914	903	1028	1067
	17-1260	584	589	690	676	747	772
	7-1750	661	760	1525	1298	1706	1786
	673-1010	866	1913	2608	2297	2773	2849
	19-1930	1240	1422	1600	1525	1641	1714
	24-1420	716	822	1003	1113	1423	1681
5738	2-1210	426	592	744	733	869	1025
	2-1380	432	624	786	843	1051	1333
	2-1750	415	442	472	513	574	690
	2-2060	424	485	566	549	597	667
5747	2-1170	429	863	1352	1389	1957	2185
	2-1320	419	712	1130	1260	1879	2233
	2-1610	413	529	619	612	716	765
	2-1860	413	446	493	515	587	648
	2-2150	424	463	479	495	519	621
	2-2260	416	502	555	560	634	671
	2-2550	422	714	959	976	1233	1536
	2-2660	413	469	733	898	1253	1889
	2-2950	420	631	817	871	1133	1292

Appendix 2: Air Matters monitoring report

GREATER WELLINGTON REGIONAL COUNCIL

AIR MATTERS REPORT 22214

Bus Cabin Carbon Dioxide Monitoring – Pilot Study

Assessment Date: 20/10/2022

Report Date: 16/12/2022

T: +64 9 912 1387 / **F:** +64 9 909 3289 / **E:** enquiries@airmatters.co.nz
Office 5, 17 Banks Ave, Mount Maunganui, Tauranga, New Zealand
W: airmatters.co.nz

Report prepared for GWRC by Air Matters Limited.

Sampling carried out by:

Nigel Goodhue

Environmental Scientist

Air Matters Report:	22214
Date:	16/12/2022
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Report written by:

Nigel Goodhue

Environmental Scientist

Report peer reviewed by:

Carol McSweeney (MNZOHS)

Occupational Hygienist

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1. INTRODUCTION

Greater Wellington Regional Council (GWRC) engaged Air Matters Limited (Air Matters) to undertake a pilot study of carbon dioxide (CO_2) concentrations within a range of bus types used on the Wellington Region's public transport network. The monitoring was requested to provide an initial scientifically-based assessment of the transmission risk of airborne pathogens and passenger comfort levels. These monitoring results are intended to provide GWRC with an indication of risk, with the aim to prioritise measures to reduce the transmission of airborne pathogens within public buses. The monitoring was undertaken by Air Matters staff, on 18, 19th and 20th October 2022.

2. AIR QUALITY IN INDOOR AREAS & BUSES

Carbon dioxide has been used as an indicator of indoor air quality (IAQ) for centuries, with the first guidelines being developed in the nineteenth century. There are two aspects to consider when monitoring CO_2 to determine IAQ and potential health risks as described below.

Direct effects of Carbon Dioxide

Firstly, CO_2 can directly lead to adverse health effects at elevated levels. There are a range of exposure standards available for workplace indoor quality. For example, WorkSafe NZ's Workplace Exposure Standards (WES) for CO_2 are 5,000ppm averaged over an 8-hour shift and 30,000ppm averaged over a 15-minute period. Given WES are intended for persons in the workforce (healthy individuals) and over work timeframes, they are not likely to be appropriate for assessing the potential health effects on public transport.

Numerous studies, for example Zhang *et al* (2015) have assessed the effects of CO_2 on cognitive ability and provide a range of CO_2 levels where effects are observed during the exposure. Increased CO_2 levels are also associated with the feeling of 'stuffiness' or 'drowsiness' within an area which is likely also contributed to by variables such as elevated humidity and temperature.

Indicator of Air Quality

Secondly, CO_2 is used as a proxy for understanding the potential risk of transmitting pathogen containing aerosols. Provided the CO_2 is generated by human respiration, then elevated concentrations could indicate an increased risk of pathogen transmission. Since the COVID-19 pandemic, research and the use of CO_2 for this purpose has become more common. For example, the Ministry for Education has released guidance on appropriate CO_2 levels to minimise the risk of COVID-19 and other pathogen transmission within school classrooms.

The purpose of this study's monitoring is to understand the potential pathogen transmission risk. Therefore, the following sections are focused on determining appropriate CO_2 concentrations that may indicate an increased risk of pathogen transmission on public transport.

While passenger areas in buses are not typically described as indoor spaces, they are enclosed environments, and as such, the guidelines for CO_2 levels in buildings have been considered applicable for pathogen risk assessment purposes. A 2021 study from the University of Colorado suggests that "the relative risk of infection in a given situation has been shown to scale with the excess CO_2 concentrations" *(Peng & Jimenez 2021).* With the recent COVID-19 pandemic, the concentration of

CO_2 within an indoor space is being used as a threshold to determine the risk of pathogen transmission and it has become regularly reviewed and researched.

A 2020 publication by the Australian Institute of Refrigeration Air Conditioning and Heating recommends an orange indicator of indoor air quality (assumed to be moderate level of viral transmission risk) from 800 to 1000 ppm, and a red indicator at more than 1000 ppm CO_2 for school buildings (AIRAH guidance for school building COVID19 2020). In New Zealand, the Ministry for Education has recommended action levels in response to COVID-19 transmission risks when CO_2 levels within classrooms exceed 800 ppm (MoE, 2022).

OzSAGE (a multi-disciplinary network of Australian experts set up to provide advice on public health, health systems and policy matters relevant to COVID-19 control during the opening up of Australia) released a guidance document in September 2021, *Creating safe workplaces during the COVID-19 pandemic* and *Safe Indoor Air (Ventilation) Recommendations.* Within these guidance documents, OzSAGE recommends the following action limits:

For restaurants, bars and shops, CO_2 level should be considered as a surrogate for the relative risk of airborne infection. Action limits should be applied as per below:

1. *Below 800 ppm – indicates a low relative risk of infection;*
2. *Between 800 ppm to 1,500 ppm – indicates moderate relative risk of infection. Improvements should be made where practicable to increase the provision of fresh air into the indoor space;*
3. *Above 1,500 ppm – indicates a high relative risk of infection. Immediate improvements must be made to increase the provision of fresh air into the indoor space or air filters must be operational.*

While not specific to public transport, the principles of enclosed space ventilation, are applicable and these criteria were considered fit for purpose to evaluate the relative level of pathogen transmission risk within buses. This guidance does not provide any quantitative assessment on how the risk changes based on exposure time. However, it does note that the more amount of time spent in a venue increases the risk and given the guidelines have been developed for areas where short term occupancy (i.e. 15-120 minutes) is expected to occur they are considered by Air Matters to be appropriate for public transport. Further research may be required to identify if these levels are being used by public transport providers around the world.

3. SAMPLING STRATEGY & METHODOLOGY

Based on scoping discussions between GWRC and Air Matters, eight buses (four double decker and four single level) of varying models were selected for the CO_2 pilot study. The monitoring duration was established to run from before the morning passenger peak to after the afternoon peak. This was undertaken by installing the monitoring on the bus prior to their departure, and after their return, to depot.

Two monitoring locations ('mid' and 'back') per bus cabin were selected to account for potential variations in air quality. In double decker buses a total of four monitors where installed, two in the lower level and two in the upper level. The bus routes were chosen by GWRC in conjunction with the bus operators. The aim was to capture a range of routes, bus types and over times where they would experience maximum patronage. Table 1 illustrates the various bus types, routes, and departure and return times over the three days of monitoring.

Dedicated CO_2 monitors were installed on the buses (Personal CO_2 meters - SAN-10). The monitors were set to log at 30-second intervals and were calibrated prior to use and fresh air calibrated each morning (where practical) prior to installation. The calibration records are available on request, and the monitor details are presented in Table 2. Personal CO_2 gas monitors were selected as the most appropriate measurement devices for this pilot study for the following reasons:

- Robust construction and small size to minimise the risk of theft or vandalism.
- Long battery life which does not require mains power.
- The monitors are available in numbers allowing for multiple samples to be collected in a single day.

In addition to the dedicated CO_2 monitors, real-time data-logging gas monitors (Ventis Pro 4/5 and MX4) were deployed within buses to measure carbon monoxide (CO) and nitrogen dioxide (NO_2). Combustion gas was collected in tandem to ensure the CO_2 readings were not being affected by external influences. Combustion gases entering the bus, while posing a risk to passengers, would not contain any human-respired pathogens and therefore were not the subject of this study. The gas monitors were set to log at ten-second intervals and were calibrated prior to use. The calibration records are available on request, and the monitor details are presented in Table 2.

Table 1. Bus type and route details over the three days of monitoring

Bus Number	Bus Type	Shift Number(s)	Route	Depart depot	Return depot
18 October 2022					
5083	Diesel (DD)	W1541	36	7:37	18:44
5738	Electric	W1359 / W1380	2	6:58	14:00*
5747	Electric	W1357 / W1547	2	6:42	19:30
19 October 2022					
3452	Diesel (LV)	2102	1	5:38	18:26
3433	Diesel (LV)	2105	24	5:56	18:30*
3523	Diesel (DD)	2103	7	5:42	18:27
20 October 2022					
3710	Electric (DD)	2100	1	5:18	15:00
3701	Electric (DD)	2101	7	5:35	14:30*

*Estimated based on GPS data

Table 2. Gas Monitoring Equipment used during the monitoring

Make & Model	Serial no.	Calibration Date
Ventis Pro 4/5 (CO + NO_2)	20033WM-002	12 October 2022
	17083PN-010	12 October 2022
	17033E4-003	12 October 2022
	17060VU-015	14 October 2022
	17013NY-029	12 October 2022
	17083PN-004	14 October 2022
MX4 (CO + NO_2)	220326H-038	22 September 2022
	220326H-039	22 September 2022
SAN-10 (CO_2)	01817	22 August 2022
	02187	7 September 2022
	02491	
	02502	
	02508	
	02528	
	02532	
	02257	22 September 2022
Q-Trak 7575-X	7575X1634001	27 November 21

The monitors were deployed statically within the bus cabins near roof height due to the restricted availability of mounting locations and in response to concerns regarding vandalism. Example photographs of the sampling locations is presented in Appendix A.

In addition to the stationary monitors, Air Matters staff rode bus #5738on 18 October 2022 and bus #3710 on 20 October 2022 over the peak period to measure CO_2 using a hand-held Q-Trak monitor. Q-Trak monitors have a higher accuracy than the static monitors, however due to their size, battery life and cost it is not practical to deploy multiple Q-Trak's in stationary locations. The hand-held monitoring instrument was set to log at 10 second intervals and was used to validate the stationary CO_2 monitoring. To investigate whether ultrafine combustion particulate could be detected inside the bus, GWRC staff measured black carbon with a hand-held aethalometer (Aethlabs MA350) at the same time as Air Matters staff were undertaking their hand-held CO_2 measurements. The black carbon results will be reported separately by GWRC.

4. RESULTS

The results of the CO_2, CO and NO_2 monitoring undertaken on 18, 19 and 20 October 2022 are summarised by the following key points:

- Weather during the three days of monitoring was fine with low to moderate wind speeds and daily temperature ranges between 10-18 degrees Celsius.

- Carbon monoxide was below the detection limit on all deployed monitors and low (<1ppm) NO_2 was detected by some monitors. This indicates that there were little to no combustion gases entering the buses that would have any noticeable effect on the CO_2 reading;

- CO_2 across all buses reached levels that are considered moderate and high risk based on the criteria described in Section 1. A summary of the results is shown in Figure 1 for all buses and measuring locations. This graph presents the proportion of time each bus spent within each risk band (low, moderate, high) over its daily route.

- Highest peak CO_2 reading of >9,000ppm was recorded on Bus 3710 during the morning peak commute. The lowest peak was recorded on Bus 5738 reaching ~1,550ppm during the morning peak commute;

- Levels of CO_2 were very strongly correlated with passenger numbers;

- Generally, the CO_2 levels within a bus were spatially consistent and there was good temporal corelation between Back and Mid locations;

- In double decker buses significant variation was observed between upper and lower floors in the two Electric buses monitored on the 20th October;

- Data checks with the Q-Trak showed a reasonable agreement with the values of the nearest monitor located in the bus.

- Data from five of deployments dropped below ambient concentrations (415ppm) during periods of the monitoring. The reason for this drop is likely due to instrument drift. Despite this drift at ambient concentrations, peaks in the data across monitors within the same buses corelated well. Consequently, this potential drift at ambient levels is not expected to affect the interpretation of results of this pilot study.

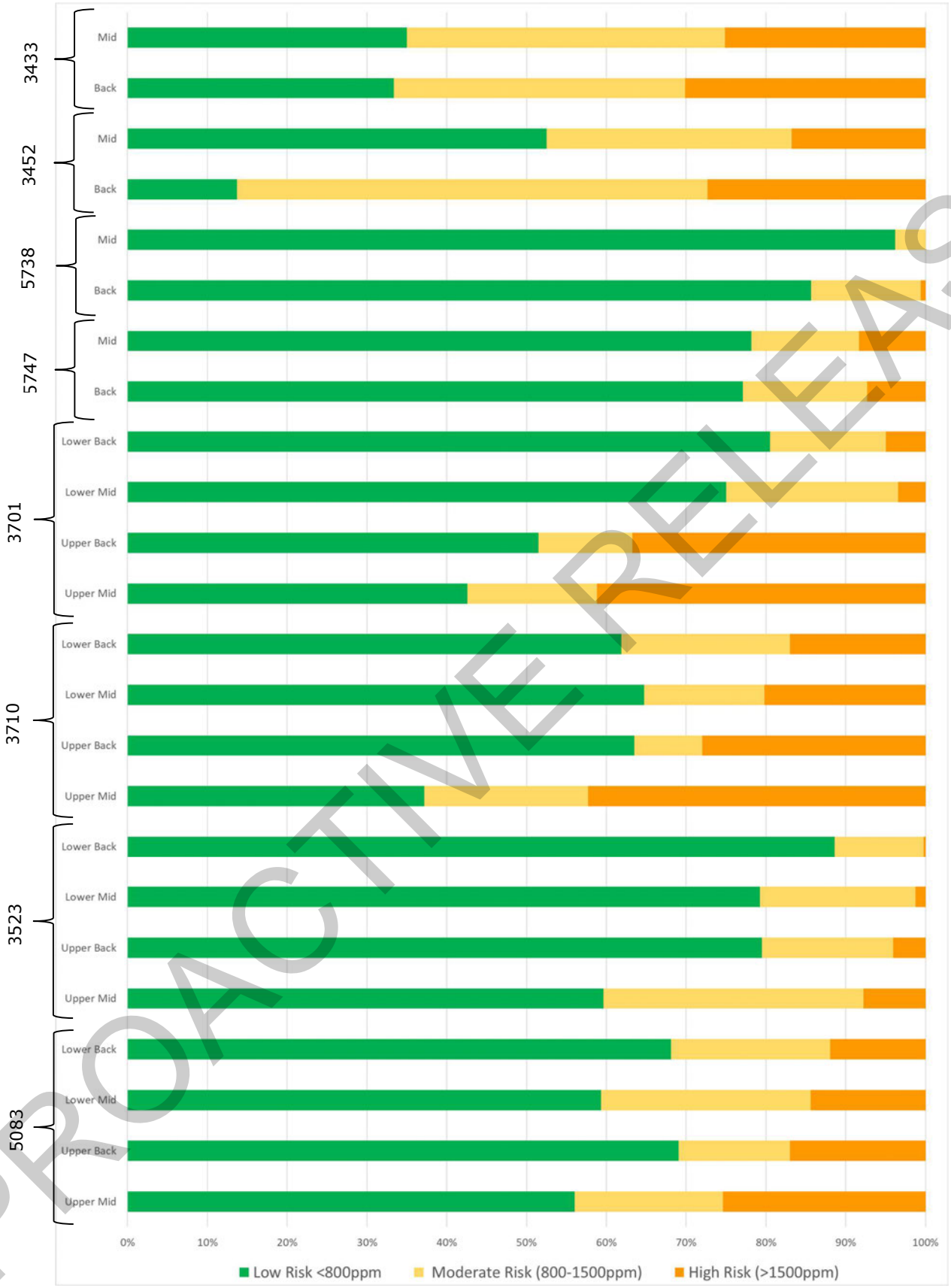

Figure 1. Air Quality risk banding shown as a percentage of time for each bus's daily route. Information on the Y axis is the various bus numbers and position of the monitor in each bus.

5. DISCUSSION

The following discussion is based on data collected over single bus runs. There are a range of factors that may influence CO_2 concentrations and pathogen transmission within a bus that could not be controlled in this pilot study. Consequently, the findings in this study shouldn't be solely relied on when determining absolute risks. Nevertheless, the results of this study show that consistent elevated CO_2 concentrations occurred across a range of bus types, routes and passenger levels. Based on this, mitigation measures to reduce potential pathogen exposure risk across all bus types should be further investigated.

The "moderate relative risk" CO_2 guideline level (>800 ppm) was exceeded in all the monitored buses and the "high relative risk" (>1,500 ppm) was exceeded in all buses, although the duration ranged significantly between buses. For example, in the high relative risk category, Bus 5738 only exceeded levels for 0.3% of the time (averaged across its two monitors), whereas Bus 3433 exceeded for 27% of the time (averaged across its monitors).

There is a very strong cause and effect relationship between measured CO_2 levels and passenger loading information. Graphed over time (refer Appendix B), the correlation is very evident in that as passenger numbers on the bus increase, so too does CO_2 levels. While this pilot study does not include any quantitative analysis of controlling factors it is expected that a reasonable statistical relationship would exist between CO_2 and passenger numbers.

Spatial variability

In terms of the spatial variation of air quality there was a good correlation between monitors located on the same level of a bus. This indicates that air circulation within the buses is 'well mixed' which is a realistic assumption given the open space, high turbulence (people moving / bus doors opening) and recirculation of the buses air conditioning.

Bus 3701 and 3710 showed the most significant difference between the upper and lower levels with the lower level having notably lower concentrations of CO_2 (refer Appendix A: Figure 5 and 6). This contrasts with the two other double decker buses (3523 and 5083) which showed a much closer correlation between upper and lower levels (refer Appendix A: Figure 7 and 8). This may have been caused by variation in passenger numbers between the levels however this information was not recorded.

The author was on board 3710 throughout the morning peak and observed that the bus was at capacity (fully seated in the upper level and seated / standing in the lower level). Concentrations on the lower level may have been reduced due to improved ventilation and/or fresh air ingress from door openings. Bus 3701 was also fitted with manually opening windows, so it is possible that passengers on the lower level had opened one or more windows allowing better circulation of fresh air.

As no information on passenger loading between levels, air condition settings or window openings was recorded it is not possible to draw any conclusions for the observed difference. Given some of the highest CO_2 values were recorded on upper levels of double decker buses, understanding these controlling factors should be given priority if mitigations or further testing is planned.

Temporal variability

The data illustrates that CO_2 concentrations rise quickly with the influx of passengers but in most cases takes an extended period of time to dissipate back to ambient concentrations. For example, on Bus 3701 after all passengers have disembarked post morning peak the CO_2 concentration in the upper level takes over 180 minutes to return to below 800ppm. No information on the bus's status (running / air conditioning) is recorded to understand this better, and it has also been identified that some passenger loading information is missing from the supplied record.

Bus 3710 which was ridden by the author over the morning peak shows a significant drop in CO_2 on lower level when parked up for a 10–15-minute rest break (green arrow in Appendix 2: Figure 6), however the upper level, does not decrease at the same rate and remains above the high-risk threshold for an extended period of time. Information on the operation of the buses ventilation system during the rest break was not recorded, however the doors were left open.

The overall results suggest that the risk of airborne pathogen transmission within most of the monitored buses is high over peak periods, and mitigation is recommended to reduce the level of risk. Mitigative actions could include increasing the fresh air ventilation rate for the bus cabins, filtering the recirculated air within the buses or a combination of both. The effectiveness of particulate filters cannot be determined using CO_2 levels as a proxy of transmission risk because the filters only filter out particulates, not gases such as CO_2. The filters must be designed to remove appropriately sized particles, based on the size of virus and or other pathogenic particles. The level and type of filtration on the buses in this study was not recorded.

It cannot be overstated that the use of masks is also an important component to manage the risk of airborne virus transmission, but it should not be the only form of control.

6. CONCLUSION

The pilot study has successfully measured CO_2 concentrations across 8 bus types and various routes and passenger loadings. In all cases the monitoring has demonstrated that there is an elevated risk of pathogen exposure when travelling as a passenger on a bus if pathogenic particles are present.

Carbon dioxide levels correlated well with passenger numbers. Highest peaks and extended durations of elevated CO_2 levels were observed in the upper levels of double decker buses. Based on the gathered information, it is recommended that further mitigation to reduce pathogen exposure risk is investigated across all bus types.

If GWRC intend to trial mitigations by increasing the fresh air ventilation rate and wish to assess the effectiveness, then the following recommendations are made:

- Due to a high number of variables, an additional extended baseline should be established of CO_2 data across 3-4 days, within the same bus while controlling as many external variables as possible;

- Based on the pilot study results, there may not be the need to monitor the full range of bus types, and this should be determined by the potential mitigations and whether they can be equally applied to all bus types. As a minimum, sampling should still include both double decker and single decker buses.

- Collect information regarding how the buses ventilation systems operate and any external ventilation use (windows) by either recording or controlling its use (i.e. not able to be used);

- Continue to collect the high-resolution passenger numbers and bus timing information and on double decker buses include information of the patronage between upper and lower levels;

- Repeat the monitoring once mitigations are implemented and replicate the baseline survey as close as possible;

Carbon dioxide monitoring is not an appropriate method to measure the effectiveness of pathogen filtration within public transport as the pathogens will be filtered out, but carbon dioxide will not. If improved filtration is to be trialled, and its effectiveness measured, then an alternative methodology would need to be developed.

7. ACKNOWLEDGEMENTS

The author would like to thank staff at GWRC for assisting in organising the monitoring and logistics of this study. Thanks also to NZ Bus and Tranzurban for allowing access to the bus fleet and assisting with the installation and retrieval of the monitors.

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APPENDICES

APPENDIX A: EXAMPLE PHOTOS OF MONITORING LOCATIONS

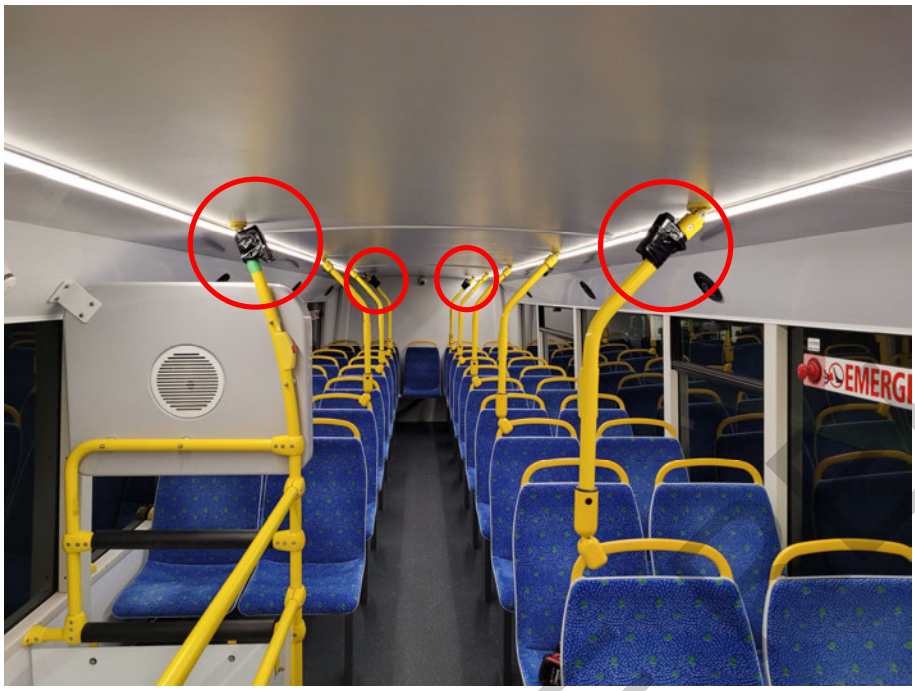

Figure 1. Example of the monitoring installation (red circles) in upper level of Bus 3701.

Figure 2. Example of the monitoring installation (red circles) in lower level of Bus 3701. Note on double decker buses the mid monitors were located back-to-back due to the location of the stairwell.

APPENDIX B: CO_2 TIME SERIES GRAPHS

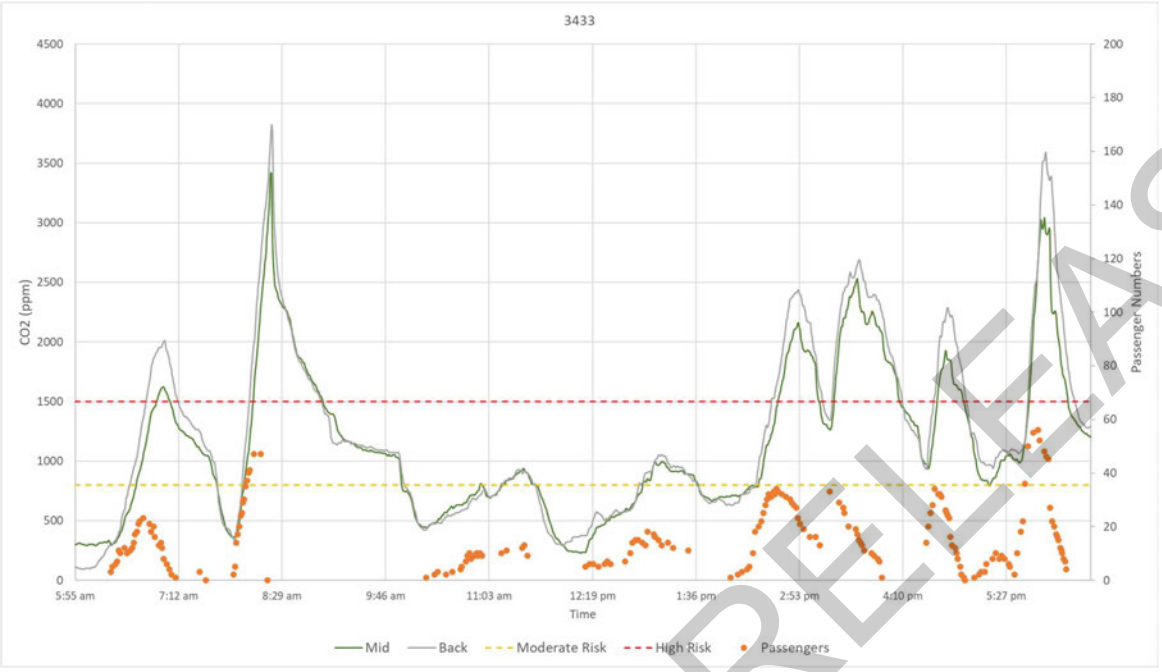

Figure 1. Bus 3433. Diesel (LV) monitored on 19 October 2022.

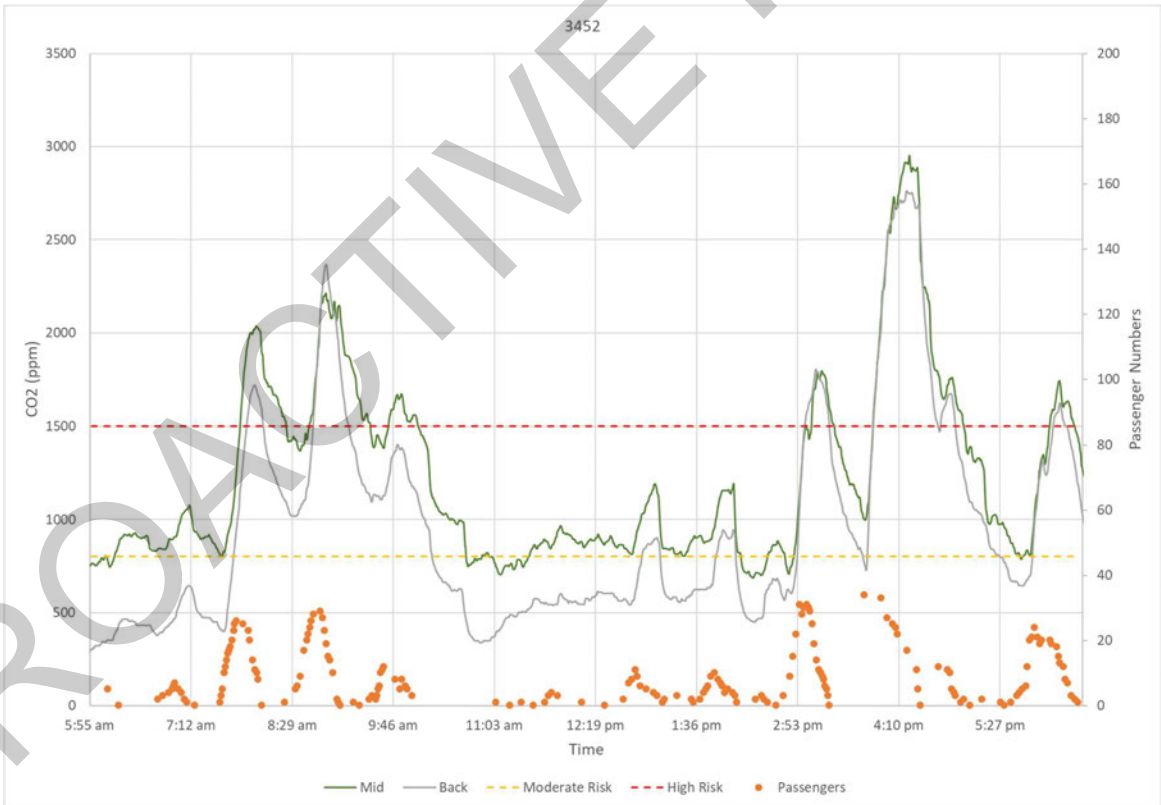

Figure 2. Bus 3452. Diesel (LV) monitored on 19 October 2022.

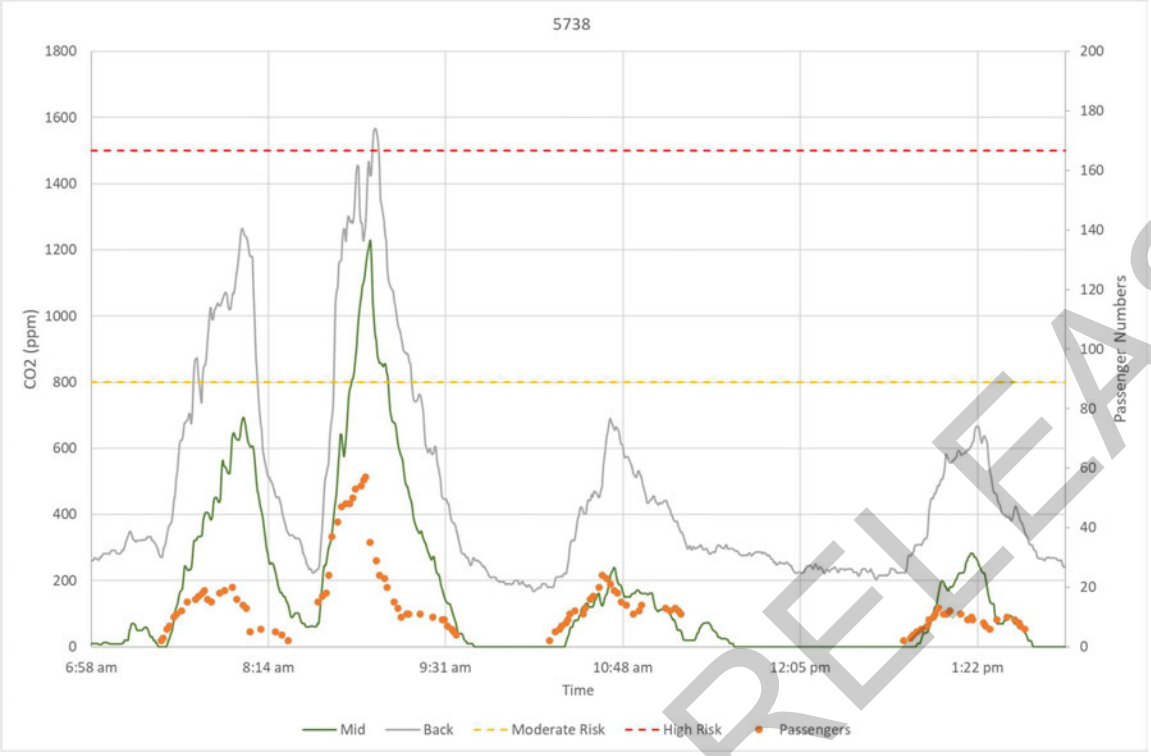

Figure 3. Bus 5738. Electric monitored on 18 October 2022. Note the Mid monitor's potential drift recording CO_2 concentrations of zero at times.

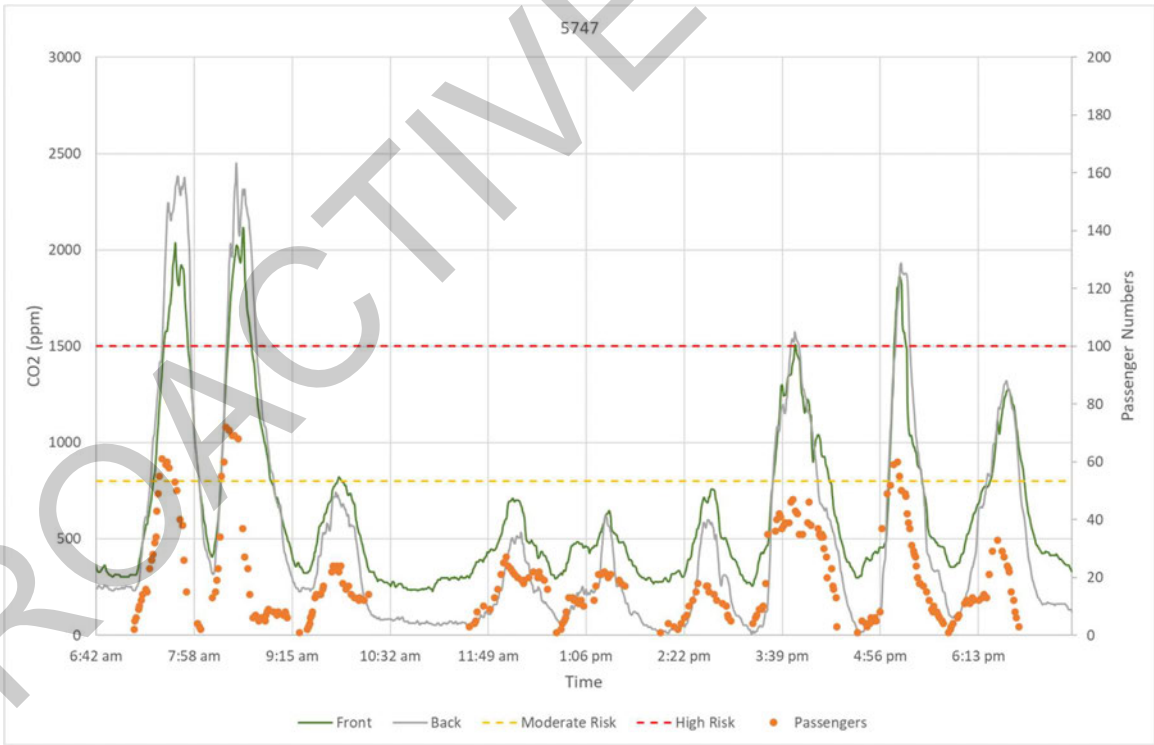

Figure 4. Bus 5747. Electric monitored on 18 October 2022.

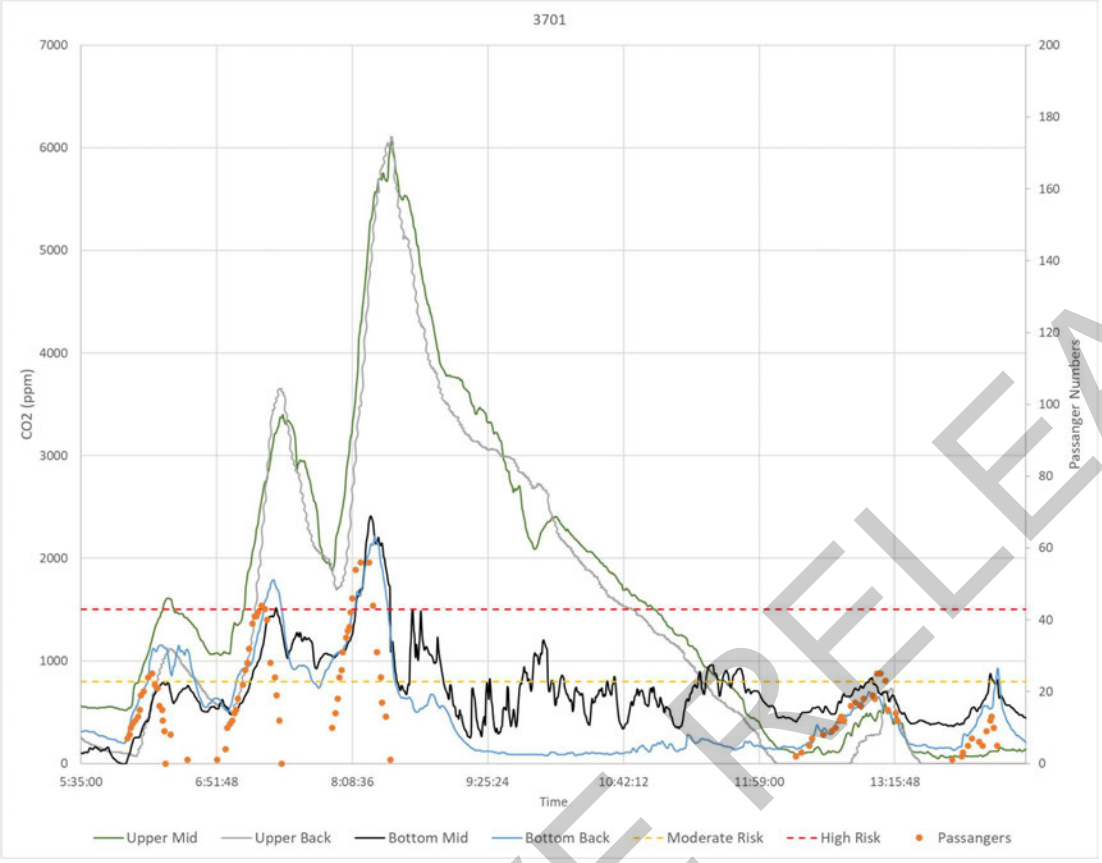

Figure 5. Bus 3701. Electric double decker monitored on 20 October 2022. Note the Upper Back monitor's potential drift recording CO_2 concentrations of zero at times.

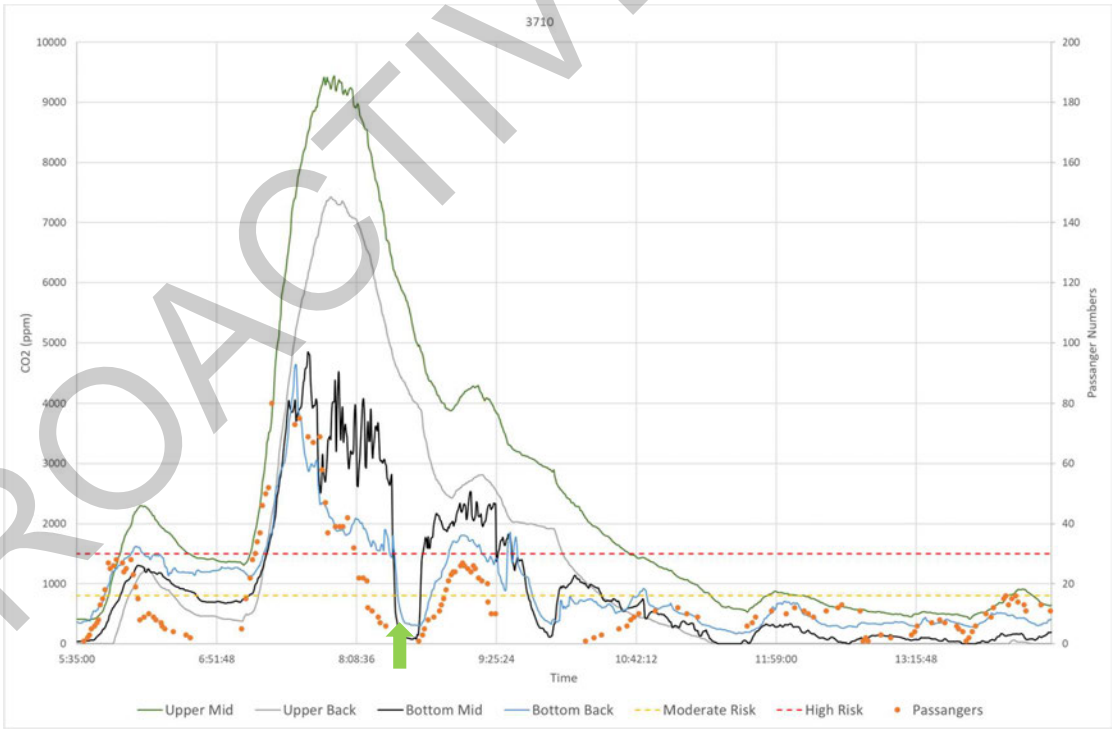

Figure 6. Bus 3710. Electric double decker monitored on 20 October 2022. Note Bottom Mid and Upper Back monitor's potential drift recording CO_2 concentrations of zero at times.

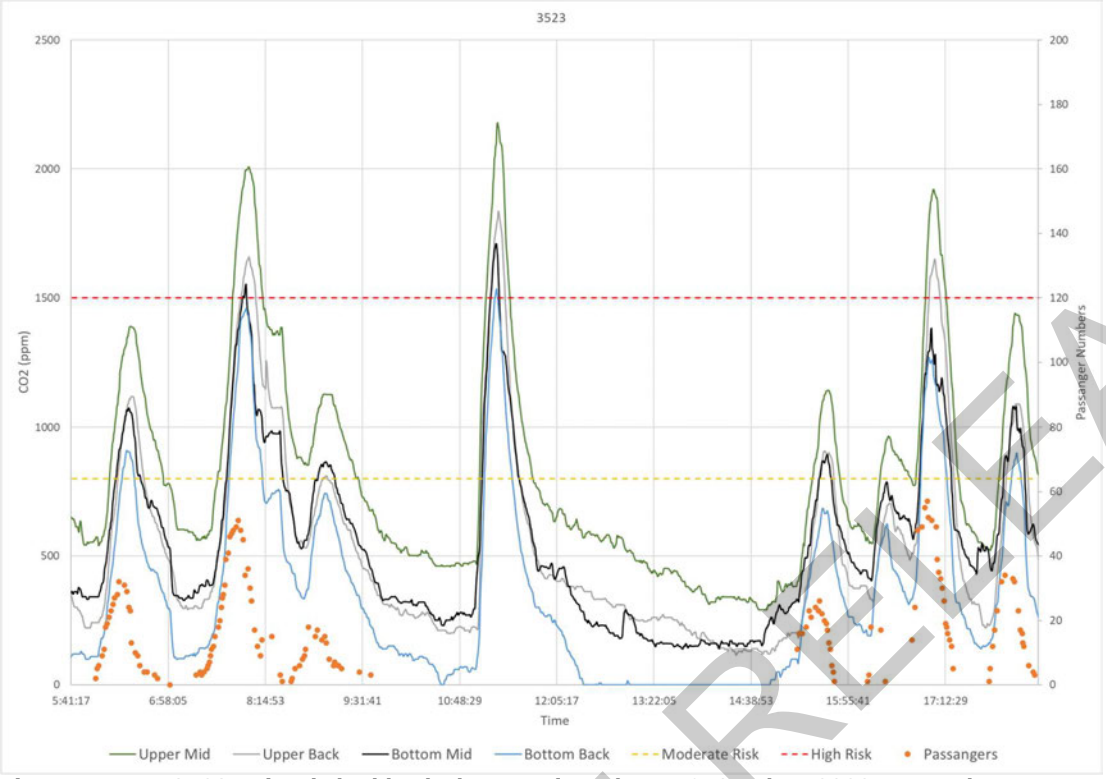

Figure 7. Bus 3523. Diesel double decker monitored on 19 October 2022. Note the Bottom Back monitor's potential drift recording CO_2 concentrations of zero at times. An increase in CO_2 between approximately 11am-midday is likely due to passengers however no passenger information was available over this period.

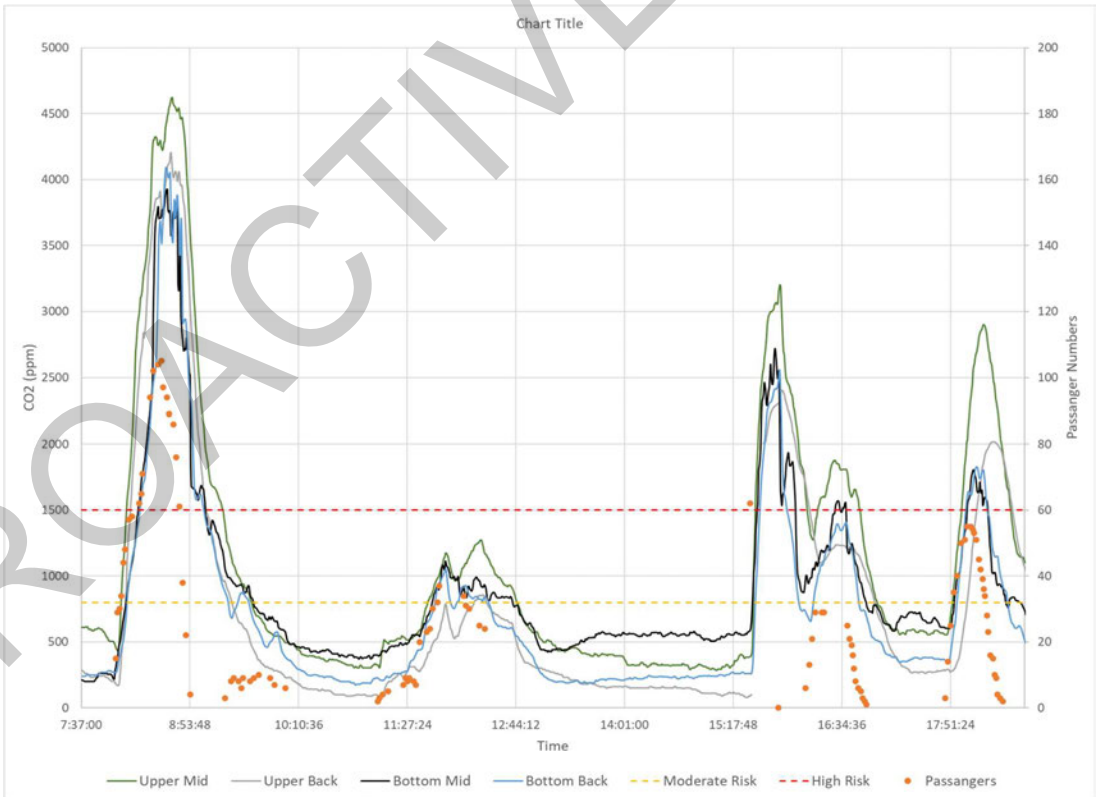

Figure 8. Bus 5083. Diesel double decker monitored on 18 October 2022. Note the gap in Upper Back CO_2 record from 15:31 – 15:39 when it is expected that the monitor was tampered with.

By email

2 May 2023

100 Cuba Street
Te Aro, Wellington 6011
PO Box 11646
Manners Street
Wellington 6142
T 04 384 5708
F 04 385 6960

Louise Karageorge - Group Manager, Intelligence, Surveillance & Knowledge
Louise.Karageorge@health.govt.nz
Imogen Roth - Manager, Scientific & Technical Advisory
Imogen.Roth@health.govt.nz
Ministry of Health

Tēnā Koe Louise and Imogen

Public health risk of CO2 from passenger respiration on urban buses

Attached is a copy of an investigation report into levels of CO2 from passenger respiration on board a sample of Wellington buses. As you may be aware, there has been interest in the media regarding the perceived COVID health issues associated with elevated CO2 levels in buses.

As such, we commissioned the study to ascertain the potential for viral illness spread in buses using CO2 levels as a proxy for this risk. The CO2 monitoring was carried out for Greater Wellington by Air Matters Ltd, occupational health specialists. The monitoring confirms that during periods of high passenger occupation, CO2 levels become elevated. As such, we can infer the risk of spread of viral illness increases proportionately.

GWRC (Greater Wellington Regional Council) does not have expertise in public health, therefore we are seeking the following from MoH:

1. Confirmation that meeting the NZ Workplace Exposure Standard for CO2 (being 5000 ppm (averaged over an 8-hr working day) and a short-term limit of 30,000 ppm (15-minute average) generally provides sufficient health protection for passengers from direct health effects of CO2 exposure.

2. Advice as to whether there are any medical conditions that could be vulnerable to elevated CO2 levels and what threshold might apply.

3. Confirmation that the relevant control for the elevated risk of viral transmission remains mask wearing.

4. Advice as to whether there are any other recommendations to protect public health given these CO2 monitoring findings.

5. Advice as to whether there is an intention to provide guidelines for ventilation and CO2 levels in the public transport environment in the future.

We believe the issue of elevated CO2 on urban buses is not unique to the Wellington fleet and any changes to standards or policy settings for ventilation on public transport should be part of a national strategy.

Nāku noa, nā

Fiona Abbott
Metlink Manager Assets and Infrastructure
Greater Wellington Regional Council

Encl: Metlink pilot monitoring study onboard air quality

TRANSDEV

WAIRARAPA SERVICE

WELLINGTON

AIR MATTERS REPORT 22228

Gas Monitoring on Wairarapa Service

Assessment Dates:	4/10/2022
	5/10/2022
Report Date:	16/11/2022
Amendment Date:	13/12/2022

T: +[redacted] / F: +[redacted] / E: [redacted]@airmatters.co.nz
[redacted] / W: airmatters.co.nz

Report prepared for TransDev by Air Matters Limited.

Sampling carried out by:

[redacted])

Environmental Technician

Report written by:

[redacted])

Environmental Technician

Report peer reviewed by:

[redacted]

Environmental Scientist

Air Matters Report:	22228
Date:	16/11/2022
Status:	Final
Amendments:	Provided clarifications on risk levels and guidelines relating to CO_2 monitoring.
	Included CO_2 WES for reference
	Included information on the length of peak NO_2 readings.
	Provided further detail on NO_2 comparisons with previous year of monitoring.
	Included notes on the use of air filtration systems and associated monitoring.

EXECUTIVE SUMMARY

A follow-up workplace exposure assessment for combustion gases (carbon monoxide and nitrogen dioxide) as well as an initial assessment of carbon dioxide was undertaken in TransDev passenger trains travelling between Masterton and Wellington. This assessment was performed on 4th October 2022 and 5th October 2022 by Alice Thomson of Air Matters Ltd. On each day, trains 1603, 1605, 1608 and 1610 were monitored. The assessment was requested by TransDev to gather further information on the current level of risk for operators working on these trains and due to further complaints from staff regarding health effects believed to be related to combustion gas exposure when working on these particular services. TransDev were also interested in determining the level of risk of airborne infectious agents being transmitted on their services by monitoring carbon dioxide concentrations as a proxy for ventilation.

Personal monitoring for carbon dioxide (CO_2), carbon monoxide (CO) and nitrogen dioxide (NO_2) was undertaken on one to three operators per train across the two days, with another four to five static locations also monitored for the gases per train per day. Notes were recorded down on how many people were in particular carriages, when the train was inside the tunnels and weather conditions inside the Remutaka tunnel across each journey.

CO_2 concentrations were frequently elevated inside the passenger carriages. Concentrations generally increased with passenger numbers, with the highest concentrations on train 1605. Concentrations were also most elevated when the trains were in the tunnels as the air intake vents were closed. Passenger numbers were still lower than normal so there is the possibility that passenger numbers and CO_2 concentrations could increase into the future. These factors all indicate that there is an increased risk of transmission of airborne infectious agents, if they are present in the carriages, if adequate controls are not in place. The risk increases with the amount of time spent in such an area.

Average NO_2 concentrations on the passenger trains were low. Multiple peaks in concentrations were measured in the vestibules and luggage carriages. Despite these elevated concentrations, the operator exposures were generally far lower as the operators are not located in these areas for extended periods of a shift. Concentrations in this round were generally more elevated than the previous round of monitoring, which covered train 1603. Average and maximum concentrations of CO were low on all trains across the two days. This is in line with previous exposure monitoring.

Controls that should be considered to keep gas concentrations low include:

- Increase the fresh air intake into the carriages when the train is outside the tunnels to reduce peak concentrations and help replace air inside the carriages after the tunnels.
- Increase the fan speed in the passenger carriages to help circulate the fresh air entering the carriage and ensure there are no dead pockets of air in the carriage.
- Continue to encourage people to evenly spread across the carriages.
- Continue to regularly maintain the locomotives to keep emissions low.
- Ensure the seals around the doors to the carriages are regularly maintained.
- Ensure operators spend as little time in the vestibules as possible when travelling through the tunnels as combustion gases were more elevated in these areas than the passenger carriages.

Further information on the controls can be viewed in Section 6 of this report.

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Terms and abbreviations

Terms & abbreviations	Explanation
HSWA	Health and Safety at Work Act 2015, New Zealand's workplace health and safety law.
HSW (GRWM)	Health and Safety at Work (General Risk and Workplace Management) Regulations 2016.
ppm	Parts of vapour or gas per million parts of air.
TWA	Timeweighted Average
WES	Workplace exposure standards
WES-TWA	The exposure standard for a time-weighted average airborne concentration of a substance calculated over an eight-hour working day.
WES-STEL	Short-term exposure limit. Typically, the 15-minute average short-term exposure limit.
WES-Ceiling	A concentration that should not be exceeded at any time during any part of the working day.
ACGIH	The American Conference of Governmental Industrial Hygienists
NIOSH	National Institute for Occupational Safety and Health
NMAM	NIOSH Manual of Analytical Methods
NZOHS	New Zealand Occupational Hygiene Society
AIHS	Australian Institute of Health and Safety

1. INTRODUCTION

A follow-up workplace exposure assessment for combustion gases (carbon monoxide and nitrogen dioxide) as well as an initial assessment of carbon dioxide was undertaken in TransDev passenger trains travelling between Masterton and Wellington. This assessment was performed on 4th October 2022 and 5th October 2022 by Alice Thomson of Air Matters Ltd. On each day, trains 1603, 1605, 1608 and 1610 were monitored. The assessment was requested by TransDev to gather further information on the current level of risk for operators working on these trains and due to further complaints from staff regarding health effects believed to be related to combustion gas exposure when working on these particular services. TransDev were also interested in determining the level of risk of airborne infectious agents being transmitted on their services by monitoring carbon dioxide concentrations as a proxy for ventilation.

Personal monitoring for carbon dioxide, carbon monoxide and nitrogen dioxide was undertaken on one to three operators per train across the two days, with another four to five static locations also monitored for these gases per train each day. Notes were recorded down on how many people were in the monitored carriages, what times the train was inside the tunnels and weather conditions inside the Remutaka tunnel across each journey.

This report presents a summary of the results, conclusions and recommendations in the body, with the monitoring methodology, exposure standards, full tables of results and additional site operation details in the appendices.

Results of exposure monitoring should be made readily accessible to any person at the workplace who may be exposed to the health hazard, however according to Section 32 of the Health and Safety at Work (General Risk and Workplace Management) Regulations 2016, any personal identifiers should remain confidential. An addendum to the report will be provided to TransDev which will identify the workers on whom personal testing was carried out. This is to remain confidential.

2. OBJECTIVES

1) To measure personal concentrations of carbon dioxide, carbon monoxide and nitrogen dioxide on operators working on passenger trains travelling between Masterton and Wellington across two separate days. Monitoring to take place on four trains per day.
2) To measure static concentrations of carbon dioxide, carbon monoxide and nitrogen dioxide in various locations inside passenger trains travelling between Masterton and Wellington across two separate days. Monitoring to take place on four trains per day.
3) To compare measurements against the Workplace Exposure Standards (WES), set by WorkSafe New Zealand, and other guidelines where applicable.
4) To provide recommendations around controls where required.

3. RESULTS

The tables below present a summary of some of the key results obtained from the study. Further information on the guidelines and exposure standards used in this report can be found in Appendix B. Tables containing the full list of results from all monitors have been included in the appendices and raw data is available on request.

Table 3.1: Summary of average and maximum CO_2 concentrations in TransDev passenger trains on 4th and 5th October 2022

Location & (fan speed)	Travel Direction	Date	Sampling Period	Average CO_2 (ppm)	Maximum CO_2 (ppm)
Servery (Low)	1603 Masterton to Wellington	4th October	6:00-8:28	**536**	**1227**
Passenger Carriage (High)				**521**	**1200**
Servery (Low)	1605 Masterton to Wellington		6:50-8:55	**1015**	**1539**
Passenger Carriage (High)				**354**	**1630**
Operator 2				**939**	**1552**
Servery (Low)	1608 Wellington to Masterton		17:50-19:20	**548**	**705**
Passenger Carriage (High)				**1178**	**1633**
Operator 3				**868**	**1410**
Servery (Low)	1610 Wellington to Masterton		18:18-20:08	**455**	**553**
Passenger Carriage 1 (High)				**623**	**743**
Passenger Carriage 2 (Low)				**1001**	**1365**
Servery (High)	1603 Masterton to Wellington	5th October	6:21-8:26	**587**	**994**
Passenger Carriage (Low)				**949**	**1738**
Servery (High)	1605 Masterton to Wellington		6:50-8:50	**923**	**1657**
Passenger Carriage (Low)				**1299**	**1823**
Servery (High)	1608 Wellington to Masterton	5th October	17:30-19:20	**663**	**834**
Passenger Carriage (Low)				**1189**	**1400**
Operator 14				**854**	**1509**
Operator 15				**867**	**1569**
Servery (High)	1610 Wellington to Masterton		18:18-20:10	**658**	**872**
Passenger Carriage (Low)				**861**	**1027**
Operator 18				**947**	**2880**
Ventilation Guideline:	<800ppm Low Relative Risk	800-1500ppm Increased Relative Risk		>1500ppm Higher Relative Risk	

The highest carbon dioxide concentrations were generally measured inside the passenger carriages when the fan setting was on low. There was also one instance where the concentrations were elevated in the servery when the fan setting was on low and in a passenger carriage when the fan was on high. Average concentrations were always low inside the vestibules and luggage compartments and were low for most of the operators aside from a few instances where the operators were working inside the

busier passenger carriages. Some maximum concentrations measured on operators and once in the passenger carriage were not considered to be elevated as the concentrations decreased again rapidly after the maximum concentration was recorded.

The passenger carriages had a higher seat capacity than the servery (around 64 seats compared to 37 seats), which meant that passenger numbers were higher in the passenger carriages than the servery. The overall passenger numbers were highest in train 1605, followed by train 1608, then train 1603 and lastly train 1610 each day. Further details on passenger numbers on each train can be viewed in Appendix A.

Table 3.2: Summary of average and maximum NO_2 concentrations in TransDev passenger trains on 4th and 5th October 2022

Location	Travel Direction	Date	Sampling Period	Average NO_2 (ppm)	Maximum NO_2 (ppm)
Luggage	1603 Masterton to Wellington	4th October	6:00-8:35	**0.07**	**1.9**
Vestibule	1605 Masterton to Wellington		6:50-8:55	**0.25**	**3.3**
Luggage				**0.43**	**3.4**
Passenger Carriage				**0.27**	**0.9**
Operator 2				**0.09**	**1.0**
Operator 5	1608 Wellington to Masterton		17:50-19:20	**0.38**	**1.3**
Vestibule	1603 Masterton to Wellington	5th October	6:21-8:26	**0.03**	**1.1**
Luggage				**0.06**	**1.2**
Vestibule 1	1605 Masterton to Wellington		6:50-8:50	**0.08**	**3.3**
Vestibule 2				**0.14**	**1.9**
Luggage				**0.07**	**2.7**
Luggage	1610 Wellington to Masterton		18:18-20:10	**0.02**	**1.5**
Exposure Guidelines – Time Weighted Average				1	-

The concentrations of nitrogen dioxide were generally most elevated inside the luggage compartment and in the vestibules across the days of monitoring, which are not frequently occupied. The three highest readings briefly exceeded 3ppm, which is the alarm level 2 for the TransDev monitors and were all measured in train 1605. The exceedances above 3ppm on 4th October lasted 30-40 seconds, and for 80 seconds on 5th October. Train 1605 is the last of three morning trains to move through the tunnel.

The average NO_2 concentrations for each journey were well below the workplace exposure standard of 1ppm. The concentrations were generally lowest in the passenger carriages followed by the servery carriage across the monitored journeys.

Table 3.3: Summary of average and maximum CO concentrations in TransDev passenger trains on 4th and 5th October 2022

Location	Travel Direction	Date	Sampling Period	Average CO (ppm)	Maximum CO (ppm)
Luggage	1603 Masterton to Wellington	4th October	6:00-8:28	**0.1**	**4**
Luggage	1605 Masterton to Wellington		6:50-8:55	**0.1**	**5**
Operator 5	1608 Wellington to Masterton		17:50-19:20	**8.7**	**13**
Luggage	1603 Masterton to Wellington	5th October	6:21-8:26	**0.2**	**5**
Vestibule 1	1605 Masterton to Wellington		6:50-8:50	**0.1**	**4**
Luggage				**0.1**	**4**
Operator 11				**0.5**	**26**
Luggage	1610 Wellington to Masterton		18:18-20:10	**<0.1**	**3**
Exposure Guidelines – Time Weighted Average and Ceiling				25	200

The carbon monoxide concentrations were very low across all monitored train journeys over the two days. The highest concentrations were measured on two operators who were noted as using hand sanitiser during the journey. Volatile organic compounds are known to interfere with the carbon monoxide gas sensor.

The next highest concentrations were measured in the luggage compartments and vestibules, with the concentrations never higher than 5ppm across the two days. Concentrations were not measured in any of the serveries or passenger carriages across the two days.

Limitations and assumptions of this report include:

- The sampling duration did not cover the entire work shifts of the workers as the focus of the monitoring was for each particular train journey. Operators could have other exposures to the monitored gases during different tasks in the middle of each day.
- It has been assumed that these results are representative of typical exposure for workers, however due to numerous variables affecting conditions between each journey, no statistical analysis has been carried out.
- There will be variations in exposure levels between workers in the way they carry out their jobs, as well as daily variation of exposure due to weather conditions, and carriage and locomotive conditions changing each day.
- Static samples cannot be directly compared to workplace exposure standards, however these can be used as a guideline to assess the potential level of risk in that area.

4. DISCUSSION

Carbon Dioxide

The carbon dioxide monitoring indicated that average concentrations were generally elevated between 800ppm and 1500ppm in the passenger carriages with multiple instances where concentrations were

elevated above 1500ppm for sections of the journeys. The monitoring suggests that if there are airborne infectious agents present, there is some risk of them being transmitted in these spaces if adequate controls are not in place.

Concentrations were generally lower in the servery carriages as there were less seats in these carriages than the fully dedicated passenger carriages, resulting in a slower build-up of carbon dioxide gas over time and lower maximum values. However, the concentrations in both the servery and the passenger carriages were variable over the days of monitoring.

The variation in concentrations could have been partially attributed to the differing passenger numbers across the different trains. Train 1610, which generally had the lowest carbon dioxide concentrations also had the lowest passenger numbers. The highest concentrations were generally on train 1605, which had the highest passenger numbers across the two days. For the morning trains the concentrations generally increased across the journey as more people entered the carriages. While the afternoon trains generally had the highest concentrations at the start of the journey and decreased over time as people exited the carriages.

The concentrations became elevated when the trains were moving through the Maymorn and Remutaka tunnels. TransDev noted that air intake into the carriages is shut off during this time to ensure that combustion gases do not enter the train and people are encouraged not to move between the carriages during this time. The fan speeds remained on the same level across the entire journey, however the fans only move the air around the carriage rather than affecting how much fresh air is moved into the carriage. The three graphs below demonstrate the changes in carbon dioxide across some of the train journeys on 4th and 5th October.

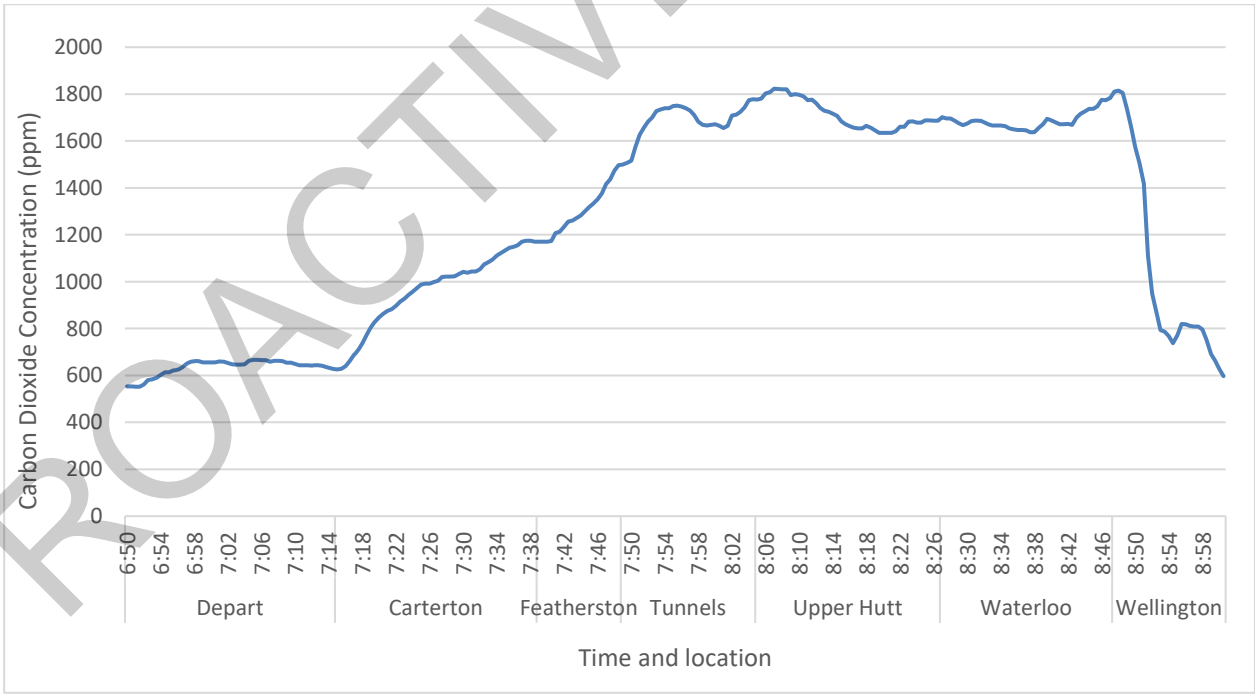

Figure 1: Graph showing carbon dioxide concentrations measured in the passenger carriage of train 1605 on 5th October with a low fan speed

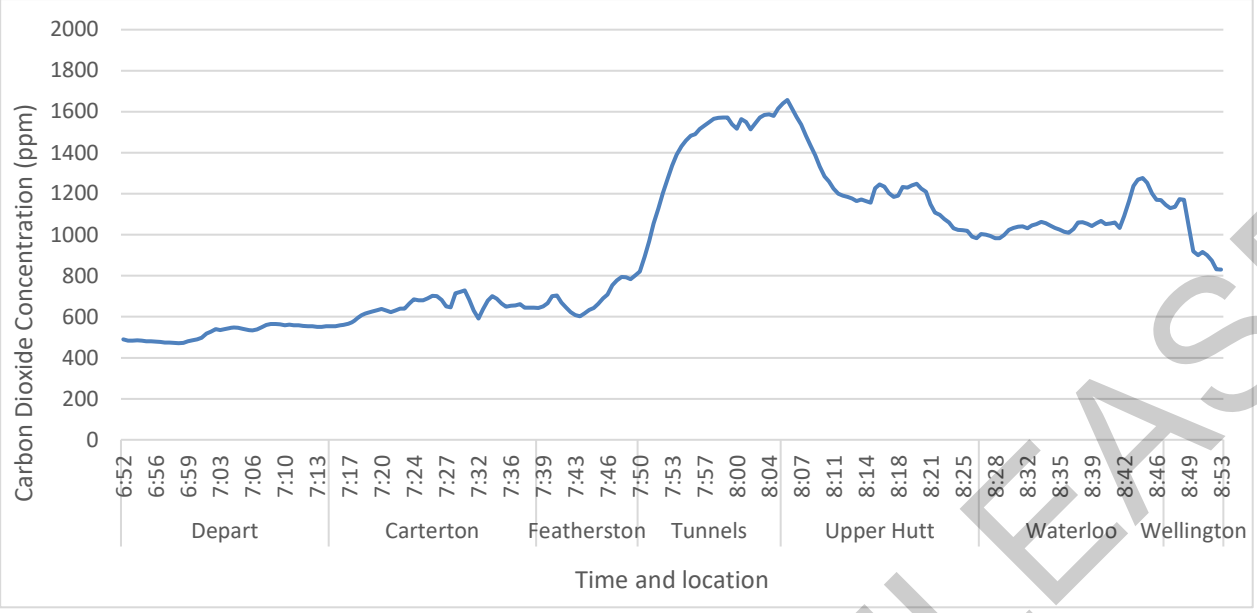

Figure 2: Graph showing carbon dioxide concentrations measured in the servery carriage of train 1605 on 5th October with a high fan speed

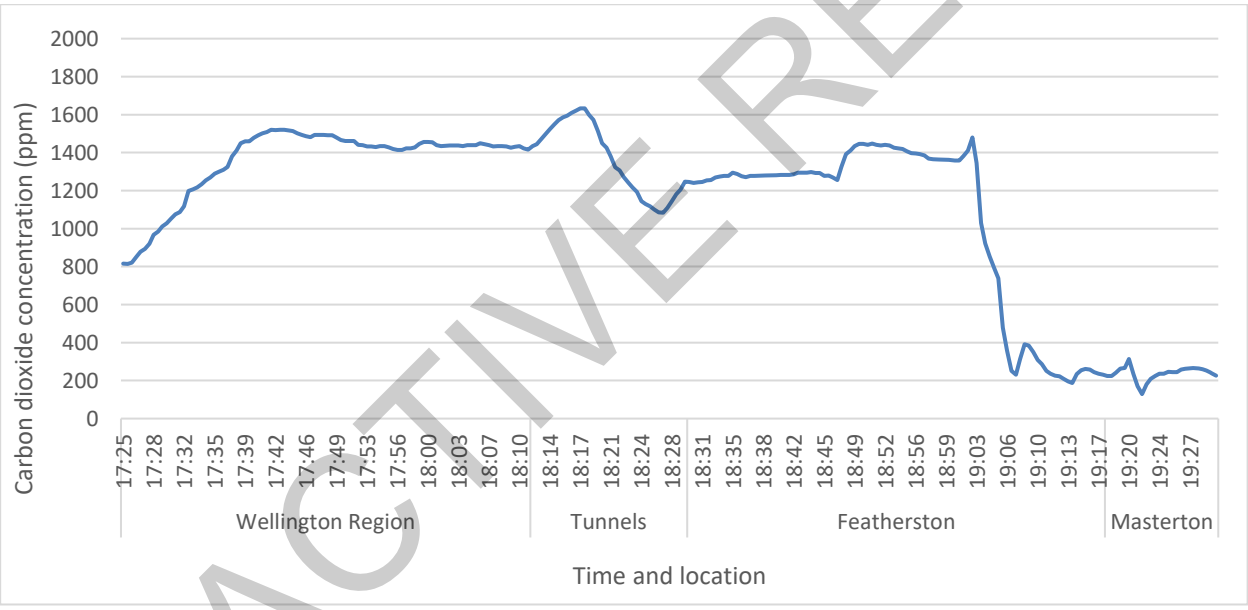

Figure 3: Graph showing carbon dioxide concentrations measured in the passenger carriage of train 1608 on 4th October with a high fan speed

Despite the general trends described above, there was still a large degree of variability in the concentrations between the different carriages on the train journeys. This is because there were several variables that affected the CO_2 levels, including changes in the passenger numbers along the journey, the carriage capacity and the fan speeds. It is also thought that in a small number of instances, the fan speed may not have been set to the correct setting that was noted for the trial however this cannot be confirmed.

TransDev noted that the passenger numbers on the two days of monitoring were normal compared to recent months, however numbers were still around 20% lower than the normal passenger numbers before COVID-19. It is likely that passenger numbers would increase again over time. Therefore,

carbon dioxide concentrations could increase into the future on these trains with increasing passenger numbers.

The average and maximum carbon dioxide concentrations were well below the relevant workplace exposure standards of 5,000ppm (Time Weighted Average) and 30,000ppm (Short Term Exposure Limit) across the two days of monitoring. It was therefore unlikely that the operators working in these train carriages would have experienced health effects from direct exposure to carbon dioxide.

Nitrogen Dioxide

The average nitrogen dioxide concentrations were low across all locations on each of the trains when compared to the guideline value of 1ppm. It should however be noted that the averages were undertaken across two-three-hour periods rather than a full 8-hour shifts, with operators covering one morning train and/or one afternoon train each day.

The highest maximum concentrations of 3.3ppm and 3.4ppm were measured in the vestibule and luggage compartments on train 1605 on 4th October, which also had two of the highest average concentrations of 0.43ppm and 0.25ppm. The concentrations were low before the Rematuka tunnel, then peaked inside the tunnel and gradually decreased back down after exiting both tunnels. Nitrogen dioxide was also measured up to 1ppm on operator 2 and up to 0.9ppm in the passenger carriage near the end of the tunnel during this journey. Two graphs showing the changes in nitrogen dioxide concentrations across train 1605's journey on 4th October are presented below. Train 1605 was the third passenger train to move through the tunnel within an hour each morning which is likely to be why this train experienced the highest gas concentrations.

There was only one other instance where nitrogen dioxide was measured above 1ppm on an operator across the two days and that was on operator 5 on train 1608 on 4th October. This operator had a maximum concentration of 1.3ppm which was measured near the end of the Rematuka tunnel. It was noted that in exceptional circumstances, operators sometimes must move between the carriages during the tunnel.

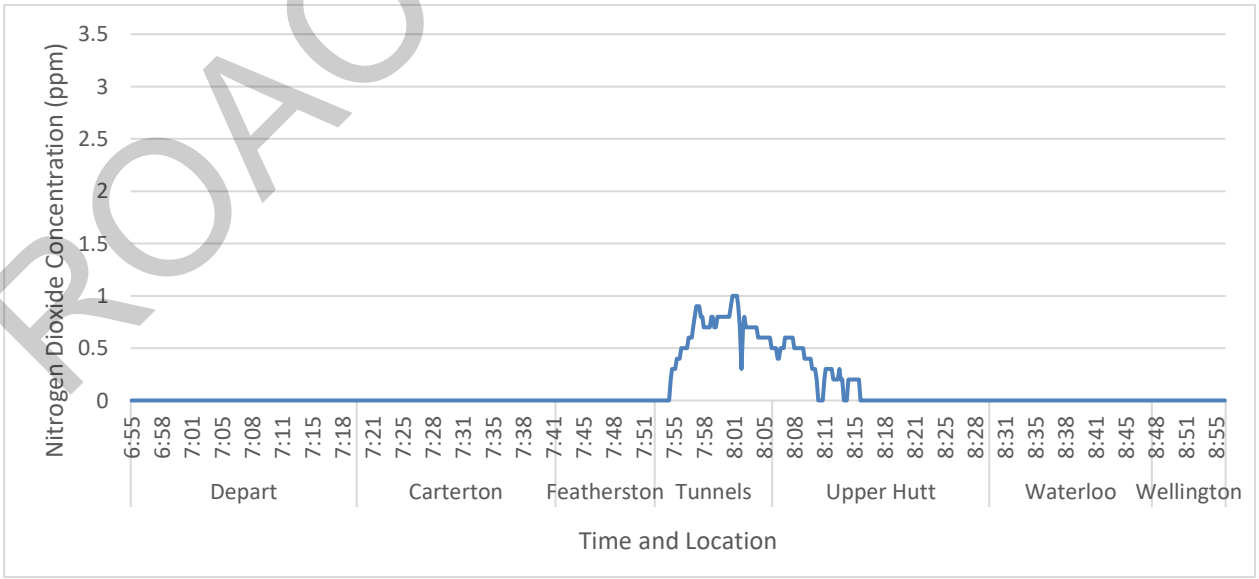

Figure 4: Graph showing nitrogen dioxide concentrations measured on operator 2 on train 1605 on 4th October

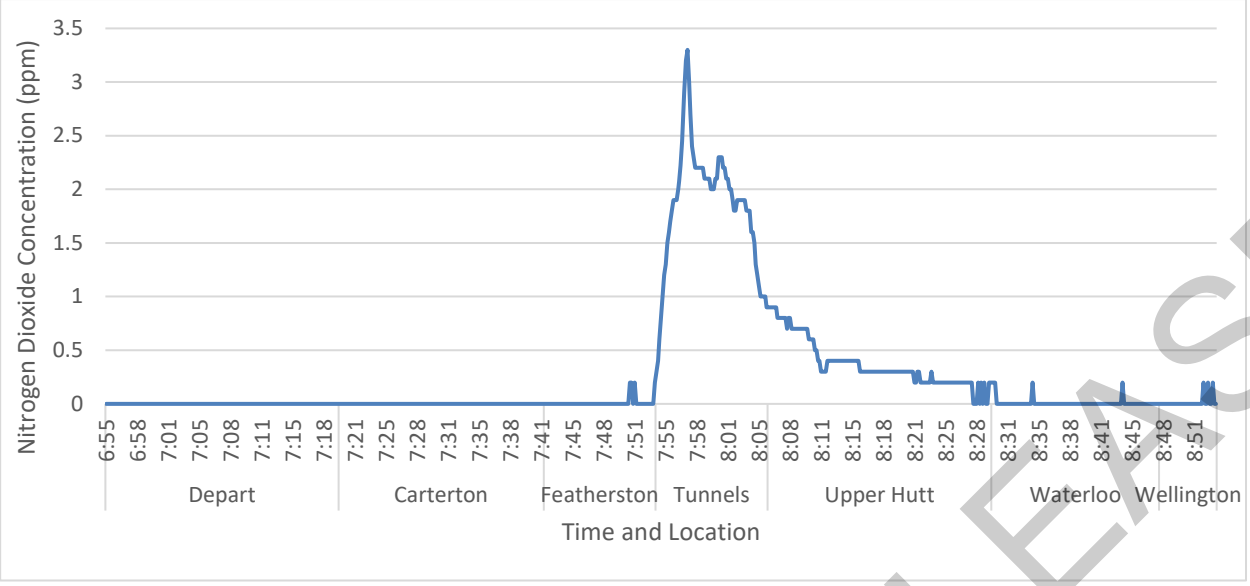

Figure 5: Graph showing nitrogen dioxide concentrations measured in the vestibule on train 1605 on 4th October

Despite the elevated peaks in concentrations measured in the vestibules and luggage compartments, operators are generally not stationed in these areas across the train journey, which means there is a lower risk of exposure. The concentrations were also only elevated for short periods of time, which means that if these areas can be avoided during the period of highest concentrations (during the Remutaka tunnel) then the operators' average exposures are likely to remain low.

Nitrogen dioxide monitoring undertaken by Air Matters in 2018 was only undertaken on Train 1603 as well as the train returning to Masterton at 8:30. Concentrations from the 2022 monitoring were similar in the passenger carriages but were higher than the 2018 results for the luggage and vestibule areas. It should be noted that there are issues with directly comparing the results from previous years due to a number of variables changing, including weather conditions and the locomotive and carriage numbers. However, since concentrations inside the passenger carriages had not increased despite levels being higher in the vestibules, this indicates that the controls introduced, such as improved door seals, might be effective at keeping concentrations down.

The Scientific Committee on Occupational Exposure Limits (SCOEL) have looked at peak exposures of nitrogen dioxide and noted that effects on the lungs can occur at low levels of exposure given sufficient duration of exposure. Human volunteer studies in which exposure at 1.5 ppm or higher for three hours showed bronchial reactivity. Based on the peaks measured in this exercise, it is not expected that these health effects would occur as they occur for a much shorter time period. However, it is essential that an Occupational Physician or Toxicologist reviews this data to confirm the above statement and to give some advice regarding chronic exposure to low levels of nitrogen dioxide.

Carbon Monoxide

The average carbon monoxide concentrations were all very low across the monitored journeys. There were only eight instances where CO was detected across the two days and most of those were in the luggage compartment, which was beside the diesel generator. There were also two occasions where concentrations were detected on an operator who was noted as using hand sanitiser. These gas

monitors are known to have cross sensitivities with volatile organic compounds. These concentrations were in line with other round of monitoring by Air Matters in 2018 on these trains and indicates that the risk of exposure to carbon monoxide on these trains is low.

5. CONCLUSION

Carbon dioxide concentrations were frequently elevated inside the passenger carriages on the trains across the two days of monitoring. Concentrations generally became more elevated as the number of passengers in the carriages increased, which resulted in the highest concentrations being measured on train 1605. Concentrations were also most elevated during the period where the trains were moving through the tunnels as the air intake vents were closed to ensure that combustion gases did not enter the train. Passenger numbers were still lower than the normal numbers experienced on the trains prior to 2020 so there is the possibility that carbon dioxide concentrations could increase on these trains into the future with increased passenger numbers. These factors all indicate that there is an increased risk of transmission of airborne infectious agents, if they are present in the carriages, if adequate controls are not in place.

Average nitrogen dioxide concentrations measured on the passenger trains were low across the two days of monitoring. Multiple peaks in concentrations were measured in static locations in the train, with the highest concentrations generally detected in the vestibules and luggage carriages. The operator maximum exposures were generally lower than these concentrations as the operators were not located in these areas for extended periods of a shift.

Average and maximum concentrations of carbon monoxide were low on all trains across the two days. This is in line with previous exposure monitoring. Diesel exhaust generally does not produce high levels of carbon monoxide, therefore it is likely that the carbon monoxide is not a hazard for operators on these trains. No further actions are required.

6. RECOMMENDATIONS

Worker exposures to gases must be kept as low as reasonably achievable below the workplace exposure standard. There is an expectation in the Health and Safety at Work Act that risks are eliminated so far as is reasonably practicable. If risks cannot be eliminated, employers must ensure the risk of exposure are minimised so far as is reasonably practicable by implementing controls in accordance with the hierarchy of controls, with the use of personal protective equipment being the least protective.

The following recommendations are provided as examples of ways of working through the hierarchy of controls to protect workers. Some of the recommendations may not be appropriate for the site and have not been assessed as to whether they are reasonably practicable. This list of recommendations is not exhaustive and other controls could be considered to ensure the risks remain low.

Air Matters recommends the following:

1. **Engineering controls**
    - Increase the fresh air intake into the carriages across the entire journey besides the period where the train is inside the tunnels. Investigation should also be undertaken to determine if the air intake could turn back on in between the Remutaka tunnel and Maymorn tunnel.
        - Increased fresh air will ensure that the CO_2 concentrations in the carriage before the tunnels are as low as possible to reduce the peak in concentrations during the tunnels
        - Increased fresh air after the tunnels will help replace the air inside the carriages faster, which will help reduce CO_2 as well as ensuring that any combustion gases that leaked into the carriages are expelled.
    - Increase the fan speed in the passenger carriages, which could help circulate the fresh air entering the carriage and ensure there are no dead pockets of air in the carriage. Further investigation would be required to determine if this control is working as monitoring in this study was somewhat inconclusive.
    - Air filtration systems for recirculated air could be considered in the passenger carriages to remove airborne infectious agents.
    - Continue to ensure that the locomotives are regularly maintained to keep the emitted combustion gases as low as possible.
    - Ensure the seals around the doors to the carriages are regularly maintained to limit the amount of combustion gas entering the carriages from the vestibules.
2. **Administrative controls**
    - Continue to encourage people to move through the carriages to find a spare seat rather than all passengers packing into one or two carriages.
    - Ensure operators spend as little time in the vestibules as possible when travelling through the tunnels. This will help to keep the combustion gases exposures low as the concentrations were always lower in the passenger carriages.
3. **Monitoring & assessments**

    As this operation has variable exposure conditions, routine exposure monitoring and health monitoring is important.

    - Sampling in this exercise is representative of the conditions at the time (i.e. natural ventilation through tunnel, condition of carriages and locomotives etc.) which can vary from day to day, therefore, it is recommended that an ongoing occupational hygiene and exposure monitoring programme is implemented to gather more information around actual exposures in the workplace. Further monitoring could be undertaken once controls have been implemented or if there are significant changes to the train journeys.
    - If air filtration systems are installed in the carriages, then carbon dioxide monitoring would not be appropriate to determine if the risk level has changed. This is because the air filters would not remove any carbon dioxide and therefore the relationship between carbon dioxide and concentrations of infectious agents' changes.

7. REFERENCES

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9) Air Matters, TransDev, Testing of nitrogen dioxide and carbon monoxide on the Wairarapa Service, Report 18090 (2018).
10) SCOEL (2014). Scientific Committee on Occupational Exposure Limits Recommendation on Occupational Exposure Limits for Nitrogen Dioxide 2014 SCOEL/SUM/53. http://ec.europa.eu/social/main.jsp?catId=148&intPageId=684&langId=en
11) WorkSafe, 2018. Workplace Exposure Standard (WES) Review, Nitrogen Dioxide.

APPENDICES

APPENDIX A: MONITORING DETAILS

OPERATING CONDITIONS

The following tables present the weather data and time that each train reached certain points along its journey as well as the person count in the servery and the passenger carriage where the gas monitors were set up on that particular journey. The servery carriages have 37 seats, and the passenger carriages have 64 seats. A count of the people in the passenger carriage was not provided for train 1603.

Table A.1: Wind speed and direction data measured in Remutaka Tunnel on 4th-5th October 2022

Variables		4th Morning	4th Evening	5th Morning	5th Evening
Average Wind Speed (m/s)	Both Portals	0.5	1.8	2.6	0.8
Average Wind Direction	Portal 1	10° Towards P2	185° Towards P1	191° Towards P1	195° Towards P1
	Portal 2	190° Towards P1	190° Towards P1	185° Towards P1	105° Towards P1

Table A.2: Journey times and passenger numbers for morning trains on 4th October 2022

4th October 2022 Morning Trains – Masterton to Wellington						
Passenger Train Details	1603			1605		
	Time	No. of Passengers		Time	No. of Passengers	
		Servery	Passenger		Servery	Passenger
Masterton	6:22	1	-	6:55	13	18
Featherston	-	21	-	7:43	32	58
Remutaka Tunnel	7:21	21	-	7:53-8:01	32	58
Maymorn Tunnel	-	21	-	8:05	32	58
Upper Hutt	-	21	-	8:11	31	58
Waterloo	-	23	-	8:30	33	55
Wellington	8:28	24	-	8:52	34	57

Table A.3: Journey times and passenger numbers for afternoon trains on 4th October 2022

4th October 2022 Afternoon Trains – Wellington to Masterton						
Passenger Train Details	1608			1610		
	Time	No. of Passengers		Time	No. of Passengers	
		Servery	Passenger		Servery	Passenger
Wellington	17:30	23	41	18:18	8	13
Waterloo	-	25	42	18:35	10	14
Upper Hutt	-	20	40	18:53	8	12
Maymorn Tunnel	18:13	20	40	19:01	8	12
Remutaka Tunnel	18:18-18:26	20	40	19:05-19:14	8	12
Featherston	-	11	33	19:22	5	7
Masterton	19:19	4	16	20:08	5	5

Table A.4: Journey times and passenger numbers for morning trains on 5th October 2022

5th October 2022 Morning Trains – Masterton to Wellington						
Passenger Train Details	1603			1605		
	Time	No. of Passengers		Time	No. of Passengers	
		Servery	Passenger		Servery	Passenger
Masterton	6:21	2	3	6:52	9	13
Featherston	-	17	35	7:40	35	64
Remutaka Tunnel	7:16-7:25	17	35	7:49-7:58	35	64
Maymorn Tunnel	-	17	35	8:02	35	64
Upper Hutt	-	23	43	8:08	37	60
Waterloo	-	30	49	8:27	36	61
Wellington	8:26	31	64	8:47	38	61

Table A.5: Journey times and passenger numbers for afternoon trains on 5th October 2022

5th October 2022 Afternoon Trains – Wellington to Masterton						
Passenger Train Details	1608			1610		
	Time	No. of Passengers		Time	No. of Passengers	
		Servery	Passenger		Servery	Passenger
Wellington	17:30	23	41	18:18	8	13
Waterloo	-	25	42	18:35	10	14
Upper Hutt	-	20	40	18:53	8	12
Maymorn Tunnel	18:13	20	40	19:01	8	12
Remutaka Tunnel	18:18-18:26	20	40	19:05-19:14	8	12
Featherston	-	11	33	19:22	5	7
Masterton	19:19	4	16	20:08	5	5

METHODOLOGY

Ventis Pro and MX4 monitors were used to measure carbon monoxide and nitrogen dioxide concentrations on the trains across the two days of monitoring. These monitors were provided by Entec and were calibrated as well as bump tested before use. These monitors were deployed in personal and static locations on each of the trains across the two days and were fresh air calibrated before each journey. The monitors used on each train are provided in the table below.

CO2 Meters San-11 were used to measure carbon dioxide concentrations on the trains across the two days of monitoring. These were purchased from Accurate Instruments and have factory calibration from 7th September 2022. These monitors were deployed in personal and static locations on each of the trains across the two days and were fresh air calibrated before each journey. The monitors used on each train are provided in the table below.

Table A.6: Gas monitors used on each train across the two days of monitoring

Monitor	Serial Number	4th Morning	4th Evening	5th Morning	5th Evening
Ventis Pro	20033WM-002	Train 1603	Train 1608	Train 1605	Train 1608
Ventis Pro	17083PN-010	Train 1603	Train 1610	Train 1605	Train 1610
Ventis Pro	17083PN-011	Train 1605	Train 1608	Train 1605	Train 1610
Ventis Pro	17033E4-001	Train 1605	Train 1610	Train 1605	Train 1608
Ventis Pro	17033E4-003	Train 1603	Train 1608	Train 1603	Train 1610
Ventis Pro	17060VU-015	Train 1605	Train 1610	Train 1603	Train 1608
Ventis Pro	17013NY-029	Train 1603	Train 1610	Train 1603	Train 1608
Ventis Pro	17101NC-003	Train 1605	Train 1610	Train 1605	Train 1608
Ventis Pro	17083PN-004	Train 1603	Train 1610	Train 1603	Train 1610
Ventis Pro	17083PN-009	Train 1605	Train 1608	Train 1603	Train 1610
Ventis Pro	20033WM-002	-	Train 1608	Train 1603	Train 1608
Ventis Pro	21043JU-005	-	Train 1608	Train 1605	Train 1610
Ventis Pro	17083PN-012	-	Train 1610	Train 1605	Train 1608
Ventis Pro	17013NY-031	-	Train 1608	Train 1603	Train 1610
Ventis MX4	220326H-036	-	-	Train 1605	-
CO2 Meter	Monitor 1	Train 1605	Train 1610	Train 1603	Train 1608
CO2 Meter	Monitor 2	Train 1605	Train 1608	Train 1603	Train 1610
CO2 Meter	Monitor 3	Train 1605	Train 1608	Train 1605	Train 1608
CO2 Meter	Monitor 4	Train 1603	Train 1608	Train 1603	Train 1608
CO2 Meter	Monitor 5	-	Train 1610	Train 1605	Train 1608
CO2 Meter	Monitor 6	Train 1603	Train 1608	Train 1603	Train 1610
CO2 Meter	Monitor 7	Train 1605	Train 1610	Train 1605	Train 1610
CO2 Meter	Monitor 8	Train 1605	Train 1608	Train 1603	Train 1608
Etrex GPS	GPS 1	Train 1603	Train 1608	Train 1603	Train 1610
Etrex GPS	GPS 2	Train 1605	Train 1610	Train 1605	Train 1608

APPENDIX B: EXPOSURE STANDARDS, GUIDELINES & HEALTH EFFECTS

Workplace Exposure Standards (WES) can only be used as guidelines in making decisions regarding safe levels of exposure to various chemical agents found in the workplace. The standards are based on available information and suggest a level of exposure that the typical worker can experience without adverse health effects. There is no definitive line between safe and dangerous exposures and the recommendation of agencies publishing these figures is that the concentrations should be kept as low as possible.

Compliance with the designated values does not guarantee protection from discomfort or possible ill health for workers. Individual susceptibility and exposure outside the workplace may lead to a varying response. More importantly there is an expectation in the legislation that employee exposure to hazardous substances will be controlled to a level as far below the relevant WES as practicable by applying the hierarchy of control required by the Health and Safety at Work (General Risk and Workplace Management) Regulations 2016 under the Health and Safety at Work Act 2015.

The health effects and applicable Workplace Exposure Standards (WES) referred to in this assessment are presented in the table below.

Combustion Gases

Table B 1: Exposure standards and health-based guidelines

Substance	Workplace Exposure Standard (ppm)			Health effects
	WES-TWA	WES-STEL	WES-Ceiling	
Carbon monoxide	20	100	200	Symptoms of CO exposure may range from headaches and dizziness to nausea, rapid breathing, unconsciousness and death
Nitrogen dioxide	1	-	-	May cause severe breathing difficulties and irritation to eyes, nose, throat and skin.

The new carbon monoxide exposure standards were adopted in 2022. The nitrogen dioxide exposure standard was adopted in 2020 and will be reviewed again in 2022.

Carbon Dioxide

Carbon dioxide monitoring can either be used to directly assess potential health effects from carbon dioxide exposure as well as an indicator of indoor air quality.

Indoor air quality

Carbon dioxide monitoring is used extensively as an indicator of ventilation efficiency in indoor spaces and has been accepted as a surrogate indicator which can be used to help assess the potential risk of infection of airborne infectious agents in indoor spaces. Carbon dioxide levels, produced from human respiration, provides information about the possible build-up and removal of this human-produced gas via ventilation.

Action limits for indoor carbon dioxide were reported by the OzSAGE (a multi-disciplinary network of Australian experts set up to provide advice on public health, health systems and policy matters

relevant to COVID-19 control during the opening up of Australia) in 2021 and have been used for this project to assess the risk level for transmission.

The following limits are specifically set for restaurants, bars and shops, and are therefore not specifically for public transport. However, train carriages are enclosed environments where people cannot socially distance easily and as such, the building guidelines below have been considered applicable for airborne infectious agent risk assessment.

It should also be noted that these action limits refer to relative risk, which is due to the carbon dioxide measurements only being an indicator of air quality in the space. This means that, if there are elevated CO_2 levels, the risk of infection is only high if the infectious agents are actually present in the air within that space. The risk is also time dependent, with the more time spent in an area with moderate or high relative risk, increasing the risk of infection.

Action limits should be applied as per below:

- CO_2 levels below 800ppm indicate a low relative risk of infection
- CO_2 levels between 800ppm and 1,500ppm indicates a moderate relative risk of infection. Improvements should be made where practicable to increase the provision of fresh air into the indoor space.
- CO_2 levels above 1,500ppm indicate a high relative risk of infection. Immediate improvements must be made to increase the provision of fresh air into the indoor space or air filters must be operational.

Workplace Exposure Standards

Carbon dioxide exposure can also lead to adverse health effects at high levels. The WorkSafe NZ's Workplace Exposure Standards (WES) for CO_2 are 5,000ppm averaged over an 8-hour shift and 30,000ppm averaged over a 15-minute period. At 5,000ppm health effects such as headaches, drowsiness and nausea can be felt, with concentrations around 30,000ppm being more closely linked with asphyxiation. Given WES are intended for persons in the workforce (healthy individuals) and over work timeframes, they are not likely to be appropriate for assessing the potential health effects for all persons on public transport.

APPENDIX C: DATA SHEETS AND RESULTS

Morning 4th October

Table C.1: Average and maximum CO_2 concentrations measured in passenger trains on 4th October

Location	Carriage No.	Travel Direction	Sampling Period	Average CO_2 (ppm)	Maximum CO_2 (ppm)
Servery (Low)	-	1603 Masterton to Wellington	6:00-8:28	537	1227
Passenger Carriage (High)	SE3288			521	1200
Vestibule	SE3380			-	-
Luggage	-			211	500
Operator 1	-			597	1091
Servery (Low)	SW3298	1605 Masterton to Wellington	6:50-8:55	1016	1539
Passenger Carriage (High)	-			355	1630
Vestibule	SW5820			554	3303
Luggage	SWG3365			429	953
Operator 2	Passenger			939	1552

Table C.2: Average and maximum NO_2 concentrations measured in passenger trains on 4th October

Location	Carriage No.	Travel Direction	Sampling Period	Average NO_2 (ppm)	Maximum NO_2 (ppm)
Servery (Low)	-	1603 Masterton to Wellington	6:00-8:35	0.02	0.6
Passenger Carriage (High)	SE3288			0.03	0.5
Vestibule	SE3380			-	-
Luggage	-			0.07	1.9
Operator 1	-			-	-
Servery (Low)	SW3298	1605 Masterton to Wellington	6:50-8:55	0.07	0.8
Passenger Carriage (High)	-			0.27	0.9
Vestibule	SW5820			0.25	3.3
Luggage	SWG3365			0.43	3.4
Operator 2	Passenger			0.09	1.0

Table C.3: Average and maximum CO concentrations measured in passenger trains on 4th October

Location	Carriage No.	Travel Direction	Sampling Period	Average CO (ppm)	Maximum CO (ppm)
Servery (Low)	-	1603 Masterton to Wellington	6:00-8:28	0	0
Passenger Carriage (High)	SE3288			0	0
Vestibule	SE3380			-	-
Luggage	-			0.1	4
Operator 1	-			0	0
Servery (Low)	SW3298	1605 Masterton to Wellington	6:50-8:55	0	0
Passenger Carriage (High)	-			0	0
Vestibule	SW5820			0	0
Luggage	SWG3365			0.1	5
Operator 2	Passenger			0	0

Afternoon 4th October

Table C.4: Average and maximum CO_2 concentrations measured in passenger trains on 4th October

Location	Carriage No.	Travel Direction	Sampling Period	Average CO_2 (ppm)	Maximum CO_2 (ppm)
Servery (Low)	-	1608 Wellington to Masterton	17:50-19:20	548	705
Passenger Carriage (High)	SW3349			1178	1633
Vestibule	SWG3365			800	1703
Luggage	SWG3365			-	-
Operator 3	Manager			868	1410
Operator 4	Servery			311	1500
Operator 5	Passenger			518	1500
Servery (Low)	SWS5660	1610 Wellington to Masterton	18:18-20:08	455	553
Passenger 1 (High)	SW3394			623	743
Passenger Carriage 2 (Low)	SW3355			1001	1365
Vestibule 1	SW3355			179	318
Luggage	SWG3422			-	-
Operator 6	Server			470	900
Operator 7	Passenger			260	700

Table C.5: Average and maximum NO_2 concentrations measured in passenger trains on 4th October

Location	Carriage No.	Travel Direction	Sampling Period	Average NO_2 (ppm)	Maximum NO_2 (ppm)
Servery (Low)	-	1608 Wellington to Masterton	17:50-19:20	0	0
Passenger Carriage (High)	SW3349			0	0
Vestibule	SWG3365			0.22	0.4
Luggage	SWG3365			0.01	0.3
Operator 3	Manager			0	0
Operator 4	Servery			0	0
Operator 5	Passenger			0.38	1.3
Servery (Low)	SWS5660	1610 Wellington to Masterton	18:18-20:08	0.07	0.3
Passenger Carriage (High)	SW3394			0	0
Vestibule 1	SW3355			0.03	0.3
Vestibule 2	SW3355			0.12	0.3
Luggage	SWG3422			0.01	0.3
Operator 6	Server			<0.01	0.2
Operator 7	Passenger			0	0

Table C.6: Average and maximum CO concentrations measured in passenger trains on 4th October

Location	Carriage No.	Travel Direction	Sampling Period	Average CO (ppm)	Maximum CO (ppm)
Servery (Low)	-	1608 Wellington to Masterton	17:50-19:20	0	0
Passenger Carriage (High)	SW3349			0	0
Vestibule	SWG3365			0	0
Luggage	SWG3365			0	0
Operator 3	Manager			0	0
Operator 4	Servery			0	0
Operator 5	Passenger			8.7	13
Servery (Low)	SWS5660	1610 Wellington to Masterton	18:18-20:08	0	0
Passenger Carriage (High)	SW3394			0	0
Vestibule 1	SW3355			0	0
Vestibule 2	SW3355			0	0
Luggage	SWG3422			0	0
Operator 6	Server			0	0
Operator 7	Passenger			0	0

Morning 5th October

Table C.7: Average and maximum CO_2 concentrations measured in passenger trains on 5th October

Location	Carriage No.	Travel Direction	Sampling Period	Average CO_2 (ppm)	Maximum CO_2 (ppm)
Servery (High)	SWS5723	1603 Masterton to Wellington	6:21-8:26	587	994
Passenger Carriage (Low)	SE3288			949	1738
Vestibule	SE2380			509	2100
Luggage	SWG5671			218	600
Operator 8	Luggage			802	2310
Operator 9	Server			480	779
Operator 10	Passenger			836	1566
Servery (High)	SWS3298	1605 Masterton to Wellington	6:50-8:50	923	1657
Passenger Carriage (Low)	SW5658			1299	1823
Vestibule 1	SWS5820			-	-
Luggage	SWG3365			127	500
Operator 11	Passenger			765	1556
Operator 12	Server			581	1459
Operator 13	Luggage			611	1600

Table C.8: Average and maximum NO_2 concentrations measured in passenger trains on 5th October

Location	Carriage No.	Travel Direction	Sampling Period	Average NO_2 (ppm)	Maximum NO_2 (ppm)
Servery (High)	SWS5723	1603 Masterton to Wellington	6:21-8:26	0.02	0.4
Passenger Carriage (Low)	SE3288			0.02	0.3
Vestibule	SE2380			0.03	1.1
Luggage	SWG5671			0.06	1.2
Operator 8	Luggage			<0.01	0.3
Operator 9	Server			0.02	0.4
Operator 10	Passenger			0.01	0.3
Servery (High)	SWS3298	1605 Masterton to Wellington	6:50-8:50	0.04	0.7
Passenger Carriage (Low)	SW5658			0.03	0.6
Vestibule 1	SWS5820			0.08	3.3
Vestibule 2	SW5658			0.14	1.9
Luggage	SWG3365			0.07	2.7
Operator 11	Passenger			0.03	0.8
Operator 12	Server			0.04	0.5
Operator 13	Luggage			0.01	0.5

Table C.9: Average and maximum CO concentrations measured in passenger trains on 5th October

Location	Carriage No.	Travel Direction	Sampling Period	Average CO (ppm)	Maximum CO (ppm)
Servery (High)	SWS5723	1603 Masterton to Wellington	6:21-8:26	0	0
Passenger Carriage (Low)	SE3288			0	0
Vestibule	SE2380			0	0
Luggage	SWG5671			0.2	5
Operator 8	Luggage			0	0
Operator 9	Server			0	0
Operator 10	Passenger			0	0
Servery (High)	SWS3298	1605 Masterton to Wellington	6:50-8:50	0	0
Passenger Carriage (Low)	SW5658			0	0
Vestibule 1	SWS5820			0.1	4
Vestibule 2	SW5658			0	0
Luggage	SWG3365			0.1	4
Operator 11	Passenger			0.5	26
Operator 12	Server			0	0
Operator 13	Luggage			0	0

Afternoon 5th October

Table C.20: Average and maximum CO_2 concentrations measured in passenger trains on 5th October

Location	Carriage No.	Travel Direction	Sampling Period	Average CO_2 (ppm)	Maximum CO_2 (ppm)
Servery (High)	SWS3298	1608 Wellington to Masterton	17:30-19:20	663	834
Passenger Carriage (Low)	SW3349			1189	1400
Vestibule	SW3349			795	1139
Luggage	SWG3365			163	300
Operator 14	Servery			854	1509
Operator 15	Manager			867	1569
Operator 16	Passenger			563	1200
Servery (High)	SWS5660	1610 Wellington to Masterton	18:18-20:10	658	872
Passenger Carriage (Low)	SW3394			861	1027
Vestibule 1	SW3394			-	-
Luggage	-			178	300
Operator 17	Front			827	1260
Operator 18	Back			947	2880

Table C.31: Average and maximum NO_2 concentrations measured in passenger trains on 5th October

Location	Carriage No.	Travel Direction	Sampling Period	Average NO_2 (ppm)	Maximum NO_2 (ppm)
Servery (High)	SWS3298	1608 Wellington to Masterton	17:30-19:20	0	0
Passenger Carriage (Low)	SW3349			0	0
Vestibule	SW3349			<0.01	0.2
Luggage	SWG3365			0.06	0.4
Operator 14	Servery			0	0
Operator 15	Manager			0	0
Operator 16	Passenger			0	0
Servery (High)	SWS5660	1610 Wellington to Masterton	18:18-20:10	0.01	0.2
Passenger Carriage (Low)	SW3394			0	0
Vestibule 1	SW3394			0.01	0.4
Vestibule 2	SWS5660			0	0
Luggage	-			0.02	1.5
Operator 17	Front			0	0
Operator 18	Back			<0.01	0.6

Table C.42: Average and maximum CO concentrations measured in passenger trains on 5th October

Location	Carriage No.	Travel Direction	Sampling Period	Average CO (ppm)	Maximum CO (ppm)
Servery (High)	SWS3298	1608 Wellington to Masterton	17:30-19:20	0	0
Passenger Carriage (Low)	SW3349			0	0
Vestibule	SW3349			0	0
Luggage	SWG3365			0	0
Operator 14	Servery			0	0
Operator 15	Manager			0	0
Operator 16	Passenger			0	0
Servery (High)	SWS5660	1610 Wellington to Masterton	18:18-20:10	0	0
Passenger Carriage (Low)	SW3394			0	0
Vestibule 1	SW3394			0	0
Vestibule 2	SWS5660			0	0
Luggage	-			<0.1	3
Operator 17	Front			0	0
Operator 18	Back			0	0

Rail Operating Code Supplement:
SW Cars - Operating Instructions for Onboard Staff

Mechanical Engineering M9383

Issue:	Version 2 - 11/07/07	Signature
Prepared by:	[redacted]	[redacted]
Checked by:	Barry Fryer	Barry Fryer
Approved by:	[redacted]	[redacted]

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Amendment Record

Changes made to this procedure since its last issue, which affect its scope or sense, are marked by ***blue italics***.

DATE	ISSUE	AMENDMENT DESCRIPTION	NAME	INITIALS
11/07/07	***V2***	***Train Start up/stabling – Train Handling – Shunting Movements Doors Closed – DC1 Circuit Breaker***	[redacted]	

1. SW Train Set Running Rights

The SW trains normal route is the Masterton to Wellington Tranz Metro service, extensive but not universal running rights are available outside this area.

The intended design life of the SW carriages is 25 years.

Important Safety Information

- SW car brakes are Graduated Release, which is not compatible with direct release brake system hence brakes on SW cars must be isolated if on other Freight or Passenger Service. See Section 4.1. If this instruction is not followed the likely consequence is dragged brakes.
- When SW cars are operated as a two-pipe system - the Main Reservoir and Brake Pipe Air Hoses must be connected to provide air for the Brake Cylinders (also to the Doors and Toilets).

  Should these cars be operated in passenger service with only the Brake Pipe connected then the cars must be configured for single pipe operation - See Section 4.3 and 11.3

  If this instruction is not followed the consequence is potentially no brakes.

  Graduated release will operate with either two pipes or single pipe set-up.
- **This is a controlled document** –
  Rail Operating Code Supplement: SW Cars - Operating Instructions for Onboard Staff, saved under Mechanical Engineering, Quality Masters, Passenger Vehicles - Document No.M9383.

  These instructions are technical instructions relating to the design of the equipment on the train and to ensure safety they must be applied in conjunction with the requirements of the Operators Safety System.

2. Train Start-up

The following procedure is to be followed when preparing the train ready for service.

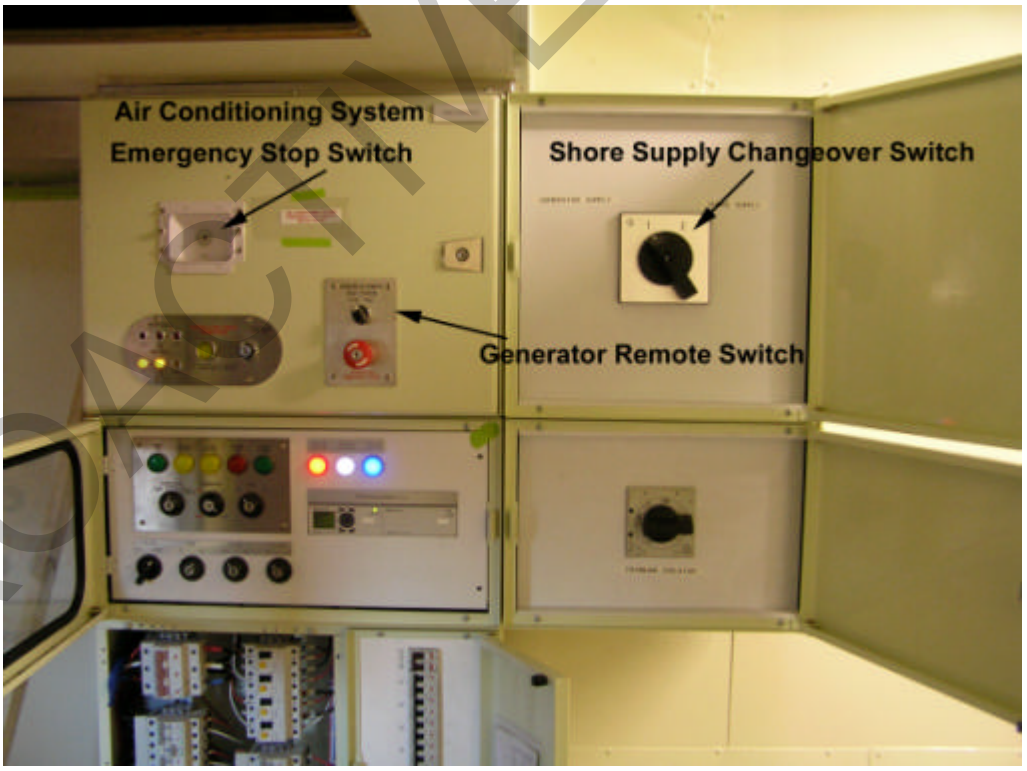
- Ensure shore supply turned off and not connected.
- Unlock and enter SWG car via corner door. (To open operate the emergency door handle. Once inside close door using the emergency door handle and then push in exterior door reset button).
- At SWG Generator Set Control Panel (beside SWG electrical cabinet):
  - Turn the STOP / RUN switch to "RUN".
  - Turn main selector switch to GENERATOR SUPPLY.(generator starts with no load)

Note: If the generator will not start ensure the switch on the generator control panel is set to Auto.

- Proceed through the train, on each individual car -
  At the electrical cabinet:
  - Check all AC and DC circuit breakers are "ON".
  - Turn "ON" the 24v main DC (battery switch) *and DC1 circuit breaker.*
  - Turn "ON" air conditioning selecting the heat/cool setting as appropriate.
  - Check that all saloon lights are working.

  At external doors:
  - Unlock deadlock on external door.
  - Push in exterior door reset button located in the hole in shelf plate above each door.
  - Concertina curtain between cars in place.

- Ensure Taillights are operating on the end of consist.
- Rear car opposite end to SWG - Bi fold doors closed and locked.
- Couple locomotive to consist, connect both Brake Pipe and Main Reservoir air hoses.
- After approximately 2 minutes, check that all brakes on the car are released (Brake pipe pressure at 550kPa).
- Ensure all handbrakes are released.



SWG Generator Set Control Panel – Next to Electrical Cabinet

Train Start-up - Continued

- Check door operation on both sides of train.
  - Starting at one end of train at door control panel, insert the door key select control and press release push button, repeat at opposite side door.
  - Return through train and randomly open doors on both sides by pressing the “Press to Open” push button either internal or external push buttons.
  - At end of train close doors both sides:
    - Press “Close” button – check door close alarm sounds.
    - Check all remote doors have closed and “Door Closed” lamp illuminates.
    - Press “Local Close” button – local door must close.
    - Remove key and “Door Closed” lamp remains illuminated.

- Carry out terminal brake test and all other safety checks required by Rail Operating Code Section 5.3 Train Marshalling, Build and Inspection Procedures clause 6.

3. Train Stabling

The following procedure is to be followed when leaving the train after service.

- Check all external doors are closed.
- Proceed through the train, on each individual car –
  At the electrical cabinet:
  - Turn “OFF” air conditioning (this is important, as the shore supply is unable to power all the HVAC units).
  - Turn “OFF” all lights and check.
  - *Turn “OFF” DC1 (Door Control) circuit breaker.*
  - Turn “OFF” the 24v main DC circuit breaker (battery switch). *To be left ”ON” if cleaning is required and then turned “OFF” by cleaners.*

  At external doors:
  - Deadlock external door.
- At SWG Generator Set Control Panel (next to electrical cabinet)
  - Set the main selector switch to EXTERNAL SUPPLY.
  - Turn the generator STOP / RUN switch to “STOP”. The Generator will take 3 minutes before it stops (allowing to cool down to minimise damage to engine).
- Leave via SWG corner door, and lock door.
- Follow Rail Operating Code procedures for securing train when locomotive is detached. (air and SE handbrake/s).
- At the shore supply point, connect the landline to the SWG car external connection and switch “ON” the external power supply.

Main Electrical Control Cabinet – All Cars

4. Train Handling Set Up

4.1 Graduated Release

All SW carriages are fitted with WG1 triple valves. The WG1 triple valves have a graduated release capability which means that in addition to the brakes being able to be applied gradually in steps, they can also be released gradually in steps.

The Passenger locomotives assigned to haul the SW train sets will have the 26C brake valve cut off valve set up for 3 positions, Out, Freight and Passenger. The Passenger position must be used on these locomotives when hauling the SW train sets.

In Locomotive Cab

- Set up as normal for lead operation
- Except set 26C brake valve to "Passenger"

If these locomotives are assigned to haul ordinary freight or passenger trains the Freight position must be selected on the brake valve cut off valve.

4.2 SW Train Handling Instructions

Key points for handling SW train sets

- The Brake Pipe is required to be reduced to below 100kPa when changing ends with the same loco, or when changing locomotives, to allow the control reservoirs on each of the cars to be correctly charged. If this is not done the brakes on the cars may not fully release when the brake pipe is fully charged from the other end.

To reduce Brake Pipe pressure:

- ❑ *Locomotive is coupled to train and MR/BP hoses connected with air cocks open.*
- ❑ *When Brake Pipe gauge registers airflow place brake valve handle to "handle off" position and reduce air pressure to below 100kpa.*
- ❑ *At 100kpa place brake valve handle to "release" position and charge brake pipe to 550kpa before performing brake test.*

- Since the locomotive may on some trains comprise up to ½ the total train weight, to avoid skids on the carriages or overheating of the wheels, the independent release on the locomotive should not be used to bleed off any automatic brake application on the locomotive.

- The locomotive and carriage brakes are capable of being applied, then partially released to any point between full service and release and can then be reapplied a further number of times. The air supply that feeds the brake cylinders is constantly topped up out of the Main Reservoir pipe, ensuring brake cylinder air is always available.

- If a brake application is made and then the brake handle is moved part way back towards release the brake cylinder pressure will reduce according to the new handle position.

- With the graduated release brakes on both the locomotives and carriages, there will always be air pressure in the brake cylinders after a brake pipe reduction, until the brake pipe is fully recharged again. If the locomotive automatic brake application is left applied as recommended the locomotive brake cylinder pressure will mimic the brake cylinder pressure on the carriages.

- The Emergency brake cylinder pressure is higher than Full Service brake cylinder pressure on the SW carriages. Emergency is 400kPa, while Full Service is approximately 330kPa. In emergency the speed of the brake application is also faster due to the faster brake pipe discharge rate.
  This design allows Locomotive Engineers to use Full Service during routine stops, without fear of locking the wheels up, plus have the assurance that there is additional braking available if required.

4.3 2 Pipe Brake System

When the SW carriages are in passenger service the Main Reservoir and Brake Pipe air hoses **MUST** be connected through the entire train.

The Main Reservoir air supply provides air to operate:

- Brake Cylinders
- Doors and extendable steps
- Water rising equipment

In the rare event it is not possible to operate the SW carriages as a 2 pipe train it is possible to configure each carriage to operate as single pipe, by changing the position of the "dead engine device" cock, see section 11.3.

4.4 Parking the SW Train Consist Unattended

Sufficient locomotive and SW car hand brakes must be applied if the SW trains consist is to be parked and left unattended.

4.5 Terminal Brake Test

The Terminal brake test for SW train consists is much the same as for other train consists:

- Make a 100Kpa brake pipe reduction.
- Set the brake valve cut out valve to "Cut Out" and monitor the brake pipe pressure over 1 minute. Maximum allowable brake pipe leakage is 35Kpa in 1 minute.
- Return the brake valve cut out valve to "Passenger" position on completion of the terminal brake test.

4.6 Cutting Out Brakes on the SW Train Consist

On SW carriages each bogie can be isolated individually in the case of an individual brake cylinder or bogie fault or the entire carriages brakes can be isolated in the case of a triple valve fault.

If the Triple Valve Isolating Cock is isolated, the isolation cock on the side of the Auxiliary Air Service box will also require isolating to prevent constant draining of the Main Reservoir.

Refer to the Rail Operating Code Section 5.3 Train Marshalling, Build and Train Inspection clause 6.5.10.

4.7 Coupling an SW Train Consist to a Locomotive Without an Auto Coupler

The SW carriages use auto couplers and will preferably be coupled to a locomotive with auto couplers.

If a train consist is to be coupled to a "non" auto coupler locomotive, a modified transition head is located on the headstock of the end SW car (painted bright green). This transition head has been modified to accept the knuckle of the SW auto coupler and ensure positive coupling.

The transition head is to be placed back on the hook on the headstock after use and not to be used on anything other than SW or other S class passenger cars.

4.8 Moving an SW Carriage on Another Freight or Passenger Service

The SW carriages are not to be conveyed on any ordinary freight or passenger train service unless the movement is covered by an Engineering initiated “Special Bulletin”.

In the rare event that an SW carriages consist needs to be conveyed on a train with direct release brakes, the vehicles must run at the rear of the train with Two loaded braked vehicles not exceeding a total of 70 tonnes on behind. Carriages or AG vans will count as loaded vehicles for the purpose of this instruction. The SW carriage brakes must be cut out when conveyed on a train with direct releasing brakes.

4.9 SW Train Assisted From the Rear by a Locomotive Hauled Train

In case of a breakdown situation and assisting locomotive/train pushing from the rear:

Consist Locomotive brake set-up compressor operative - as per Rail Operating Code instructions for assisting loco BP coupled only. (Main Reservoir still supplied to all SW cars, but may couple Main Reservoir Pipe also).

Consist Locomotive brake set-up compressor inoperative - as per Rail Operating Code instructions for dead loco BP coupled only, EXCEPT also couple the Main Reservoir Pipe.

In the event that Main Reservoir air cannot be provided to all SW cars in the consist, then each of the SW cars must have the “Dead Engine” isolation cock and the Main reservoir cock opened. This ensures air supply is available to the brake cylinders, doors etc of the SW carriages, refer also to section 11.3.

4.10 SW Train Assisted by a Locomotive on the Front of the Train

In case of a breakdown situation where an assisting locomotive is attached to the front of the train.

Couple all brake hoses between the locomotives (Brake Pipe (BP), Main Reservoir (MR) and BC Equalising Pipe (EP). Leave the Brake Pipe and Main Reservoir pipes connected throughout the SW train.

On the Assisting Locomotive if possible put the brake valve into the "Passenger" position to allow graduated release, otherwise use the "Freight" position. Be aware the brakes on the train may take longer to release (i.e. until the brake pipe is fully charged) and the Graduated release feature is not available.

EMU/DMU's and Silverfern railcars are <u>NOT</u> permitted to assist SW car trains.

All other procedures are as per the Rail Operating Code Instructions.

4.11 Shunters Riding Position

The shunters riding position on a SW carriage is within the vehicles. Windows are provided in the intercar doors for shunting purposes.

External riding is not permitted. The space between the carriages will close up during curve negotiation.

Coupling/Uncoupling SW Cars

Refer to Rail Operating Code:
Section 5.1 Operating Instructions for Yard Shunting and Allied Personnel.
Section 5.3 Train Marshalling, Build and Inspection Procedures.
This manual refer also to: Section 5.9 Re-Marshalling Door Checks.
Section 8.8 Trainline 410/23VAC Electrical Jumper.

4.13 Coupling SW Carriages With Other Vehicles

SW carriages are only permitted to run with each other and locomotives modified for passenger operation (ie with their graduated release brake feature enabled).

4.14 Use of Interconnecting and Saloon End Doors

Passengers are permitted through interconnecting doorways between SW carriages. However take care when moving between cars while the train is going through turnouts etc, as the 2 concertinas can move sideways in relation to one another restricting the available passage way.

The end door at each end of the consist should be locked, along with the Saloon/Generator door on the SWG car.

5. Door Operation

Important Note:

The Train Manager MUST not insert there door key into the door control panel or operate the doors in any way until the train has completely stopped. When stopped Train Manager may then insert there key in one of the control panels located next to each corner door on the side adjacent the platform.

Right of Way is only to be given after ALL doors including the local door are completely closed and a door light is illuminated.

If the train door closed light extinguishes while the train is in motion the Locomotive Engineer must be instructed to stop the train. Insecure door/s or steps to be secured and if necessary isolated and door out of order signs attached.

Door Control Panel

5.1 Door Release

The Train Manager can only release the doors for operation. This is accomplished by inserting the door key into the bottom right key switch and selecting "Control" on any door control panel on the desired side of the train. The "Release" button is pressed which will cause the locking bolts to withdraw on each door on that side of the train only, a brief alarm will be sounded to indicate a door release has occurred. The key can then be turned back to "Run" position and removed, and the doors will remain released.

5.2 Opening of Doors on a Side

Once the Train Manager has released the doors the door open push button lights up and passengers may open the door by pressing the “Press to Open” button at any given door on that side of the train (internally or externally).

Note: The Wheelchair Hoist Door in the SWS carriage can only be opened or closed by Train Manager at that door station. A passenger may request assistance by pressing the Help Call button at this door station, refer Section 19.

When the door opens an automatic step will also extend. If a platform (or obstruction) prevents the step from fully extending the step will automatically retract and stay retracted.

Note: The step has the ability to hinge upwards, if it extends slightly above a platform and the carriage drops with the additional weight of people boarding step may catch on the platform.

5.3 Closing of the Doors:

On any door control panel on that side, insert the door key into the bottom right key switch and select “Control”. Press the “Close” button, door close alarm will sound and all doors except the local door will close.
Check the “Door Closed” lamp has illuminated and perform a second door check by stepping out onto the platform **(Check the gap as step will have retracted when “close” button pressed).** Press the “Local Close” button to close the local door.

Turn door key switch back to “Run” and remove the key, the “Door Closed” lamp remains illuminated showing that the local door is also closed and secure for service to proceed.

The Train Manager **MUST** not give the Locomotive Engineer right away until the “Closed Light” is illuminated, or followed the fault finding procedures below and hence confirmed the train is safe to proceed.

Note: The Wheelchair Hoist Door in the SWS carriage can only be opened or closed by the Train Manager at that door station. If a help call button at this door station has been pressed, the “Door Closed” light will not be achievable until it is attended, refer section 19.

5.4 Obstacle Detection

The doors have obstacle detection installed in both open and close directions, while the extendable step has obstacle detection installed in the extend direction only.

If the Door or Step ‘sees’ an abnormally high force during operation the system will automatically change the direction of the door/step.

Extreme wind may be sufficient to cause the obstacle detection to prevent it from opening or closing. The collision detection may be over ridden by holding the Open or Close button down. If the Train Manager holds the Close button down to ensure a door closure, they must visually ensure there are no real obstructions.

5.5 Emergency Door Release

A manual emergency door handle is provided on each door, which allows the safety systems to be over-ridden and a door to be opened without the Train Manager in the event of an emergency.

When the emergency handle is used it interrupts the door closed circuit and the “Door Closed” light will go out, an audible warning will sound continuously at that door station, and an audible warning will be sounded briefly throughout the train to indicate a change of status. The Train Manager must stop the train and identify the cause of the change of status as soon as practically possible.

Once a door is opened using the emergency handle it must be closed and then reset by pressing the reset button. The reset button is located in the upper shelf plate immediately above each door. A pen or similar should be used to press the button through the small 10mm hole. The door will not be operational again until this reset button is pressed.

Note: Steps will not operate when a door has been opened using the Emergency Door Release. The crew can be guided to the open door via the Train Management System, refer to Section 17 for more details.

5.6 Internal / External "This Door Open" Light

To assist with the detection of faulty doors/steps an external light has been provided above each corner door. If the door or steps at a location are open or not properly closed the external light and internal "This Door Open" light illuminate. On the door control panel the internal "Door Closed" light will not be illuminated and the red LED light will be illuminated

5.7 External Door Lock out Procedures

Should a door fail in service, insert door key into the upper right key switch on the door control panel adjacent to the defective door and select "isolate". The "door out of order" light on the door control panel will now light up and the door will be rendered inoperative.

Prior to selecting the "Isolate" position ensure both the door and the step is in the closed position. Cable tie the step into the closed position and lock the door using the deadlock. When in the "Isolation" position the door and step closed sensors are no longer monitored, so if there is a fault in these sensors it is possible to still achieve the "Closed Light" by selecting the "Isolate" position. Therefore it must be determined that the door and step are safely closed and secured.

If the "Emergency Door Release" is used to open this "Isolated" door it will still be detected and the "Closed Light" will go out and an audible alarm will be briefly sounded to indicate the change of state.

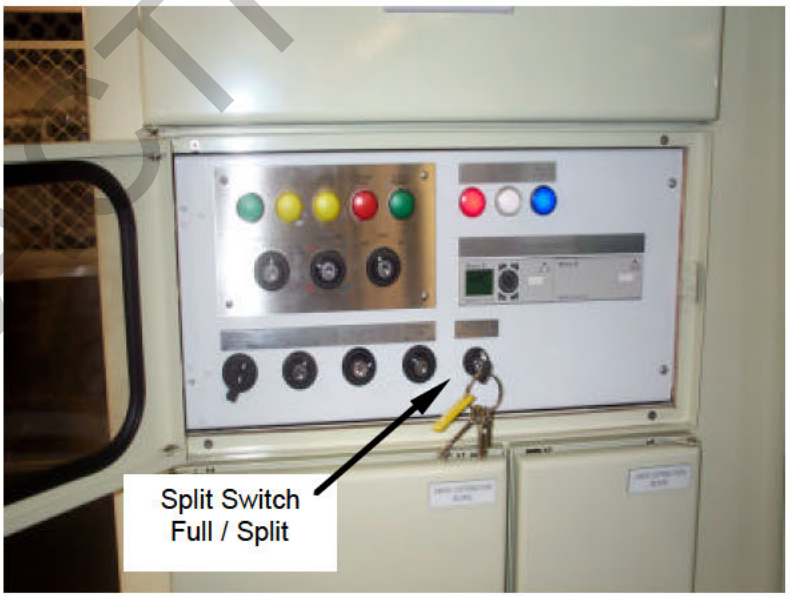
Refer to "Emergency Door Release" Section 5.5 for instructions on resetting an emergency door release.

5.8 Short Platform – Door Control Split Switch - SWS

The electrical cabinet on the SWS carriage has an extra switch (Door Control Split Switch) to control doors at short platforms. When the train consist is too long for a platform the Train Manager will operate the switch prior to arriving at a short platform. Only doors north inclusive of the wheelchair hoist will operate (i.e SWG, SW and half of SWS) all other doors will be automatically isolated until switch is returned to the "Full" position after departing a short platform.

PID displays and announcements will be made informing passengers location to disembark.

Note: When using this process ensure door controls north of the Wheel Chair Hoist are operated only.



Split switch – main electrical cabinet SWS cars only

5.9 Re – Marshalling Door Checks

Whenever SW car train consists are re – marshalled (cars on or off) the following check is to be performed to ensure all external doors in the consist are operating safely and correctly.

- Ensure that automatic coupling, air hoses and trainline 410/230VAC electrical jumpers are correct.
- Ensure jumper socket lid furthest end of consist from the SWG car is firmly latched closed.
- Set consist up and perform a full door check.
    - On any door control panel, insert the door key into the bottom right key switch and select "Control".
    - Press the "Release" push button. This will withdraw the locking bolts on each door on that side of the train only. The "Press to Open" push buttons on each door control panel will light up once each locking bolt has withdrawn fully. Remove key.
    - Any door on that side can now be opened as desired, by depressing the "Press to Open" push button on the adjacent door control panel. Test them all, use randomly either the internal or external button.
    - On any door control panel on that side, insert the door key into the bottom right key switch and select "Control".
    - Press "Close" button – check door close alarm sounds.
    - Check all remote doors have closed and "Door Closed" lamp illuminates.
    - Press "Local Close" button – local door must close.
    - Remove key and "Door Closed" lamp remains illuminated.
- Repeat above process for other side of train. Both sides can be checked at same time.
- Once both sides have been checked with all doors closed and the closed light illuminated, at furthest end of consist from the SWG car operate the emergency handle to open an exterior door. Ensure that the train closed light extinguishes as the door is opened.

Note: If taillights are set to the automatic position and with the 410/230VAC lid correctly closed the taillights for that car will now be illuminated.

5.10 Interior Vestibule/Saloon Doors

The automatic interior vestibule/saloon doors are opened, by standing on the footpads on each side of the door. After stepping of the pads doors will automatically close after 3 seconds.

In the event of power failure, the doors may still be opened or closed using the pneumatic "Open" / "Close" push button on the wall beside the door.

To assist with movement through out the train (possible low air pressure) when stabled in passenger storage yards the DC1 (Door Control) circuit breaker maybe turned "OFF". Push the pneumatic "Open" push button, the doors will now stay in the open position until the DC1 cb is turned "ON" and air pressure restored.

5.11 Emergency Stop (Brake) Push Button

"Emergency Stop" push buttons are located on the saloon end walls. To reset ***"100"*** key

If the "Emergency Stop" button has been depressed, it will prevent the Door Closed Light from being illuminated, a brief audible alarm will sound throughout the train and the Train Management System will guide the crew to the activated push button. Please refer to Section 17 Train Management System for more details.

5.12 Shunting Movements – Doors Closed

For shunting movements doors are to be closed and a door light obtained. If it is now necessary to exit for shunting purposes then manually operate emergency door handle to open door and exit, closing door from outside.

Note: *Steps will not operate when a door has been opened using the Emergency Door Release.*

6. Door Fault Procedures

The procedures below are provided as guidelines to aid fault rectification, and/or to allow a train to complete its journey if at all possible. However, under ALL circumstances the Operators Safety System takes precedents over these procedures to ensure passenger safety.

Symptom	Cause	Remedy
Door will not respond to controls and out of order light off	1.Emergency door handle has been used or deadlock has not been released	Locate the 10mm hole in the panel immediately above the door. Push a pen or similar object through this hole to operate door reset push button, then operate the door as normal. Check deadlock has been released.
	2. Low Air Pressure	Locomotive attached – air pressure to 550kpa.
No "Door Closed" light illuminates after the door closed button operated.	1. Help Call	A Help call has been made at the Wheelchair Hoist. Crew must attend and reset the help call at the station before the train can proceed. TMS Panel will indicate Help Call and direction if this is the case. Crew must attend to the help call. Refer Sections 18.2
	2. Circuit incomplete	Use Train Management System to find the cause, could be - open door or step - activated smoke detector - activated emergency brake - 410/230VAC plug lid at end of train not properly closed - 410/230VAC jumper between cars – Generator must be shut down before handling - 24VDC jumper between cars - a carriages circuit breakers "OFF" - wiring/component failure
	3. Door blocked by obstacle	Cycle the doors again. If problem does not clear itself, look for obstacle or move to 4. If it is wind causing the detection of an obstruction. Hold down the "Close" button until the door is completely closed. Visually ensure no person is obstructing door way while closing.
	4. Defective door bolt, reed switch or door bolt not fully engaged	Find the defective door, by using the TMS Panel, and "This Door Open" lights on the control panels: a. Push a pen through the small hole in the panel above the defective door to press the door reset push button to ensure an emergency door release has not occurred. b. Cycle the doors again, at the defective door. c. If the door light still does not come up check doorstep is fully retracted and door is closed. If necessary use the emergency door handle to close that door. Cable tie the step closed, lock the door, then isolate.
One train closed light not illuminated, all other doors illuminated with "all doors" closed.	Blown bulb in the location that is not lit	Ensure other train closed lights are on and no faults are listed on the Train Management PLC Display. Book up fault in 54D book, and continue as normal.
Compressed air blowing in the vestibule roof area with possible erratic door operation	Leaking pneumatic components	Cable tie closed the defective step, lock the defective door and Isolate door, using upper right key switch on the main door control panel at the defective door location.

Notes: The Operators Safety System must be followed if any conflicts exist with above guidelines.
The train-set 54D repair book will be located in the Train Managers compartment of the SWG car.

7. Diesel Alternator Set

The 200kVA diesel alternator set located in the SWG car will supply all 410/230VAC power for lighting, heating and ventilation, plus charge the 24VDC battery back-up system, for a consist of up to 8 SW, plus 1 SWS and the SWG car itself.

7.1 Generator Emergency Shut down

7.1.1 Emergency Shutdown

The generator may be shut down in an emergency situation via the emergency stop beside the saloon/generator door, the SWG electrical cabinet, or on the generator canopy.

The emergency pushbutton on the SWG electrical cabinet and in the saloon requires the use of the door key to reset, while the generator canopy stop button is a turn to release push button.

If a emergency stop button is pressed the reset procedure description in section 7.1.2 will have to be followed.

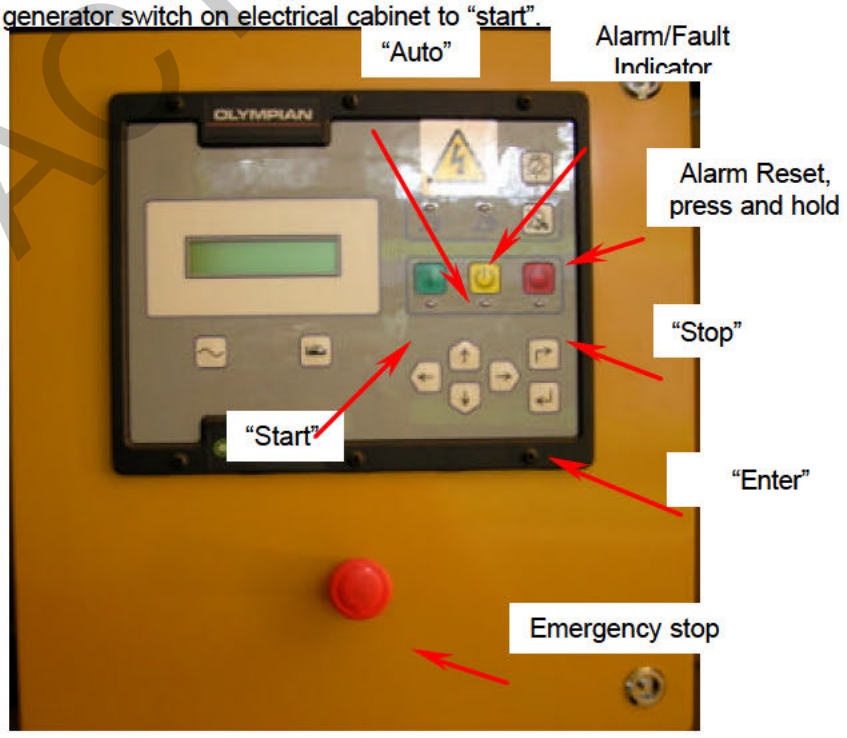
7.1.2 Resetting Generator Faults/Alarm, Including Emergency Shutdown

If the emergency stop button is pressed, it creates an alarm condition, which prevents the generator from being re started until it is reset.

If an alarm or fault has occurred the "Alarm/Fault Indicator" will illuminated on the generator control panel.

Follow the following steps to clear a fault/alarm:

1) Ensure cause of fault/alarm is no longer active, i.e. release the activated emergency stop (by use or door key or turn to release)
2) Open canopy door to get access to generator main panel.
3) Push the "Stop" button (Red Square push button)
4) Press on hold for a couple of seconds the "Alarm Reset" button.
   The screen will change to ask if you wish to reset faults.
5) Press the "Enter" button
6) Press the yellow "Auto" button
   Note generator may start if remote switch on electrical cabinet is already in "start" position
7) Close canopy door.
8) Turn remote generator switch on electrical cabinet to "start".



7.2 Diesel Generator Set Fire Extinguisher System

Each diesel generator set is equipped with a “Lifeline 2000” automatic fire extinguisher system. This extinguisher system uses a fusible link detector in the genset housing to monitor a fire occurrence. If a fire is detected the extinguisher system automatically sprays AFFF (Aqueous free forming foam) over the diesel engine and alternator and shuts down the generator. After a fire extinguisher has operated, the generator will not be able to be restarted, until the main extinguisher bottle has been replaced.

The AFFF fire retardant produces no harmful fumes and the foam produced will break down naturally over a short time period. The AFFF fire retardant foam is rated for use up to 10,000 volts.

7.3 Diesel Generator Set Fuelling

The fuel tanks are located under the SWG and holds 550 litres of fuel, this is sufficient fuel for 2 days of typical operation.

The fuel tank can be fuelled using an Aeroquip dry break system on the A-Side of the carriage, or alternatively a traditional fuel nozzle direct into the fuel tank on the B-side of the carriage.

The fuel tank is located at the opposite end of the carriage from the generator, to give better weight distribution for the carriage.

7.4 Shore Supply Switch

A shore supply / generator supply change over switch is provided in the SWG generator room beside the main electrical cabinet. Refer to photo in Section 2 page 5.

In the generator position it allows power from the Generator to be supplied to the SWG and the connected carriages via the 410/230VAC trainline.

In the external (shore) supply position it allows a land base connection to be plugged into the headstock of the SWG, which provides a limited amount of power to run lights, refrigerators and cleaning equipment.

Note: The HVAC system in the entire consist must be turned off when connected to the shore supply.

7.5 Trainline Circuit Breaker Protection

The Trainline circuit breaker is located in the SWG generator room. This circuit breaker should remain in the “ON” position, its purpose is to protect the Trainline cable, plugs and sockets. This circuit breaker will essentially turn off power to the entire train (except the SWG which receives a direct power feed from the generator) if it trips. In the event of a trip, reset it and record it in the 54D book.

7.6 Generator Set Room Lighting

7.6.1 Generator 230VAC Lights

There are non maintained (ie genset must be running and/or Shore supply connected for these to operate) 230VAC lights in the generator room, these lights only operate on the 230VAC supply and are turned on via the switch on the electrical cabinet along with the saloon lights.

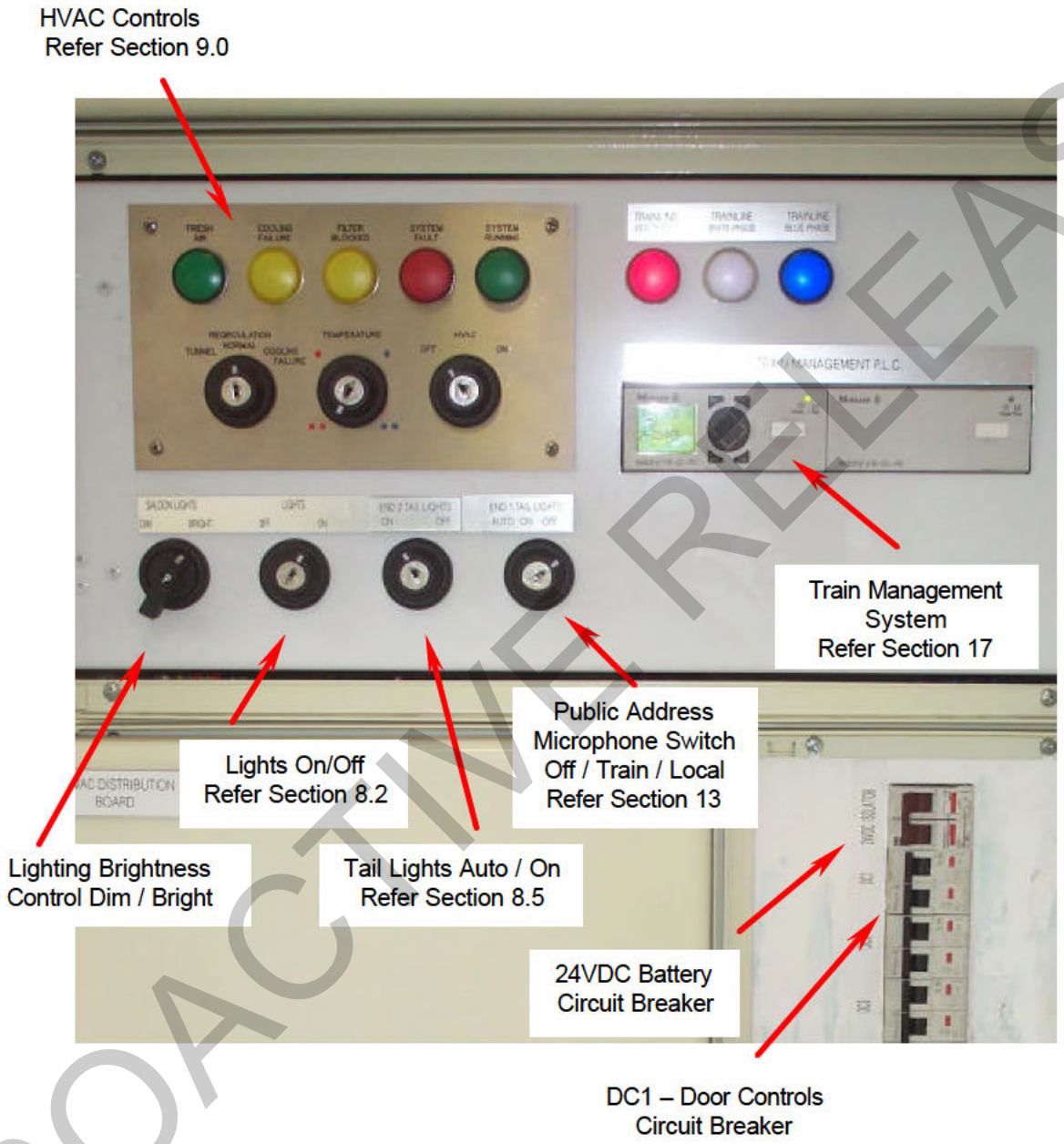
7.6.2 Generator Emergency 24VDC Lights

There is maintained lighting (powered by 24VDC battery supply) located in the generator room, this light is turned on via the saloon lighting switch located in the electrical cabinet.

8. Electrical Cabinet Switch Board – 230V / 24V

8.1 Battery Isolation Switch – 24v Main DC Circuit Breaker

The Battery Isolation Switch is located in the electrical cabinet on each car. This switch is to be used to turn the battery supply "OFF" instead of using the fuses located in the battery box under the car.



8.2 Saloon Lighting

The switch to turn the lights on / off is located on the electrical cabinet in each car. This switch turns on both the emergency lights (24V) and the 230VAC non-maintained saloon lighting. The 230VAC fluorescent lights will only operate when the genset is operating or the car is connected to "shore" supply.

A Dim/Bright selection switch is also provided. In the Bright position all lights (except individually switched reading lights) will be illuminated. In the Dim position, the Auxiliary Lights in the luggage racks will be turned off, along with the outer main lights in the centre of the carriage.

All non-maintained lights are RCD protected.

8.3 Emergency Lighting

The switch to turn the emergency lights (24V) on / off is combined with the saloon lighting switch, which is located on the electrical cabinet in each car. The batteries running these lights are automatically charged when the 230V system is operating.

Note: These lights must be turned on at all times in case the 230V system fails.

In the main saloon there is a number of the central fluorescent tubes powered via a 24VDC-230VAC inverter, these are the maintained emergency lights.

8.4 Power Failure

If the genset stops, the 230V system will not operate but the emergency lights, taillights, PA system and doors will still operate as they run off the 24V-battery system. The batteries have a nominal capacity of 4 hours when fully charged.

The use of the wheelchair hoist in the SWS will also remain operational, but its use should be kept to its absolute minimum (one operational cycle is safe) to conserve battery power. In the event the wheelchair hoist requires more use, please ensure to use the manual hydraulic pump as outlined in section 19.5

8.5 Tail Lights

The Train Management System is able to detect which carriage is at the end of the train by monitoring the position of the 410/230VAC-receptacle lid. If the lid is closed, it is deemed to be the last carriage of the consist.

If the Train Management System detects that the lid is closed, it will automatically turn on the taillights in this carriage, provided the Tail Light switch is in the Automatic position. The Taillights can also be manually turned "on" and "off".

In the event of a failed switch in the 410/230VAC-receptacle lid in the centre of the train, the Train Management System will detect an End of Train Fault. ie the switch says the carriage is at the end of the train when it is not.

The SWG also has a Taillight fitted to the No. 2 end of the carriage. An On/Off switch (no automatic function) in the SWG electrical cabinet controls this taillight.

8.6 Power Points

230VAC power points are provided along the carriages at ankle level in a wall mounted duct. A double socket is located under each table and at every seat row. Power point sockets are also provided in each toilet.

All power points are RCD protected.

8.7 Fire Extinguisher

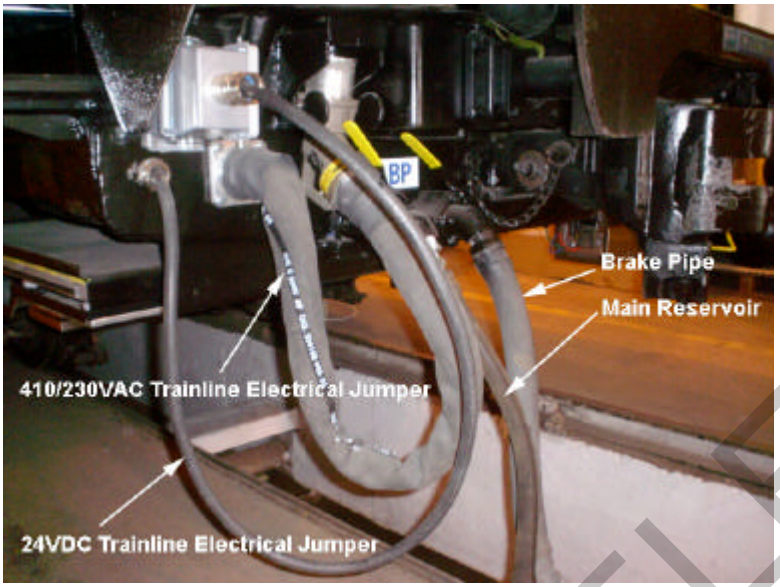
There is a fire extinguisher in each car located behind the first seat at the south end (non-toilet end) of the passenger saloon.

8.8 Trainline 410/230VAC Electrical Jumper

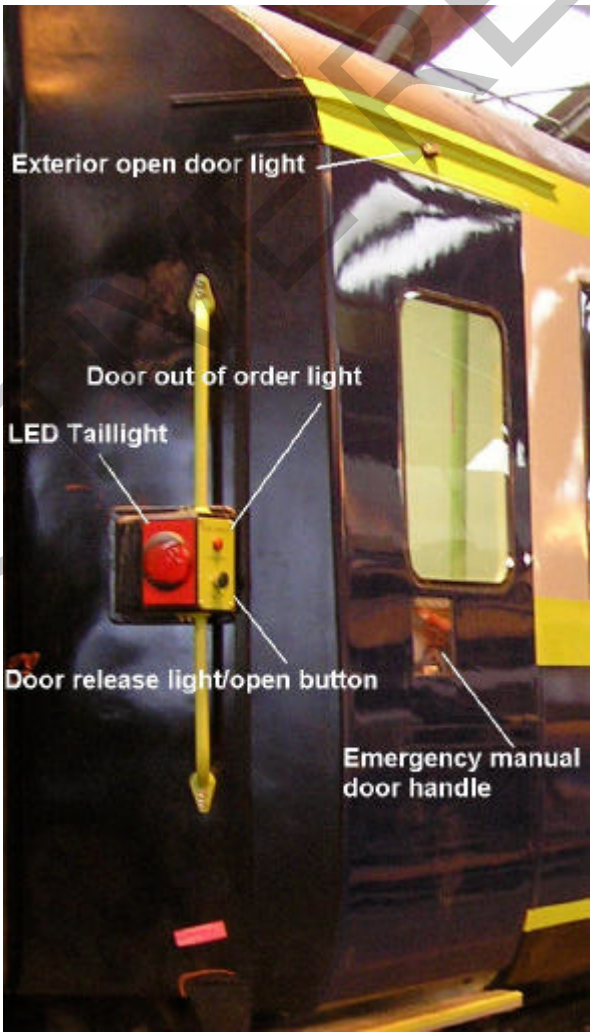
When handling the trainline 410/230VAC electrical jumper connection between cars then turn the Shore Supply Changeover Switch to "Shore Supply" position and ensuring Shore Supply is not connected. This could occur during coupling/uncoupling movements or inspecting a suspected connection due to loss of power between cars.

8.9 Trainline 24VDC Electrical Jumper

This electrical jumper is fitted between cars to trainline the low voltage circuits to operate doors, PA system, passenger information display (Auto controls for air conditioning system, Rimutaka Tunnel), help call, and train management alarms.



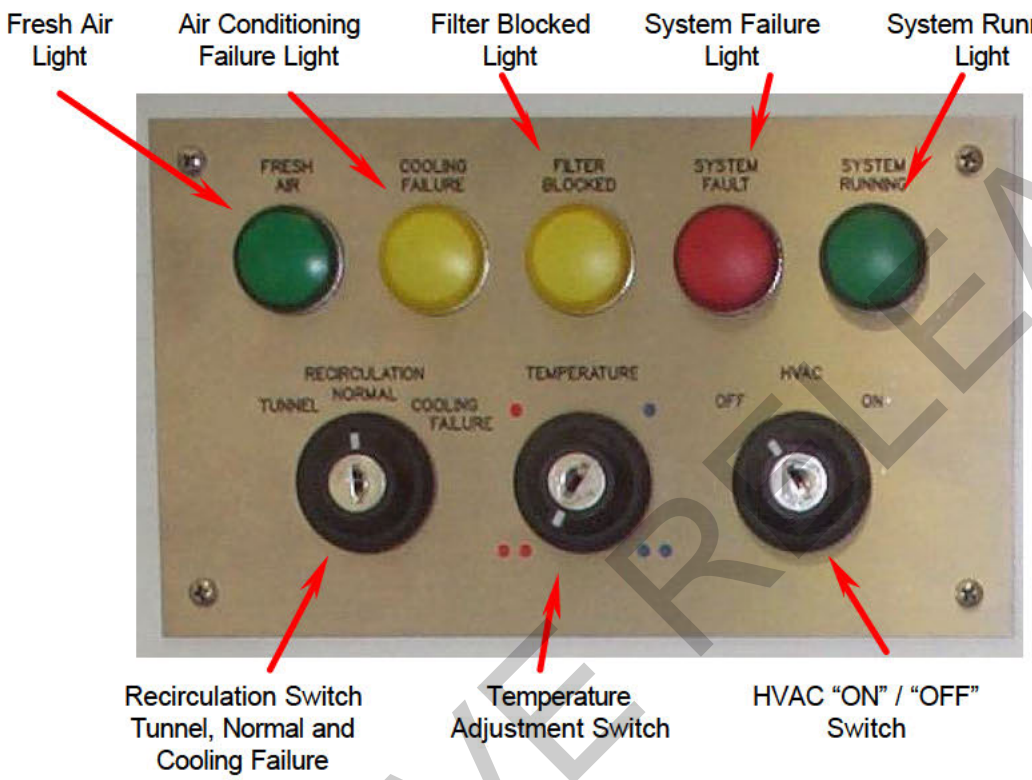
Trainline Electrical Jumpers and Air Hoses – Refer Section 8.0



External Door Area
Refer - Taillights section 8.5, Emergency Door Handle Section 5.5

9. Air Conditioning System

SW cars are fitted with Coolzone 979U air conditioning units (HVAC). The control panel is located in the electrical cabinet for each car. Controls are used for both heating and cooling.



9.1 Normal Operation

Using the HVAC key, move the on/off switch to "ON", a green indicator lamp should light (System Running). If no green lamp shows, ensure the generator is operating and check the position of circuit breakers feeding power to the HVAC system.

The switch marked "recirculation" controls the position of the 2 fresh air dampers in the HVAC unit, the switch has 3 positions:

Auto/Normal Should be set to this position normally.

In this position one of the fresh air dampers is open most of the time, except when travelling through the Rimutaka Tunnel, at which time both fresh air dampers will be closed to prevent any external air from being drawn into the carriages.

When both the fresh air dampers are automatically closed the green **Fresh Air** light will turn off.

The signal for closing the fresh air damper comes from the PID Controller in the SWG carriage.

Tunnel In this position both of the fresh air dampers will be closed so no fresh air is drawn into the carriage. When in this position the green Fresh Air light will not be illuminated.

This mode should only be needed if the train is operating through a long tunnel other than the Rimutaka Tunnel (such as Otira or Kaimai Tunnel) while on a charter service or if the PID system is not operating.
This mode should only be used for short periods of time, as the comfort level will decrease over time as the oxygen levels deplete and the carbon dioxide levels increase as a result of no fresh air intake.

Cooling Failure In this position both the fresh air dampers will be open, allowing more fresh air to circulate through the carriage. While in this mode the amber **Cooling Failure** light will be illuminated.

This mode is to be used in the event of a cooling failure (see faults below) on summer days, hence allows the HVAC unit to circulate more cooler outside air through the carriage. Using this mode during winter will make the carriage less comfortable (colder).

The temperature control is pre-set and will not normally require adjustment by the Train Manager / Passenger Operators, however a "**temperature**" key switch provides 4 different temperature settings, 2 cooler (blue) and 2 warmer (red) settings. This switch provides a total variation in set temperature of 4 degrees Celsius from the coldest to the hottest setting.

If the above set up is completed and power is available, the HVAC unit supply fan should be running. Operation of the heating/cooling sectors is automatic, controlled by electrical/electronic equipment in the HVAC panel. The system will try to maintain whichever of the four set point temperatures is selected.

The HVAC system will turn the under-seat heaters on or off as the temperature requires it. In addition to the under-seat heaters the HVAC unit also has 2 banks of heaters inside the unit slung under the carriage.

9.2 Air Conditioning Faults / Procedures

9.2.1 Fault Indicator

In the event a red light shows at the "Fault" indicator, the heating/cooling function will be disconnected, but the supply fan should still be running. The following system functions can cause a fault indication:

- Compressor high amperage (overload)
- Refrigerant high pressure
- Refrigerant low pressure
- Electrical heater battery over temperature

Such faults require action by maintenance staff at their depot. Temperature and/or pressure change within the control system may reactivate some or all functions automatically after a time but the reasons for the fault indication must still be investigated.

In the event of a **cooling** failure, turn the **"recirculation"** switch to "cooling failure" to open both fresh air dampers. The "amber" light will remain on while in the "recirculation" mode. Do not use this mode if heating is required, as the system will be bringing in more fresh air from outside, but it will not be cooled or heated. In all but the hottest conditions this should allow a journey or roster to be completed.

Book any fault indications in the carriage 54D repair book.

9.2.2 Filter Indicator

Advise maintenance staff by using the 54D repair book if the amber light marked **"filter"** activates. This indicates that the filter(s) require cleaning, even though the HVAC unit is still operational.

10. Water Systems

The SW and SWS carriages have on board 400 litres of drinkable water and have a retention tank to hold up to 400 litres of waste water.

The water tank is located under the carriage and is pressurised using air from the brake system to reticulate the water around the carriage.

The water tank can be filled from either side of the carriage. The tanks are to be filled with drinkable water only. The filling air cocks are to be set into the filling position, which de-pressurises the tank and allows filling to occur via a standard clip on hose connection. Once full, water will overflow out the de-pressuring cock.

The water is filtered as it enters the storage tank.

The water which is piped to the on board water cooler is sterilised by a UV steriliser. The UV steriliser is only operational when there is 230VAC available to the carriage; ie the generator running or shore supply is connected.

The water to the toilet and SWS servery hand basin is not sterilised, but is heated to at least 60 degrees Celsius in the under sink water heater. The water taps in the toilet and servery are installed with timers to prevent excessive use of water. The water from the toilet hand basin should not be drunk.

The toilet installed in the SW and SWS requires all of the following to be available to function correctly: 24VDC power, pneumatic air pressure, and water supply.

Water Filling Points A and B Side

11. Isolating Cocks

11.1 Bogie Brake Isolating Cock

The bogie brake isolating cocks are located by each brake cylinder, located in the centre of the vehicle either side of the underslung HVAC unit. This cock can be used to isolate a complete bogie. The brakes will automatically release on the bogie if the cock is isolated while in the ON position.

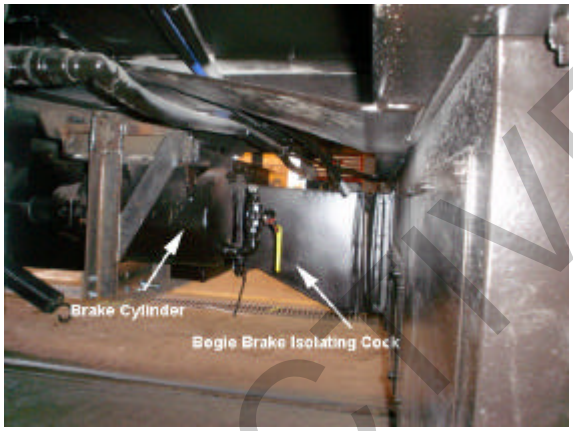
Referring to the Rail Operating Code Section 5.3 Train Marshalling, Build and Inspection Procedures clause 6.5.10 each individual bogie that is cut out counts as half a carriage.

11.2 Car Brake Isolating Cock

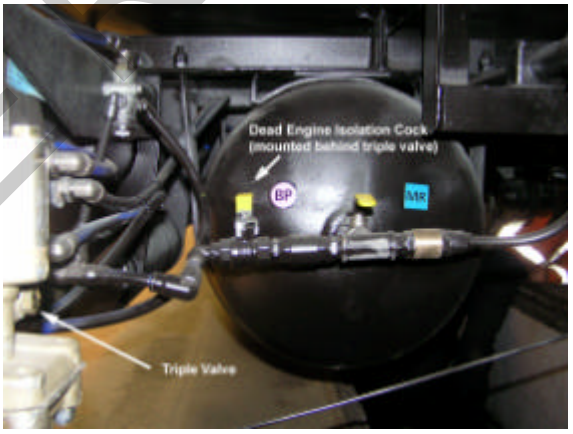
The car brake isolating cock is located on the Triple valve and is painted yellow. This cock can be used to isolate entire carriage brakes. The Main Reservoir air supply to the triple valve will also have to be isolated, by turning off the isolation cock located on the side of the Auxiliary Air Service box, this prevents the Main Reservoir from draining.

11.3 Main Reservoir Supply Cock and "Dead Engine Device"

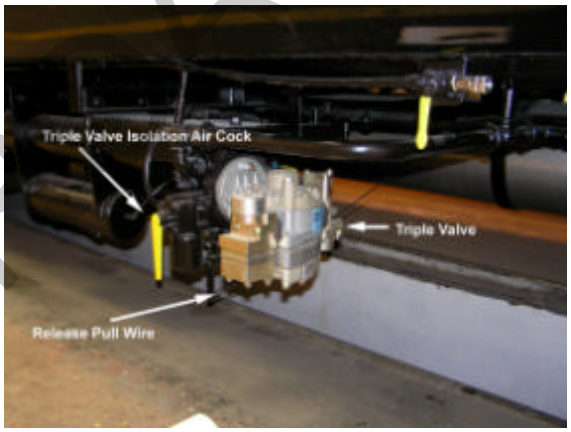
The Main Reservoir Supply Cock is located on the end of the Main Reservoir. The isolation cock closest to the main reservoir can be used to prevent charging of the carriages main reservoir. This cock should be cable tied in the open position, as isolating this cock will potentially cause reduced functionality of the brakes, doors and water systems.



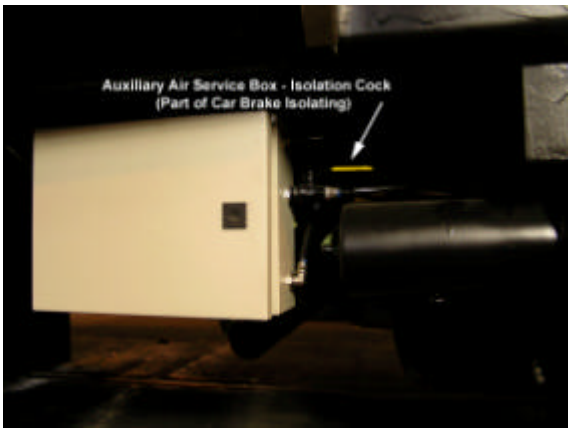
Bogie Brake Isolating Air Cock



Dead Engine Device Air Cock



Car Brake Isolating Air Cock – Triple Valve



Auxiliary Air Service Box - Main Reservoir Supply Air Cock

The Main Reservoir is permanently connected to the carriages trainline Main Reservoir piping, with a check valve preventing back flow from the main reservoir into this piping. In normal operation the carriages are connected to the main reservoir supply of the locomotive via this piping.

In the event that a 2 pipe system (Brake Pipe and Main Reservoir) is not available, a “dead engine” device is provided to allow the carriage’s Main Reservoir to be charged via the brake pipe. The Isolation Cock located next to the Main Reservoir cock allows the activation of the dead engine device. The dead engine device cock should be cable tied in the isolated position during normal service.

If running single pipe operation, ensure:

- Dead engine isolation cock is open.
- Main reservoir cock open.
- All main reservoir cocks on the end of each carriage are closed.

11.4 Release Pull Wire

The Release Pull Wire will NOT release the brakes if the Brake Pipe is charged, but will release the brakes completely on the carriage if the cars Brake Pipe pressure is below 100kPa.

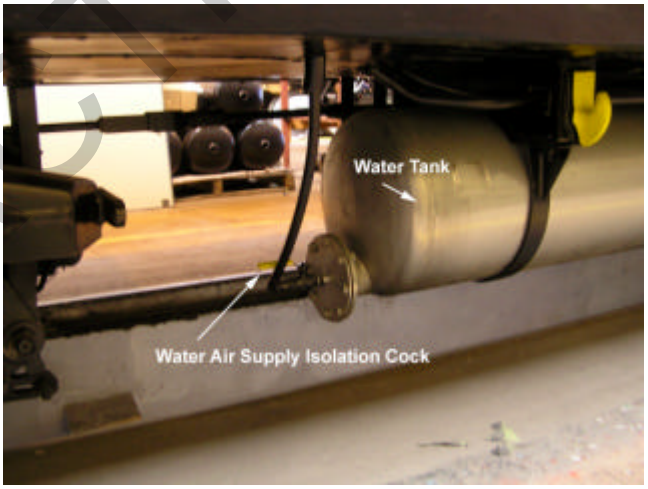
11.5 Water Isolation Cocks

Water supply to the entire carriage can be isolated by turning off the isolation cock located on the end of the fresh water tank located under the carriage on the 1B corner.

Maintenance personal also have access to the ceiling cavity, which allows the water to be turned off to the toilet and UV steriliser, water cooler and coffee machine.

11.6 Door/Step Isolation Cocks

An isolation air cock is mounted behind each step assembly for isolating air to the door and steps at that location, also maintenance personal have access to the ceiling cavity, which also allows the air supply to the individual doors and extendable steps to be isolated.



Water Air Supply Isolation Cock

12. Park Brake System

At No. 1 End, A Side a locomotive style lever action ratchet park brake is located.

To apply the park brake crank the long handle until you can no longer lift the handle (as much force as you can apply to it).

To release the park brake, pull the small lever, and ensure that the chain has released and the brakes blocks have moved away from the wheels.

13. Public Address System (PA system)

A microphone is located on the electrical cabinet of each SW car, which connects with the speakers throughout all cars in the consist. The PA is used to communicate with passengers particularly for safety critical information or instructions.

Note: The SWG car does not have a microphone located on the electrical cabinet due to the noisy environment instead it is located in the Train Managers compartment.

13.1 Functions of the PA system

The PA or public address system can be used to advise passengers of:

- Emergency or safety information
- Critical passenger information such as notice of delay
- Specialised tour group announcements

NOTE: The PA system will remain operative even if the 230V power system fails.

13.2 Control of PA system

On each electrical cabinet is a 3-position switch, which controls the microphone and the Public Address system.

Off The microphone is OFF, but the PA system will still relay trainlined announcements from other carriages. This is the position the switch should be left in.

Train The wall-mounted microphone is activated and the announcement will be made to all carriages in this train.

Local The wall-mounted microphone is turned on, and the announcement will be made only to the local carriage.

The volume has been pre-set. Please contact maintenance depot for adjustments.

13.3 Automated Announcements

The Passenger Information Display system is connected to the Public Address system to allow automated announcements (eg. next station, regular safety announcements).

13.4 Hearing Loops

The SWS carriage is fitted with a Hearing Loop, which allows persons wearing a hear aid to hear the Public Address Announcements via the built in transformer in the hearing aid, rather than the actual audio announcement.

14. Passenger Information Display (PID) System

Each SW class carriage has two Passenger Information Displays, one located at each end of the saloon. These PIDs are controlled automatically (using Global Position System (GPS) waypoints) to display the next station on the Wairarapa Service route. The GPS and the sign controller is located in the SWG carriage, and the information is trainlined to all of the PIDs in the consist.

The PID controller provides an automated audio announcement into the PA system and provides the signal to control the fresh air dampers for the Tunnel mode. Refer to Section 9.0.

In the event that there is a malfunction with the PID signs these can be turned off using the PID 24VDC circuit breaker.

The automated audio and visual messages are stored on a memory card and can be to changed at any appropriate time. *(not changed by onboard staff)*

15. CCTV System

Each carriage is fitted with 4 CCTV cameras, 2 per saloon and 1 in each vestibule, a camera is also located in the generator room of the SWG. The footage from these CCTV cameras is stored on a Digital Video Recorder (DVRs) in each carriage. The CCTV DVRs are able to retain approximately 2 weeks worth of operational footage.

There is a CCTV monitor located in the servery. This monitor wirelessly receives live security camera footage from each carriage, to allow crew to monitor activity on the entire train.

The CCTV camera's and Digital Video Recorder is operated from the 24VDC battery backed power supply, hence security footage is still being recorded even in the event of main 230VAC supply failure. Note the monitor in the servery will not function in the event of main's 230VAC failure.

16. Smoke Detectors

There are 3 Smoke detectors fitted in each carriage. They are located in the saloon, No.1End Vestibule and the toilet (in the generator room for SWG).

These smoke detectors are powered via the on board 24VDC battery backed up circuits, when operational the LED's on the smoke detectors flash faintly.

If a smoke detector is activated it creates an audio alarm at the smoke detector as well as an alarm throughout the train, via the Train Management System, refer section 17.

17. Train Management System (TMS)

The carriages feature a Train Management System, which monitors the external doors/steps, on board smoke detectors and Emergency Brake buttons, and aid the crew quickly identifying any device in an “unsafe” state.

In the electrical cabinet of each carriage there is a PLC which is the heart of the Train Management System. The PLC monitors all the devices in that carriage and communicates with the carriages adjacent to it.

17.1 Train Management Alarm System

If the train goes into a non-safe state the Train Management System will sound an alarm throughout the train for 5 seconds, to alert the crew of the change of state. The Train Management System considers the following as non-safe states anywhere in the train:

- Activation of smoke detector
- Emergency brake button activated
- A door opens or step extends
- End of train not correctly detected

The TMS is able to distinguish a Train Crew commanded door release from other non-safe states. In the event a commanded door release is detected, a short 1-second alarm will be heard, to alert the passengers that the doors can be opened.

Once the Train Management System has detected a non-safe state, it will not signal the train safe again until:

- All external doors and steps are safely closed
- No emergency brake taps are activated
- No smoke detectors are activated
- End of train is correctly identified
- No help calls have been made from Wheelchair hoist position in SWS. (refer section19.1)

The TMS guides the train crew to the location of the detected unsafe condition on the train.

17.2 TMS Guidance System

This PLC has a small screen on which fault messages are posted to help the crew to identify any device in an “unsafe” state.

In addition to the PLC screen there is also a Train Management/Help Point located in 2 places in every carriage. Generally on the electrical cabinet, at No. 2 end of the carriage and on the HVAC riser in the centre of the saloon.

The TMS section of the panel has 3 lights, “Left”, “This Car” and “Right”

If a device goes into an unsafe state an audible alarm will sound throughout the train, and one or more of these lights will illuminate on each of the carriages TMS/Help Panels.

If the “Left” light illuminates it means the unsafe device is in a carriage to the left of you. (So walk in the left direction until you find a carriage with “This Car” illuminated.)

If the “This Car” light illuminates it means the unsafe device is in the carriage you are in.

If the “Right” light illuminates it means the unsafe device is in a carriage to the right of you. (So walk in the right direction until you find a carriage with “This Car” illuminated.)

The PLC screen in the electrical cabinet will also provide information to allow the crew to identify the cause of the alarm. In the event multiple alarms are occurring, then the screen will scroll through each of the faults.

Train Management Control Panel

Examples of the messages displayed on a PLC screen is given below:

NO FAULTS 26.10.06 14:53	FAULT END 2 DIRECTION	OPEN DOOR OR STEP 2B CORNER
Train is in Safe State	Fault is in a carriage in the End 2 Direction.	Door or Step is open in this carriage at the 2B corner of carriage
FAULT: END OF TRAIN	DANGER: SMOKE ALARM THIS CAR	EMERGENCY BRAKE END 2
410/230VAC Trainline Plug is indicating it is closed but carriage is not at end of train	A Smoke Detector in this carriage is activated. It will be beeping.	Emergency Brake at End 2 of this carriage has been pressed.

18. Help Points

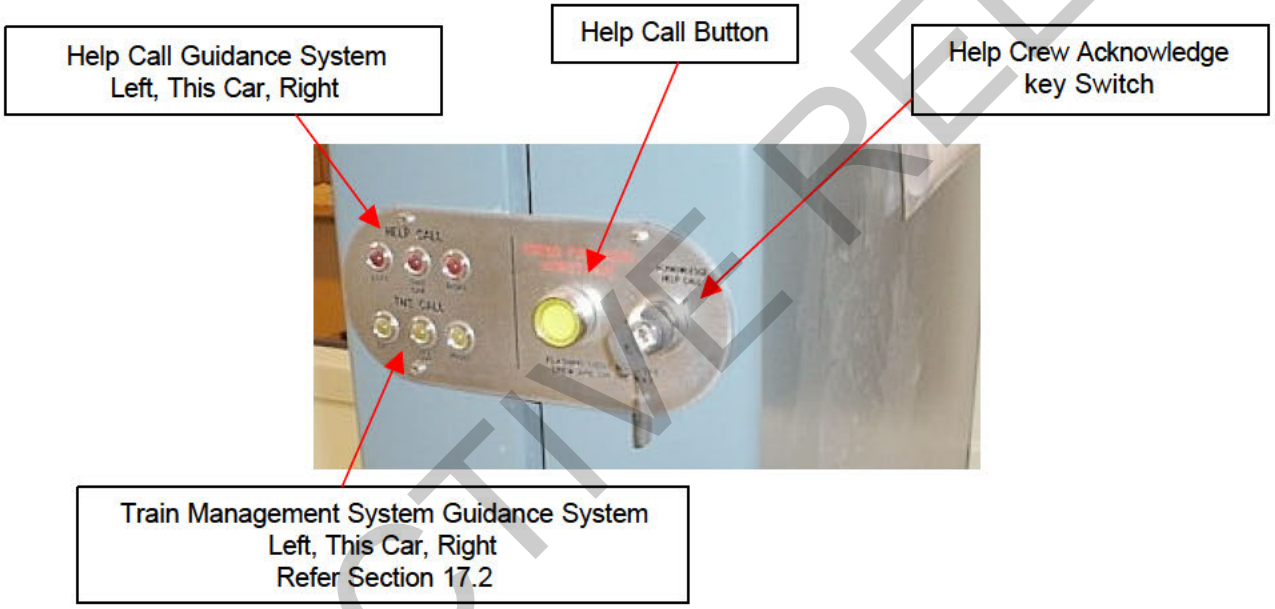
The Help Points in the carriages provides passengers with the ability to call for crew assistance.

The Help Points are located as follows:

SW carriage:
Electrical Cabinet No. 2 End of the carriage
HVAC Riser in centre of saloon

SWS carriage:
No. 2 End wall
HVAC Riser
Universal Toilet (indication light provided in ceiling outside toilet)
Wheelchair Seating Table
Wheelchair Hoist Doors (internal and external)

SWG carriage:
Electrical Cabinet in Generator Room
HVAC riser in saloon



18.1 Help Call

If the Help Call button is pressed, that button will illuminate. It will also send an audible buzz throughout the train to notify the train crew a Help Call has been made.

The audio tone will be slightly different in each carriage; this helps the train crew find the help call.
Help Call in that carriage On for 2 seconds
Help Call in No. 1 End Direction On for 1 sec, off for 2 sec, on for 1 sec.
Help Call in No. 2 End Direction On for 2 sec, off for 1 sec, on for 2 sec.

Once a Help Call has been received a crewmember may go to any Help Panel in the train, insert there door key and momentarily select the acknowledge position. This will cause the activated Help Call button in the train to start flashing, which provides feedback to the person requiring assistance that a crewmember is on the way.

The Help Panel will guide the crew to the help call with the use of 3 lights.

Left — Help Call is in a carriage in the left hand direction, walk in this direction until you find a carriage with "This Car" illuminated

This Car	Help Call has been activated in this carriage. The crewmember will have to look at each help call button to find the one illuminated.
Right	Help Call is in a carriage in the right hand direction, walk in this direction until you find a carriage with “This Car” illuminated.

To release a Help Call the Help Button just needs to be pressed in again to unlatch it.

Note: If multiple help calls are made the help guidance system will illuminate to indicate the direction of each help call. Therefore it is possible for all 3 guidance lights to illuminate in a central carriage.

18.2 Wheelchair Hoist Doors (internal and external) Help Buttons

The help buttons located internally and externally beside the Wheelchair hoist doors in the SWS carriage prevents the train safe light from re-illuminating after a door open/close cycle has occurred. This ensures the crew attends to the operation of the doors and wheelchair hoist. (refer section 19.1 for details)

19. Wheelchair Systems

The SWS car has two Ricon Wheelchair Hoists installed adjacent to the servery area, one for each side of the carriage.

The wheel chair hoists are only to be operated by the Train Manager.

19.1 Wheelchair Hoist Door Help Button – Prevents Train Closed Signal

The internal and external help push buttons can be pressed at any time, and operate similar to a normal help button. ie Sends a help call throughout the train. The difference with these help buttons is, if the doors are released, then it will latch open to prevent the train closed light from illuminating, until the Train Manager attends the wheelchair hoist Help Call.

In order to get the train closed light, the Train Manager must unlatch the help button, by pressing the illuminated help button again. They must then use their door key, select the door control position, return the key to the central position and then remove the key. Generally this would be done as part of the required door open sequence.

19.2 Open Wheelchair Hoist Door

Unlike the other external doors, passengers are unable to open the wheelchair hoist door, even when the door is released.

To open the Wheelchair Hoist Door the Train Manager must put the door control key into the control key switch and turn to the door control position, then press the Local Open push button.

The Train Manager then has full access to the door control buttons on the panel. They may now release all the trains doors from this panel by pressing the “Release” button, and close all the doors in the train by pressing “Close” push button as for any of the corner door controls (refer section 5.1 and 5.3 respectively).

19.3 Closing Wheelchair Hoist Door

~~The wheelchair hoist door will not respond to a train lined door close command.~~ To close the door insert door control key and turn to door control position, and then press the “Local Close” button. Pressing this button will close ~~the entire train as will as closing~~ the local door only.

Note: As for the corner door control panels, it is possible to close the entire train except the local door by pressing the “Close” push button. When the door key is in the “Door Control” position it is possible to achieve the “Door Closed” light, even with the local wheelchair hoist door still open.

This door is fitted with obstacle detection in the closing cycle of the door, if the door experiences an abnormal obstruction, the door will re open and stay opened.

19.4 Operating Wheelchair Hoist

In order to operate the wheelchair hoist the Train Manager will first open the doors as per above then turn the door control key to the “Hoist” position; this provides power to the hoist.

Note: **DO NOT** operate both hoists at once.

Use the remote control attached to the Hoist to control the platform.

There are 2 operations available on the hoist remote

1. Platform in and out,
2. Platform up and down.

The platform in and out function allows the platform to be folded away when not in use, or extended out ready to be loaded or unloaded. The wheelchair hoist door should not be open or closed unless the platform is fully in its retracted position.
The platform up and down function allows the platform to be raised and lowered, allowing wheelchair "roll on roll off" service over the full range of platform heights.

The hoist has the ability to lift 364kg safely.

If 230VAC supply is not available (Generator not running) avoid using the wheel hoist if possible. Batteries only have the capacity to do 1 lift cycle without reducing the 4hr lighting emergency battery back up capacity below 4hrs.

It is possible to raise and lower the platform without power, but using the handle provided and pumping the platform up and down in a similar manner to a hydraulic jack.

19.5 Manual Operation Wheelchair Hoist

In the event the hoist becomes inoperable under its own power it maybe manually operated. Follow the manual operation decal mounted on hoist pump assembly.

19.6 Wheel chair positions

Two wheelchair passengers can be accommodated in the servery car where wheelchair-securing points are provided. The securing points are similar to retracting seatbelts and simply pull out and plug in around the passenger.

Wheel chair hoist door SWS – Request button and door control

Wheel Chair Hoist – extended to Ground Level

20. Universal Toilet Facilities

A universal toilet is provided in the SWS carriage. This toilet is large enough for persons in wheelchairs and includes a baby change table.

The universal toilet has a Help Button installed on the right-hand side of the vanity (within reach from the toilet). If this Help Button is pushed it will alert the crew in the same way as the other Help Points (refer section 18). A light in the ceiling immediately outside of the toilet will also illuminate, to assist the crew to determine whether help really is required within the toilet.

The crew is able to unlock the universal toilet door from the outside in the event assistance is required by forcing up the red lock indicator on the exterior of the door.

21. Servery Facilities

The SWS carriage features a number of food and drink facilities.

A vending machine is provided for pre-packed foods and drinks to be dispensed, along with a coffee machine. A staffed kiosk is also provided for the sale of food and drinks that are not possible to dispense from a vending machine.
The vending and coffee machine are on a lease agreement, the operating manuals including phone numbers are located in servery cupboard.

Each carriage (except the SWG carriage) has a water cooler located in the vestibule.

22. Bike Access and Storage

Bike storage is allowed for in the SWG car generator room and space is provided here for other large luggage items.

There are no bike access or storage facilities on the SW or SWS cars.

23. Emergency Equipment

Each saloon has an Emergency Exit Break Glass hammer to allow escape via the windows in the event that the doors are not accessible and/or functional.

Two portable radio battery chargers are provided in the Train Managers Compartment in the SWG carriage.

Each carriage contains a secure box, which can be used to store emergency equipment as well as train crews personal items:

- Wheel chocks (all carriages)
- First Aid Kit (SWS and SWG only)
- Torches (SWS and SWG only)
- Light sticks (SWS and SWG only)
- Gas Mask (SWG)
- Cable ties for faulty steps
- Tail Light
- Ladder (mounted on top of the Generator)

In the event of an emergency within a tunnel, where it is not possible to evacuate the train via the side doors, the carriage end doors are to be used. Extreme care shall be taken when exiting the train without a platform.

The 54D repair book is located on the wall of the Train Managers compartment, SWG car.

24. Operating Keys

For operating the SW Cars, 6 keys are required:

Key	Operates
S Key	Locking External Doors, Generator to Saloon, TM Compartment
B Key	Servery – (Limited issue)
H Key	End Door Key – Bi fold doors at end each of consist
KN Key	Air Conditioning, Lights, PA (new AC Key)
AB Door Key	Door Key, Generator Emergency Reset
100 Key	Electrical Cabinet Locks, Emergency Brake Push Button Reset, Storage/Emergency Equipment Box

25. List of Technical References

SW Technical Data Reference

SW General Arrangement	15018400
Clearance Diagram	15018401
Stencilling Diagram	15018402
Brake Arrangement	15019182
Brake Schematic	15016919
Water Schematic	15016917
Body Arrangement	15018422
Seating and Table Arrangement	15019123
Bogie Arrangement	X28020
Underframe Equipment Arrangement	15019050
Handbrake Arrangement	15019060
Drawgear Arrangement	15018319
Concertina Installation	15013320
Electrical System	15016945
Seating Capacity	66 Seats
Triple Valve	WG1 Triple Valve with EL 42/50 Relay
Brake Cylinder	8”x12” Lightweight, SAP 115184
Slack Adjuster	SAB 450, SAP 101456
Handbrake type	Locomotive Power Unit
Brake Blocks	LT14

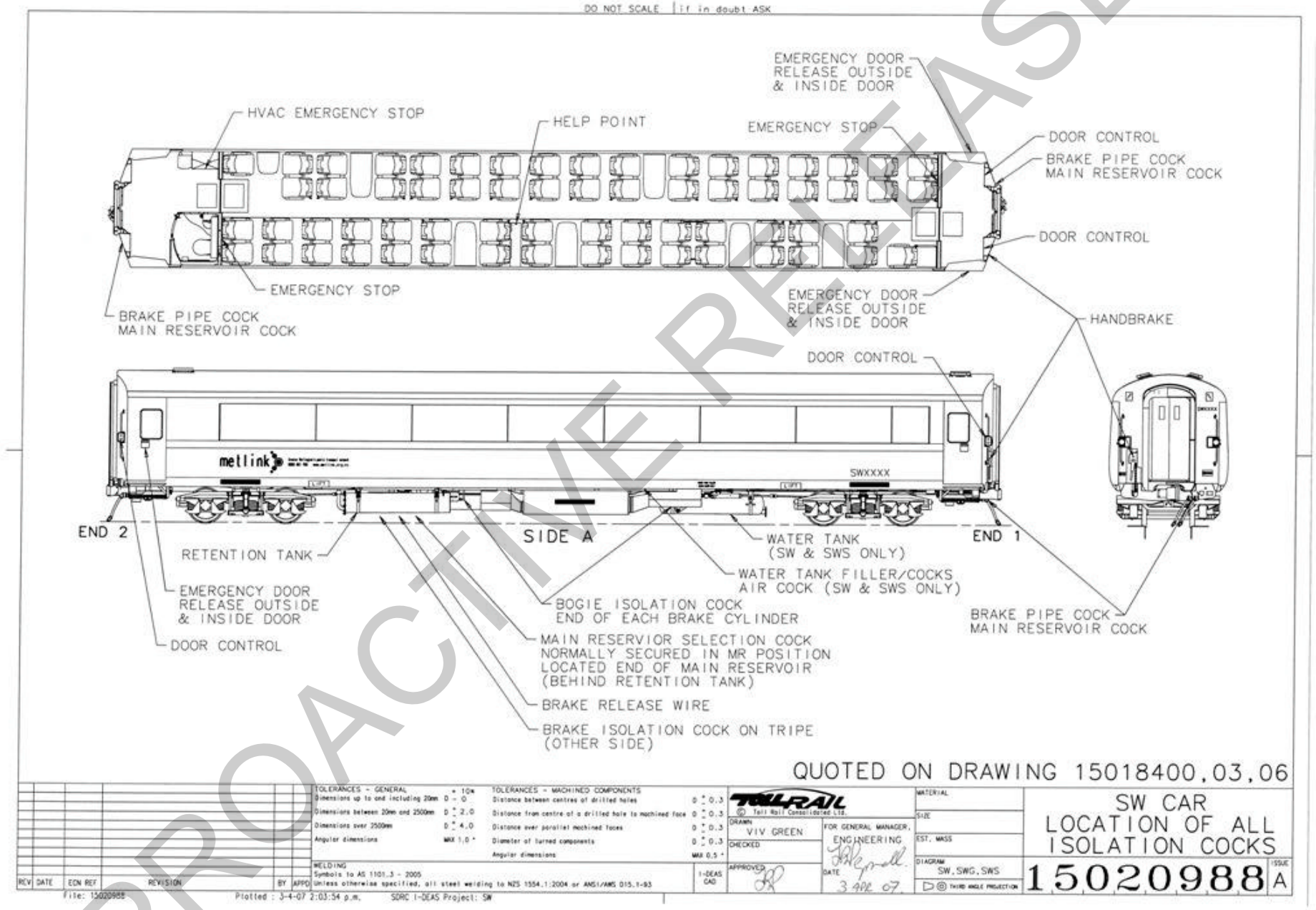
SWG Technical Data Reference – The same as SW except

SWG General Arrangement	15018403
Stencilling Diagram	15018405
Body Arrangement	15020250
Seating and Table Arrangement	15019127
Water Schematic	N/A
Underframe Equipment Arrangement	15020254
Electrical System	15019819
Seating Capacity	37 Seats
Diesel Alternator	Perkins / Leroy Somer - Caterpillar P200H
Diesel Alternator Rating	200 kVA
Fuel Capacity	550litres

SWS Technical Data Reference – The same as SW except

SWS General Arrangement	15018406
Stencilling Diagram	15018408
Body Arrangement	15019850
Seating and Table Arrangement	15019131
Water Schematic	15016918
Underframe Equipment Arrangement	15019974
Electrical System	15019802
Seating Capacity	37 Seats, or 31 and 2 Wheelchairs.

26. Location of Isolating Cocks



Tranz Metro

KiwiRail

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Rail Operating Code Supplement:
SE Cars - Operating Instructions for Onboard Staff

Mechanical Engineering M9398

Issue Number	Prepared (P), Reviewed (R), Amended (A) by	Approved by	Date of Approval	Review Date
Issue 1	[redacted]	[redacted]	18/11/08	
Issue 2	[redacted]	[redacted]	24-6-13	

[redacted]

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Amendment Record

Changes made to this procedure since its last issue, which affect its scope or sense, are marked by ***blue italics***.

DATE	ISSUE	AMENDMENT DESCRIPTION	NAME	INITIALS
24/06/13	*2*	***Removed reference to EO locomotives. Added ABD and PBSIG alarms. Updated to run with 5 cars, with non- dedicated Diesel locos and added toilets.*** ***Brake set up instructions updated.***	[redacted]	

1. SE Train Set Running Rights

The SE train's normal route is within the Wellington Tranz Metro area. Extensive but not universal running rights are available outside this area.

Two restrictions apply for the SE on the Wairarapa line:

1. *Trentham Station Down Main: Can only run if piloted. (27mm clearance on north end curve). This is not used except for special to the races and passing freight trains.*
2. *Carterton Veranda: 25kph, stops at the station so not an issue.*

Important Safety Information

- SE car brakes are Graduated Release, which is not compatible with direct release brake system hence brakes on SE cars must be isolated if on other Freight or Passenger Service. See Section 4.1. If this instruction is not followed the likely consequence is dragged brakes.
- When SE cars are operated as a two-pipe system - the Main Reservoir and Brake Pipe Air Hoses must be connected to provide air for the Brake system and Door operation

These carriages may be operated in passenger service for recovery purposes with only the Brake Pipe connected; however the operation of services may be sluggish, due to the restricted supply of air. *Air bag inflation will have to be monitored.* Graduated release will operate with either two pipes or single pipe set-up. *For single pipe set up see section 4.1 and 4.3*

If this instruction is not followed the consequence is potentially no brakes.

AAR27 pin jumper
This electrical jumper is fitted between carriages and locomotive to trainline the Tranzlog Alarm.
It must be fitted to the locomotive.

This is a controlled document –
Rail Operating Code Supplement: SE Cars - Operating Instructions for Onboard Staff, saved under Mechanical Engineering, Quality Masters, Passenger Vehicles - Document No.M9398.

These instructions are technical instructions relating to the design of the equipment on the train and to ensure safety they must be applied in conjunction with the requirements of the Operators Safety System.

Number of Passengers Carried

The maximum number of people permitted to ride in the carriages is:

SE	-	75 seated, 21 standing (74 seated, 1 flip up seat)
SEG	-	44 seated, 21 standing
SES	-	48 seated, 21 standing (44 seated, 2 x 2 seated flip up seats)

2. Train Start-up

The following procedure is to be followed when preparing the train ready for service.

- Ensure shore supply off and not connected.
- Unlock and enter SEG car via corner door. (To open operate the emergency door handle. Once inside close door using the emergency door handle and then push in exterior door reset button).
- At SEG Generator Set Control Panel (beside SEG electrical cabinet):
  - Turn the STOP / RUN switch to "RUN".
  - Turn main selector switch to GENERATOR SUPPLY (generator starts with no load)
  - Close the 24 volt battery CB and Tranzlog CB
  - End Bi fold doors closed and locked.

NOTE: If the generator will not start ensure the switch on the generator control panel is set to Auto.

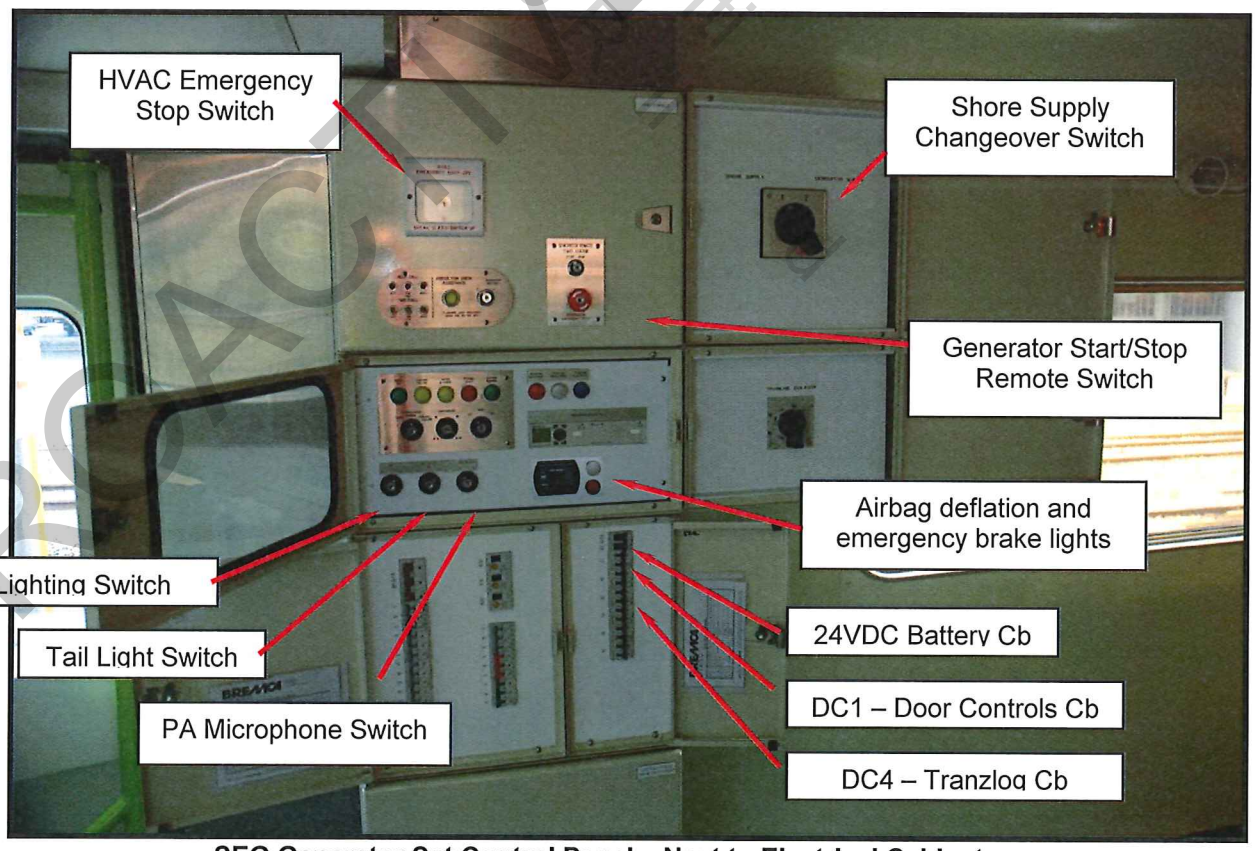
- Proceed through the train, on each individual car -
  At the electrical cabinet:
  - Check all AC and DC circuit breakers are "ON".
  - Turn "ON" the 24v main DC (battery switch).
  - Turn "ON" air conditioning selecting the heat/cool setting as appropriate.
  - Check that all saloon lights are working.

  At external doors:
  - Unlock deadlock on external door.
  - Push in exterior door reset button located in the hole in shelf plate above each door.
  - Concertina curtain between cars in place.

  In saloon of each car:
  - 2 x Window hammers.
  - 1 x Fire Extinguisher.

- Ensure Taillights are operating on the end of consist.

- Rear car opposite end to SEG - Bi fold doors closed and locked.



SEG Generator Set Control Panel – Next to Electrical Cabinet

Train Start-up - Continued

- Check door operation on both sides of train.
  - Starting at one end of train at door control panel, insert the door key select control and press release push button, repeat at opposite side door.
  - Return through train and randomly open doors on both sides by pressing the "Press to Open" push button either internal or external push buttons.
  - At end of train close doors both sides:
    - Press "Close" button – check door close alarm sounds.
    - Check all remote doors have closed and "Door Closed" lamp illuminates.
    - Press "Local Close" button – local door must close.
      Remove key and "Door Closed" lamp remains illuminated.

- Carry out terminal brake test and all other safety checks required by Rail Operating Code Section 5.3 Train Marshalling, Build and Inspection Procedures.

3. Train Stabling

The following procedure is to be followed when leaving the train after service.

- Check all external doors are closed.
- Proceed through the train, on each individual car –
  At the electrical cabinet:
  - Turn "OFF" air conditioning (this is important, as the shore supply is unable to power all the HVAC units).
  - Turn "OFF" all lights and check.
  - Turn "OFF" the 24v main DC circuit breaker (battery switch).
    NOTE: If cleaning is required and then DC1cb to be turned "OFF" this will leave internal saloon doors in the 'open' position, 24v DC cb turned 'off after cleaning has been completed.

  At external doors:
  - Deadlock external door.
- At SEG Generator Set Control Panel
  - Set the main selector switch to EXTERNAL SUPPLY.
  - Turn the generator STOP / RUN switch to "STOP". The Generator will take 3 minutes before it stops (allowing to cool down to minimise damage to engine).
- Leave via SEG corner door, and lock door.
- Follow Rail Operating Code procedures for securing train – park brakes. If locomotive is detached this is covered under ROC CSR4.1.
- If required at the shore supply point, connect the landline to the SEG car external connection and switch "ON" the external power supply.

4. Train Handling Set Up

4.1 Graduated Release

All SE cars and vans are fitted with WG1 triple valves. These have a graduated release capability which means that brakes can be applied and released gradually in steps.

The locomotives assigned to haul the SE train sets will have the 26L brake cut off valve set up for 3 positions: "Out", "Freight" and "Passenger". The "Passenger" position must be used on these locomotives when hauling the SE train sets.

In locomotive cab:

- *Set up as normal for lead operation*
- *Set 26L cut off valve to "Passenger"*

If these locomotives are assigned to haul freight or passenger trains fitted for "one pipe" operation, the "Freight" position must be selected on the locomotive brake cut off valve. Note that this option is not for normal passenger operations.

This is not for normal passenger service.
NOTE: If the Locomotive Engineer is not certified for graduated release operation, the 26L brake cut off valve must be set to "Freight" and one pipe direct release braking operated with both BP and MR connected. The MR will maintain the Airbag inflation.

4.2 SE Train Handling Instructions

Key points for handling SE train sets

The Brake Pipe is required to be reduced to below 100kPa when changing ends with the same loco, or when changing locomotives, to allow the control reservoirs on each of the cars to be correctly charged. If this is not done the brakes on the cars may not fully release when the brake pipe is fully charged from the other end.

- To reduce Brake Pipe pressure:
  - Locomotive is coupled to train and MR/BP hoses connected with air cocks open.
  - When Brake Pipe gauge registers airflow place brake valve handle to "handle off" position and reduce air pressure to below 100kpa.
  - At 100kpa place brake valve handle to "release" position and charge brake pipe to 550kpa before performing brake test.
- Since the locomotive may on some trains comprise up to ½ the total train weight, to avoid skids on the carriages or overheating of the wheels, the independent release on the locomotive should not be used to bleed off any automatic brake application on the locomotive.
- The locomotive and carriage brakes are capable of being applied, then partially released to any point between full service and release and can then be reapplied a further number of times. The air supply that feeds the brake cylinders is constantly topped up out of the Main Reservoir pipe, ensuring brake cylinder air is always available.
- If a brake application is made and then the brake handle is moved part way back towards release the brake cylinder pressure will reduce according to the new handle position.
- With the graduated release brakes on both the locomotives and carriages, there will always be air pressure in the brake cylinders after a brake pipe reduction, until the brake pipe is fully recharged again. If the locomotive automatic brake application is left applied as recommended the locomotive brake cylinder pressure will mimic the brake cylinder pressure on the carriages.

- The Emergency brake cylinder pressure is higher than Full Service brake cylinder pressure on the SE carriages. Emergency is 400kPa, while Full Service is approximately 330kPa. In emergency the speed of the brake application is also faster due to the faster brake pipe discharge rate.
  This design allows Locomotive Engineers to use Full Service during routine stops, without fear of locking the wheels up, plus have the assurance that there is additional braking available if required.

4.3 2 Pipe Brake System

When the SE carriages are in passenger service the Main Reservoir and Brake Pipe air hoses **MUST** be connected through the entire train.

The Main Reservoir air supply provides air to operate:
- Brake Cylinders
- Doors and extendable steps

In the rare event it is not possible to operate the SE carriages as a 2 pipe train, e.g. for recovery purposes or moving cars on freight services, it is possible to configure each carriage to operate as single pipe, by changing the position of the Main Reservoir to Brake Pipe Selection Cock.

Operation of services may be sluggish, due to the restricted supply of air. Air bag inflation will have to be monitored. Graduated release will operate with either two pipes or single pipe set-up.

4.4 Parking the SE Train Consist Unattended

Sufficient SE Park Brakes must be applied if the SE train consist is to be parked and left unattended.

4.5 Terminal Brake Test

The Terminal brake test for SE train consists is much the same as for other train consists:
- Make a 100Kpa brake pipe reduction.
- Set the brake valve cut out valve to "Cut Out" and monitor the brake pipe pressure over 1 minute. Maximum allowable brake pipe leakage is 35Kpa in 1 minute.
- Return the brake valve cut out valve to "Passenger" position on completion of the terminal brake test.

4.6 Cutting out Brakes on the SE Train Consist only

When brake faults occur on SE carriages the two Brake Cylinders on each axle of each bogie can be isolated or the entire carriages brakes can be isolated in the case of a Triple Valve fault.

If the Triple Valve Isolating cock is isolated, the Main Reservoir Drain Prevention Cock will also require isolating to prevent constant draining of the Main Reservoir

The SE train consist (6 cars) may run with either:
- ***The brakes on one SE carriage only in the consist cut out in any position on the train except the end of the train.***
- ***The brakes of up to two bogies on one or two carriages (in any position) cut out except the end of train.***

The SE train consist (5 cars) may run with:
- ***The brakes on one bogie only in the consist cut out in any position on the train except the end of the train.***

4.7 Coupling the SE Train Consist to a Locomotive

When the SE train consist is coupled to the allocated locomotive, the 27 way loco jumper cable must be connected between the loco jumper socket and the AAR 27 pin socket on the train. Only the long locomotive jumper cable must be used for this purpose, the short DX cables are not suitable.
The jumper cable ensure that the SE Tranzlog can operate the loco alarm bell for 15 seconds when the train is moving for the following alarm conditions;

- *Loss of train safe light*
- *Park brake applied warning*
- *Airbag deflated warning*

4.8 Coupling an SE Train Consist to a Locomotive without an Auto Coupler

The SE carriages use auto couplers and will preferably be coupled to a locomotive with auto couplers.

If a train consist is to be coupled to a "non-" auto coupler locomotive, a modified transition head is located on the headstock of the end SE car (painted Gold). This transition head is designed for the SE (Buckeye) auto coupler to ensure positive coupling.

The transition head is to be placed back on the hook on the headstock after use and not to be used on anything other than SE or other S class passenger cars.

4. 9 Moving an SE Carriage on another Freight or Passenger Service

The SE carriages are not to be conveyed on any ordinary freight or passenger train service unless the movement is covered by an Engineering-initiated "Special Bulletin".

In the rare event that an SE carriages consist needs to be conveyed on a train with direct release brakes, the vehicles must run at the rear of the train with two loaded braked vehicles not exceeding a total of 70 tonnes on behind. Carriages or AG vans will count as loaded vehicles for the purpose of this instruction. The SE carriage brakes must be cut out when conveyed on a train with direct releasing brakes.

Running SE with SW trains for rescue only

- *The Braking systems of both trains are graduated release so MR and BP are to be connected between the cars.*
- *SW SE are not TMS compatible so must be run as two separate trains.*
- *The SE consist should be directly behind the loco to trainline the Tranzlog alarms (PBA, ABD and Train Safe) via the AAR 27 pin jumper to the LE/Loco.*

- *If the SE consist is not directly behind the loco the Tranzlog alarm for PBA, ABD and Train Safe cannot be trainlined to the loco. When running in this configuration the TM must monitor, at all times, the ABD, PBSIG and TS alarms on the SE cars and stay in easy radio contact with the LE.*

- *Ride heights, the SE ride higher than the SW when all new. This will require limiting any movement between SW and SE carriages when in motion.*

4.10 SE Train Assisted From the Rear by a Locomotive Hauled Train

In case of a breakdown situation and assisting locomotive/train pushing from the rear:

Consist: Locomotive brake set-up compressor operative:

- As per Rail Operating Code instructions for assisting loco BP coupled only i.e. Main Reservoir still supplied to all SE cars, but may couple Main Reservoir Pipe also.

Consist: Locomotive brake set-up compressor inoperative:

- As per Rail Operating Code instructions for dead loco BP coupled only, EXCEPT also couple the Main Reservoir Pipe.

In the event that Main Reservoir air cannot be provided to all SE cars in the consist, then each of the SE cars must have the Main Reservoir to Brake Pipe Selection Cock moved to the BP position cock This ensures air supply is still available to the brake cylinders, doors etc of the SE carriages.

4.11 SE Train Assisted by a Locomotive on the Front of the Train

In case of a breakdown situation where an assisting locomotive is attached to the front of the train

Couple all brake hoses between the locomotives (Brake Pipe (BP), Main Reservoir (MR). Leave the Brake Pipe and Main Reservoir pipes connected throughout the SE train.

On the Assisting Locomotive if possible put the brake valve into the "Passenger" position to allow graduated release, otherwise use the "Freight" position. Be aware the brakes on the train may take longer to release (i.e. until the brake pipe is fully charged) and the Graduated release feature is not available.

EMU/DMU's and Silverfern railcars are <u>NOT</u> permitted to assist SE car trains.

4.12 Shunter's Riding Position

The shunter's riding position on an SE carriage is within the vehicles. Windows are provided in the inter-car doors for shunting purposes.

External riding is not permitted. The space between the carriages will close up during curve negotiation.

If Locomotives are coupled on the end of the SE consist the correct riding positions on locomotives will apply.

4.13 Coupling/Uncoupling SE Cars

Refer to Rail Operating Code:

Section 5.1 Operating Instructions for Yard Shunting and Allied Personnel.
Section 5.3 Train Marshalling, Build and Inspection Procedures.

This manual refer also to:

Section 5.9 Re-Marshalling Door Checks.
Section 8.0 Trainline Electrical Jumpers.

4.14 Coupling SE Carriages with Other Vehicles

SE carriages are only permitted to run with each other and locomotives modified for passenger operation (i.e. with their graduated release brake feature enabled) and also the AG222 power van.

4.15 Use of Interconnecting and Saloon End Doors

Passengers are permitted through interconnecting doorways between SE carriages. However take care when moving between cars while the train is going through turnouts etc, as the 2 concertinas can move sideways in relation to one another restricting the available passage way.

The end door at each end of the consist should be locked, along with the Saloon/Generator door on the SEG car.

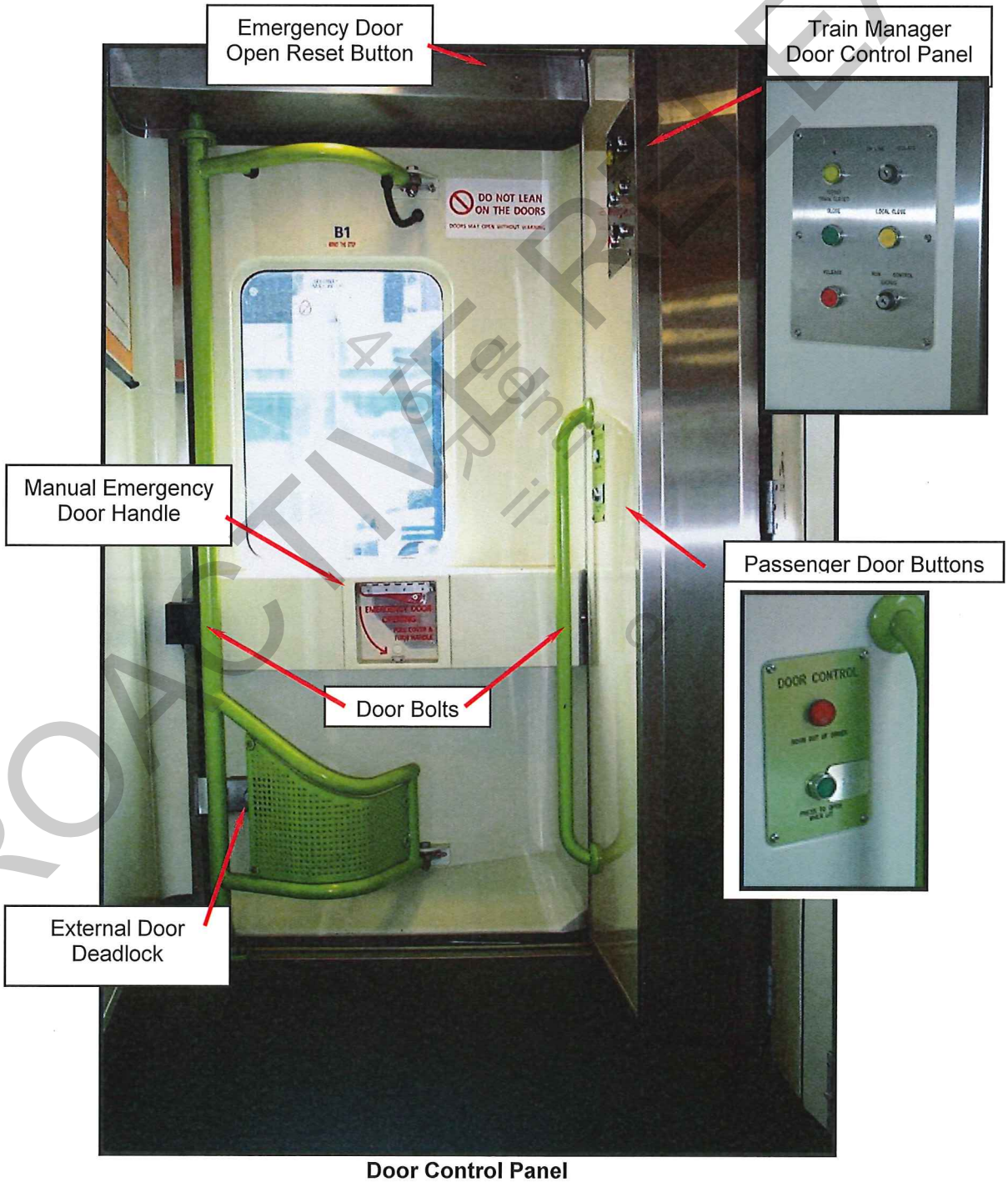
5. Door Operation

Important Note:

The Train Manager MUST not insert their door key into the door control panel or operate the doors in any way until the train has completely stopped. When stopped the Train Manager may then insert the door key in one of the control panels located next to each corner door on the side adjacent the platform.

Right of Way is only to be given after ALL doors including the local door are completely closed and a door light is illuminated.

If the train door closed light extinguishes while the train is in motion the Locomotive Engineer must be instructed to stop the train. Insecure door/s or steps to be secured and if necessary isolated and door out of order signs attached.



Door Control Panel

5.1 Door Release

The Train Manager can only release the doors for operation. This is accomplished by inserting the door key into the bottom right key switch and selecting "Control" on any door control panel on the desired side of the train. The "Release" button is pressed which will cause the locking bolts to withdraw on each door on that side of the train only, a brief alarm will be sounded to indicate a door release has occurred. The key can then be turned back to "Run" position and removed, and the doors will remain released.

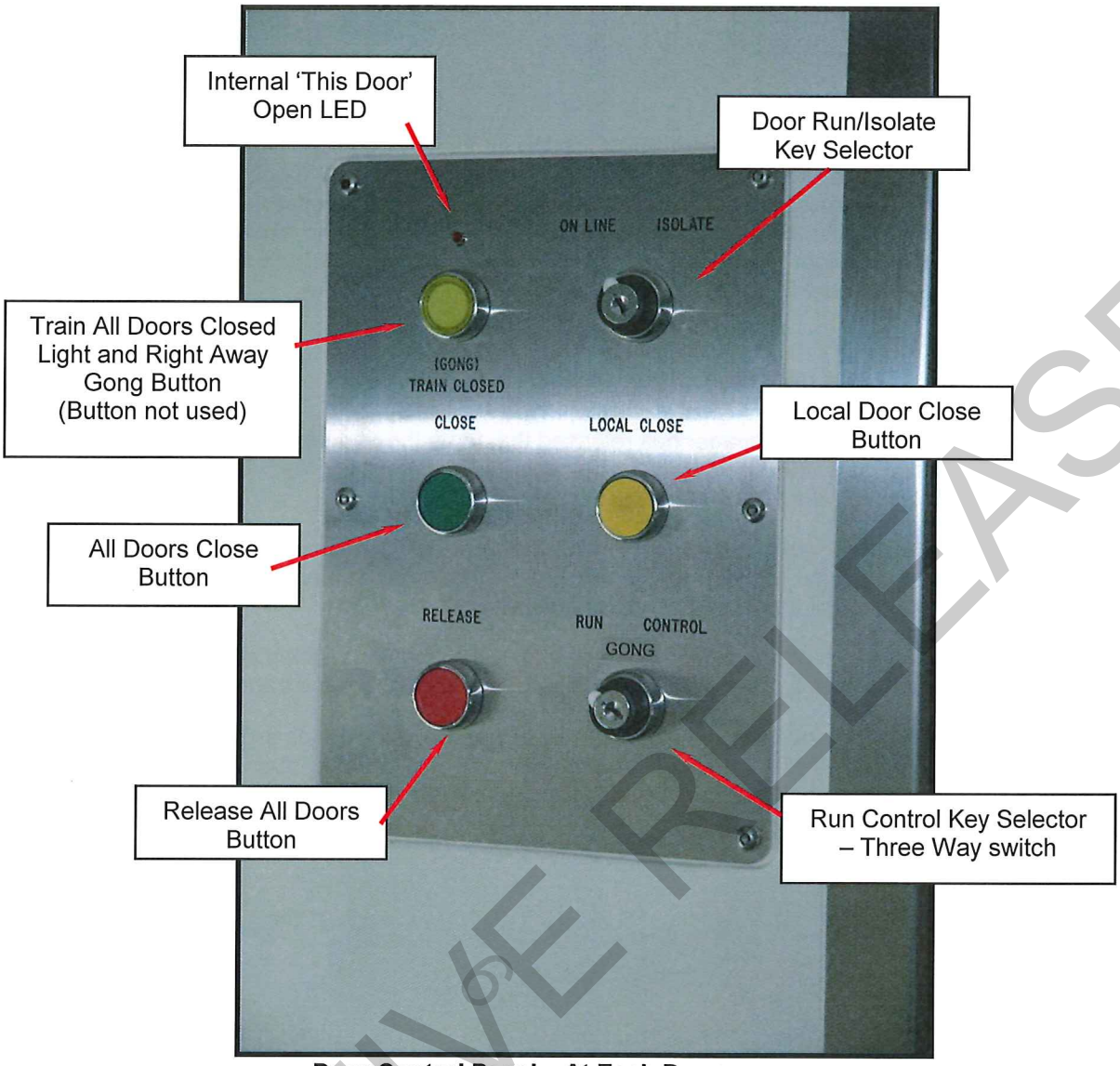
5.2 Opening of Doors on a Side

Once the Train Manager has released the doors the door open push button lights up and passengers may open the door by pressing the "Press to Open" button at any given door on that side of the train (internally or externally).

NOTE: The Wheelchair Hoist Door in the SES carriage can only be opened or closed by the Train Manager at that door station. A passenger may request assistance by pressing the Help Call button at this door station, refer Section 17.

When the door opens an automatic step will also extend. If a platform (or obstruction) prevents the step from fully extending the step will automatically retract and stay retracted.

NOTE: The step has the ability to hinge upwards, if it extends slightly above a platform and the carriage drops with the additional weight of people boarding step may catch on the platform. Bump stops have been fitted to assist in preventing this issue occurring.



Door Control Panel – At Each Doorway

5.3 Closing of the Doors:

The key selector switch has three positions Run, Gong and Control:

Run	*Normal position to run, key removed.*
Gong	*Confirms 'Local Door' is closed ('All Doors' light still illuminated) indicates 'Right Away'. (this not used in this service so does not require pressing)*
Control	Allows the release 'All Doors' for opening and closing 'All Doors' then the 'Local Door' after second door check has been performed.

At any door control panel on that side, insert the door key into the bottom right selector key switch and select "Control". Press the "All Door Close" button, door close alarm will sound and all doors except the local door will close.

Check the "Train Closed" lamp has illuminated at the same time performing a second door check by stepping out onto the platform **(Check the gap as the step will have retracted when 'close' button pressed).**

Press the 'Local Close' button closing the local door.

Now select the "Gong" position the 'All Doors' light illuminated will confirm that the 'Local Door" has correctly closed.

Turn door key selector switch back to "Run" and remove the key.

Give the right of way to the LE over the radio

NOTE: If the local door has not closed correctly a right away signal to the Locomotive Engineer is not to be given. Follow procedure for fault finding to solve or isolate problem.

NOTE: **The Wheelchair Hoist Door in the SES carriage can only be opened or closed by the Train Manager at that door station. If a help call button at this door station has been pressed, the "Door Closed" light will not be achievable until it is attended to,** refer section 17.

5.4 Obstacle Detection

The doors have obstacle detection installed in both open and close directions, while the extendable step has obstacle detection installed in the extend direction only.

If the Door or Step 'sees' an abnormally high force during operation the system will automatically change the direction of the door/step.

Extreme wind may be sufficient to cause the obstacle detection to prevent it from opening or closing. The collision detection may be over ridden by holding the Open or Close button down. If the Train Manager holds the Close button down to ensure a door closure, they must visually ensure there are no real obstructions.

5.5 Emergency Door Release

A manual emergency door handle is provided on each door, which allows the safety systems to be over-ridden and a door to be opened without the Train Manager in the event of an emergency.

When the emergency handle is used it interrupts the door closed circuit and the "Door Closed" light will go out, an audible warning will sound continuously at that door station, and an audible warning will be sounded briefly throughout the train to indicate a change of status. The Train Manager must stop the train and identify the cause of the change of status as soon as practically possible.

Once a door is opened using the emergency handle it must be closed and then reset by pressing the reset button. The reset button is located in the upper shelf plate immediately above each door.

A pen or similar should be used to press the button through the small 10mm hole. The door will not be operational again until this reset button is pressed.

NOTE: Steps will not operate when a door has been opened using the Emergency Door Release. The crew can be guided to the open door via the Train Management System, refer to Section 16

5.6 Internal / External "This Door Open" Light

To assist with the detection of faulty doors/steps an external light has been provided above each corner door. If the door or steps at a location are open or not properly closed, the external light and internal "This Door Open" light will illuminate. On the door control panel the internal "Door Closed" light will be extinguished and the red LED light will be illuminated

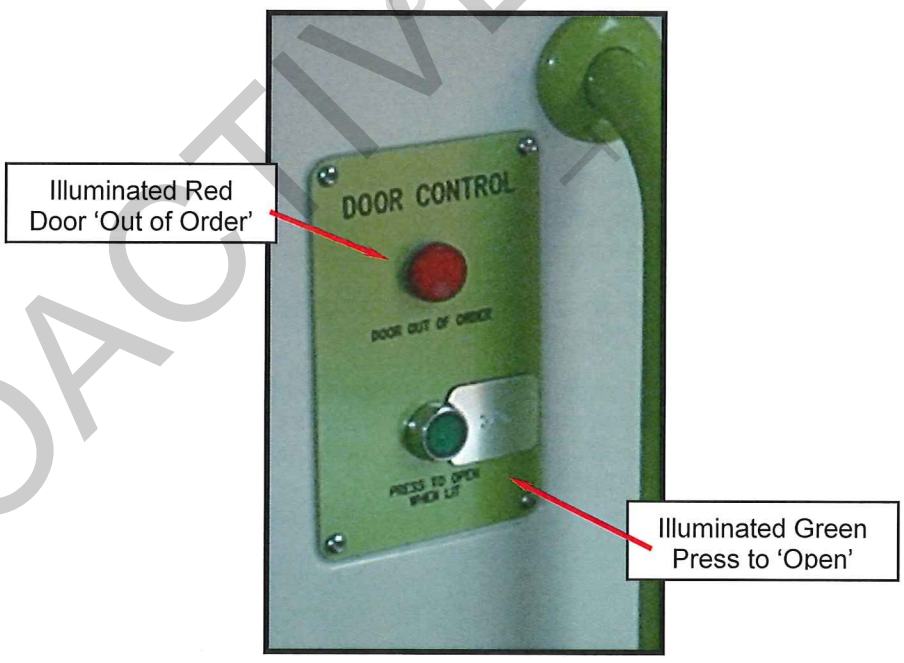
5.7 External Door Lock out Procedures

Should a door fail in service, insert the door key into the upper right key switch on the door control panel adjacent to the defective door and select "isolate". The "Door Out of Order" light on the door control panel will now light up and the door will be rendered inoperative.

Prior to selecting the "Isolate" position ensure both the door and the step is in the closed position. Cable tie the step into the closed position and lock the door using the deadlock. When in the "Isolation" position the door and step closed sensors are no longer monitored, so if there is a fault in these sensors it is possible to still achieve the "Closed Light" by selecting the "Isolate" position. Therefore it must be determined that the door and step are safely closed and secured.

If the "Emergency Door Release" is used to open this "Isolated" door it will still be detected and the "Closed Light" will go out and an audible alarm will be briefly sounded to indicate the change of state.

Refer to "Emergency Door Release" Section 5.5 for instructions on resetting an emergency door release.



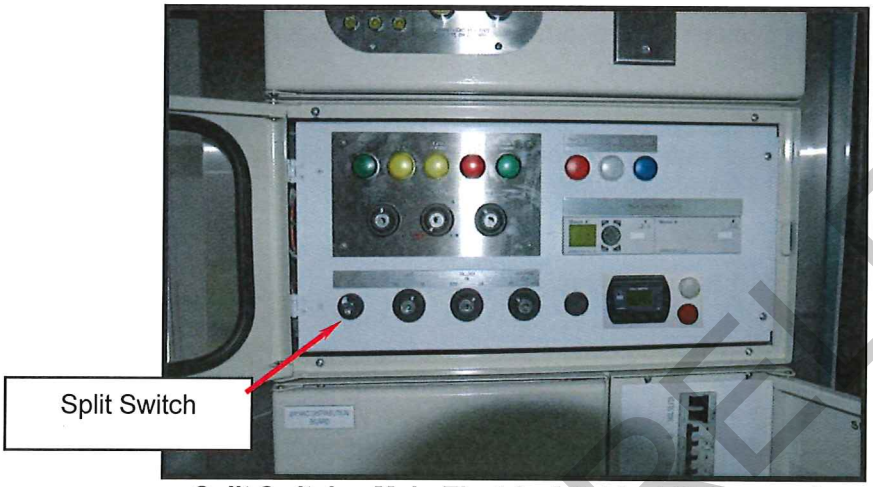
Passenger Door Control Buttons – Internal and External

5.8 Short Platform – Door Control Split Switch - SES

The electrical cabinet on the SES carriage has an extra switch (Door Control Split Switch) to control doors at short platforms. When the train consist is too long for a platform the Train Manager will operate the switch prior to arriving at a short platform. Only doors north inclusive of the wheelchair hoist will operate (i.e SEG, SE and half of SES) all other doors will be automatically isolated until the switch is returned to the "Full" position after departing a short platform.

PID displays and announcements will be made informing passengers location to disembark.

NOTE: When using this process ensure door controls north of the Wheel Chair Hoist are operated only.



Split Switch – Main Electrical Cabinet SES car only

5.9 Re – Marshalling Door Checks

Whenever SE car train consists are re – marshalled (cars on or off) the following check is to be performed to ensure all external doors in the consist are operating safely and correctly.

- Ensure that automatic coupling, air hoses and trainline 410/230VAC electrical jumpers are correct.
- Ensure jumper socket lid furthest end of consist from the SEG car is firmly latched closed.
- Set consist up and perform a full door check.
  - On any door control panel, insert the door key into the bottom right key switch and select "Control".
  - Press the "Release" push button. This will withdraw the locking bolts on each door on that side of the train only. The "Press to Open" push buttons on each door control panel will light up once each locking bolt has withdrawn fully. Remove key.
  - Any door on that side can now be opened as desired, by depressing the "Press to Open" push button on the adjacent door control panel. Test them all, use randomly either the internal or external button.
  - On any door control panel on that side, insert the door key into the bottom right key switch and select "Control".
  - Press "Close" button – check door close alarm sounds.
  - Check all remote doors have closed and "Door Closed" lamp illuminates.
  - Press "Local Close" button – local door must close.
  - Remove key and "Door Closed" lamp remains illuminated.
- Repeat above process for other side of train. Both sides can be checked at same time.
- Once both sides have been checked with all doors closed and the closed light illuminated, at furthest end of consist from the SEG car operate the emergency handle to open an exterior door. Ensure that the train closed light extinguishes as the door is opened.

NOTE: If taillights are set to the automatic position and with the 410/230VAC lid correctly closed the taillights for that car will now be illuminated.

5.10 Interior Vestibule/Saloon Doors

The automatic interior vestibule/saloon doors are opened, by standing on the footpads on each side of the door. After stepping of the pads doors will automatically close after 3 seconds.

The doors may also be opened or closed using the pneumatic "Open" / "Close" push button on the wall beside the door.

In the event of the 24VDC power failing or air pressure dropping below 300 kPa the saloon doors will open and stay open until power or air pressure is restored.

To assist with movement throughout the train (possible low air pressure) when stabled in passenger storage yards the DC1 (Door Control) circuit breaker maybe turned "OFF". Push the pneumatic "Open" push button, the doors will now stay in the open position until the DC1 cb is turned "ON" and air pressure restored.

5.11 Emergency Stop (Brake) Push Button

"Emergency Stop" push buttons are located on the saloon end walls. Use the ***"100"*** key to reset.

If the "Emergency Stop" button has been depressed, it will prevent the Door Closed Light from being illuminated, a brief audible alarm will sound throughout the train and the Train Management System will guide the crew to the activated push button. Please refer to *Section 17: Train Management System* for more details.

5.12 Shunting Movements – Doors Closed

For shunting movements doors are to be closed and a door light obtained. If it is then necessary to exit for shunting purposes, manually operate the emergency door handle to open the door and exit, and then close the door from outside.

NOTE: Steps will not operate when a door has been opened using the Emergency Door Release.

6. Door Fault Procedures

The procedures below are provided as guidelines to aid fault rectification, and/or to allow a train to complete its journey if at all possible. However, under ALL circumstances the Operators Safety System takes precedents over these procedures to ensure passenger safety.

Symptom	Cause	Remedy
Door will not respond to controls and out of order light off	1.Emergency door handle has been used or deadlock has not been released	Locate the 10mm hole in the panel immediately above the door. Push a pen or similar object through this hole to operate door reset push button, and then operate the door as normal. Check deadlock has been released.
	2. Low Air Pressure	Locomotive attached – air pressure to 550kpa.
No "Door Closed" light illuminates after the door closed button operated.	1. Help Call	A Help call has been made at the Wheelchair Hoist. Crew must attend and reset the help call at the station before the train can proceed. TMS Panel will indicate Help Call and direction if this is the case. Crew must attend to the help call. Refer Sections 17.2
	2. Circuit incomplete	Use Train Management System to find the cause, could be - open door or step - door key selector switch in wrong position - activated smoke detector - activated emergency brake - 410/230VAC plug lid at end of train not properly closed - 410/230VAC jumper between cars – Generator must be shut down before handling - 24VDC jumper between cars - a carriages circuit breakers "OFF" - wiring/component failure
	3. Door blocked by obstacle	Cycle the doors again. If problem does not clear itself, look for obstacle or move to 4. If it is wind causing the detection of an obstruction. Hold down the "Close" button until the door is completely closed. Visually ensure no person is obstructing door way while closing.
	4. Defective door bolt, reed switch or door bolt not fully engaged	Find the defective door, by using the TMS Panel, and "This Door Open" lights on the control panels: a. Push a pen through the small hole in the panel above the defective door to press the door reset push button to ensure an emergency door release has not occurred. b. Cycle the doors again, at the defective door. c. If the door light still does not come up check doorstep is fully retracted and door is closed. If necessary use the emergency door handle to close that door. Cable tie the step closed, lock then isolate door.
One train closed light not illuminated, all other doors illuminated with "all doors" closed.	Blown bulb in the location that is not lit	Ensure other train closed lights are on and no faults are listed on the Train Management PLC Display. Book up fault in 54D book, and continue as normal.
Compressed air blowing in the vestibule roof area with possible erratic door operation	Leaking pneumatic components	Cable tie closed the defective step, lock the defective door and Isolate door, using upper right key switch on the main door control panel at the defective door location.

NOTES:
The Operators Safety System must be followed if any conflicts exist with above guidelines.
The train-set 54D repair book will be located in the Train Managers compartment of the SES car.

7. Diesel Alternator Set

The 200kVA diesel alternator set located in the SEG car will supply all 410/230VAC power for lighting, heating and ventilation, plus charge the 24VDC battery back-up system, for a consist of up to 8 SE, plus 1 SES and the SEG car itself.

7.1 Generator Emergency Shut down

7.1.1 Emergency Shutdown

The generator may be shut down in an emergency situation via the emergency stop beside the saloon/generator door, the SEG electrical cabinet, or on the generator canopy.

The emergency pushbutton on the SEG electrical cabinet and in the saloon requires the use of the door key to reset, while the generator canopy stop button is a turn to release push button.

If an emergency stop button is pressed the reset procedure description in section 7.1.2 will have to be followed.

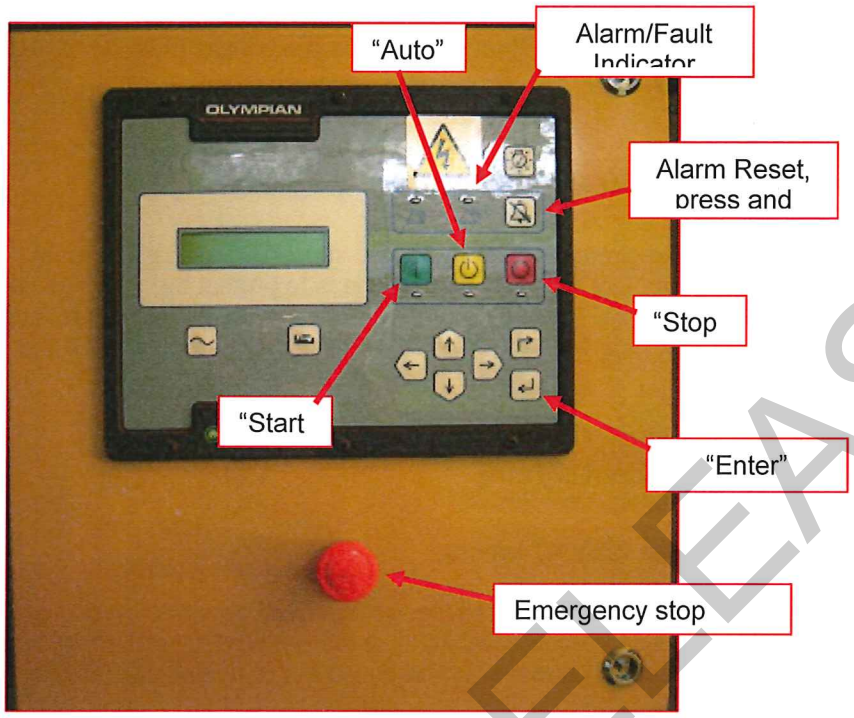
7.1.2 Resetting Generator Faults/Alarm, Including Emergency Shutdown

If the emergency stop button is pressed, it creates an alarm condition, which prevents the generator from being re started until it is reset.

If an alarm or fault has occurred the "Alarm/Fault Indicator" will illuminated on the generator control panel.

Follow the following steps to clear a fault/alarm:

1) Ensure cause of fault/alarm is no longer active, i.e. release the activated emergency stop (by use or door key or turn to release)
2) Open canopy door to get access to generator main panel.
3) Push the "Stop" button (Red Square push button)
4) Press on hold for a couple of seconds the "Alarm Reset" button.
   The screen will change to ask if you wish to reset faults.
5) Press the "Enter" button
6) Press the yellow "Auto" button
   Note generator may start if remote switch on electrical cabinet is already in "start" position
7) Close canopy door.
8) Turn remote generator switch on electrical cabinet to "start".



7.2 Diesel Generator Set Fire Extinguisher System

Each diesel generator set is equipped with a "Lifeline 2000" automatic fire extinguisher system. This extinguisher system uses a fusible link detector in the genset housing to monitor a fire occurrence. If a fire is detected the extinguisher system automatically sprays AFFF (Aqueous free forming foam) over the diesel engine and alternator and shuts down the generator. After a fire extinguisher has operated, the generator will not be able to be restarted, until the main extinguisher bottle has been replaced.

The AFFF fire retardant produces no harmful fumes and the foam produced will break down naturally over a short time period. The AFFF fire retardant foam is rated for use up to 10,000 volts.

7.3 Diesel Generator Set Fuelling

The fuel tank is located under the SEG and holds 550 litres of fuel; this is sufficient fuel for 2 days of typical operation.

The fuel tank can be fuelled using an Aeroquip dry break system on the A-Side of the carriage, or alternatively a traditional fuel nozzle direct into the fuel tank on the B-side of the carriage.

The fuel tank is located at the opposite end of the carriage from the generator, to give better weight distribution for the carriage.

7.4 Shore Supply Switch

A shore supply / generator supply change over switch is provided in the SEG generator room beside the main electrical cabinet. Refer to photo in Section 2 page 5.

In the generator position it allows power from the Generator to be supplied to the SEG and the connected carriages via the 410/230VAC trainline.

In the external (shore) supply position it allows a land base connection to be plugged into the headstock of the SEG, which provides a limited amount of power to run lights and cleaning equipment.

NOTE: HVAC systems throughout the entire consist must be turned off when connected to the shore supply.

7.5 Trainline Circuit Breaker Protection

The Trainline circuit breaker is located in the SEG generator room. This circuit breaker should remain in the "ON" position; its purpose is to protect the Trainline cable, plugs and sockets. This circuit breaker will essentially turn off power to the entire train (except the SEG which receives a direct power feed from the generator) if it trips. In the event of a trip, reset it and record it in the 54D book.

7.6 Generator Set Room Lighting

7.6.1 Generator 230VAC Lights

There are non-maintained (i.e. genset must be running and / or Shore supply connected for these to operate) 230VAC lights in the generator room, these lights only operate on the 230VAC supply and are turned on via the switch on the electrical cabinet along with the saloon lights.

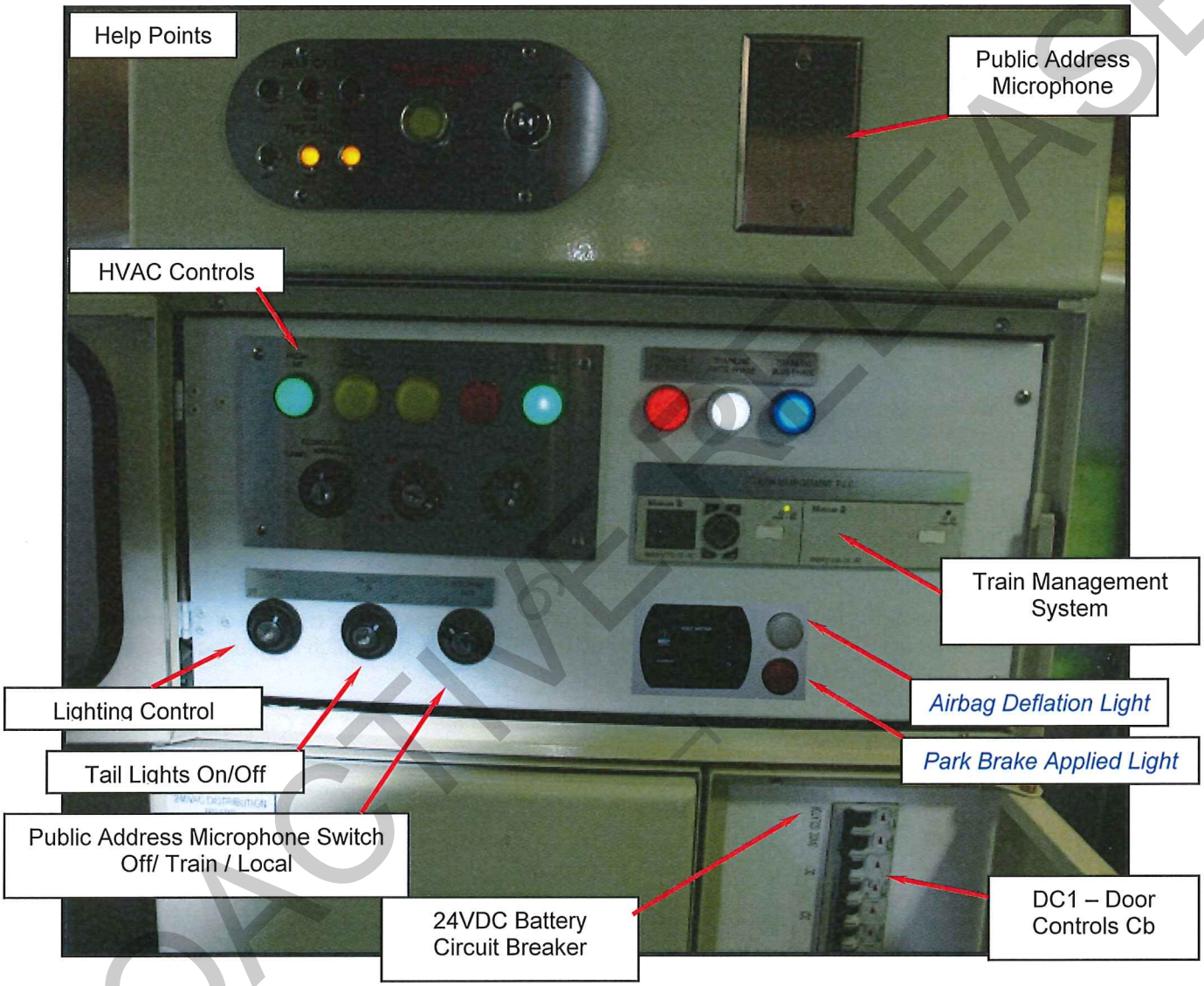
7.6.2 Generator Emergency 24VDC Lights

There is maintained lighting (powered by 24VDC battery supply) located in the generator room, this light is turned on via the saloon lighting switch located in the electrical cabinet.

8. Electrical Cabinet Switch Board – 230V / 24V

8.1 Battery Isolation Switch – 24v Main DC Circuit Breaker

The Battery Isolation Switch is located in the electrical cabinet on each car. This switch is to be used to turn the battery supply "OFF" instead of using the fuses located in the battery box under the car.



8.2 Saloon Lighting

The switch to turn the lights on / off is located on the electrical cabinet in each car. This switch turns on both the emergency lights (24V) and the 230VAC non-maintained saloon lighting. The 230VAC fluorescent lights will only operate when the genset is operating or the car is connected to "shore" supply.

All non-maintained lights are RCD protected.

8.3 Emergency Lighting

The switch to turn the emergency lights (24V) on / off is combined with the saloon lighting switch, which is located on the electrical cabinet in each car. The batteries running these lights are automatically charged when the 230V system is operating.

NOTE: These lights must be turned on at all times in case the 230V system fails.

In the main saloon there is a number of the central fluorescent tubes powered via a 24VDC-230VAC inverter, these are the maintained emergency lights.

8.4 Power Failure

If the genset stops, the 230V system will not operate but the emergency lights, taillights, PA system and doors will still operate as they run off the 24V-battery system. The batteries have a nominal capacity of 4 hours when fully charged.

The use of the wheelchair hoist in the SES will also remain operational, but its use should be kept to its absolute minimum (one operational cycle is safe) to conserve battery power. In the event the wheelchair hoist requires more use, ensure to use the manual hydraulic pump as outlined in section 18.5

8.5 Tail Lights

The Train Management System is able to detect which carriage is at the end of the train by monitoring the position of the 410/230VAC-receptacle lid. If the lid is closed, it is deemed to be the last carriage of the consist.

If the Train Management System detects that the lid is closed, it will automatically turn on the taillights in this carriage, provided the Tail Light switch is in the Automatic position. The Taillights can also be manually turned "on" and "off".

In the event of a failed switch in the 410/230VAC-receptacle lid in the centre of the train, the Train Management System will detect an End of Train Fault. I.e. the switch says the carriage is at the end of the train when it is not.

The SEG also has a Taillight fitted to the No. 2 end of the carriage. An On/Off switch (no automatic function) in the SEG electrical cabinet controls this taillight.

8.6 Power Points

230VAC power points are provided 2 per car on the saloon bulkhead for cleaner use and 1 in the Train Managers compartment (SES car) for the portable radio battery charger -. All power points are RCD protected.

8.7 Fire Extinguisher

There is a fire extinguisher in each car located behind the first seat at the No.1 end of the passenger saloon on the HVAC room bulkhead.

8.8 Trainline 410/230VAC Electrical Jumper

When handling the trainline 410/230VAC electrical jumper connection between cars turn the Shore Supply changeover switch to "Shore Supply" position ensuring Shore Supply is not connected. This could occur during coupling/uncoupling movements or inspecting a suspected connection due to loss of power between cars.

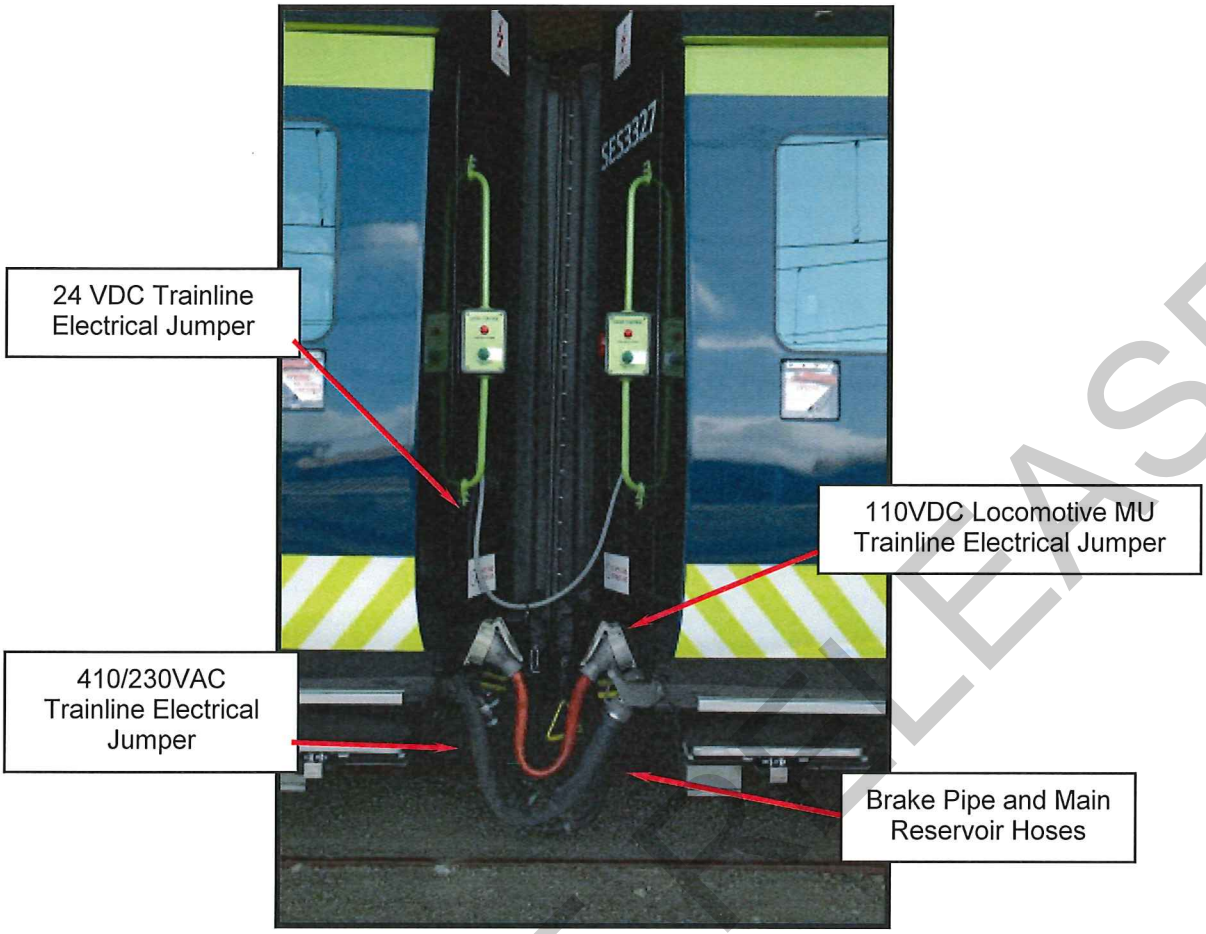
Earth bond Wire
There is an earth bond wire (green and yellow) attached between the cars at the headstock. This wire is bolted to the headstock and must be in place when the cars are in service.

8.9 Trainline 24VDC Electrical Jumper

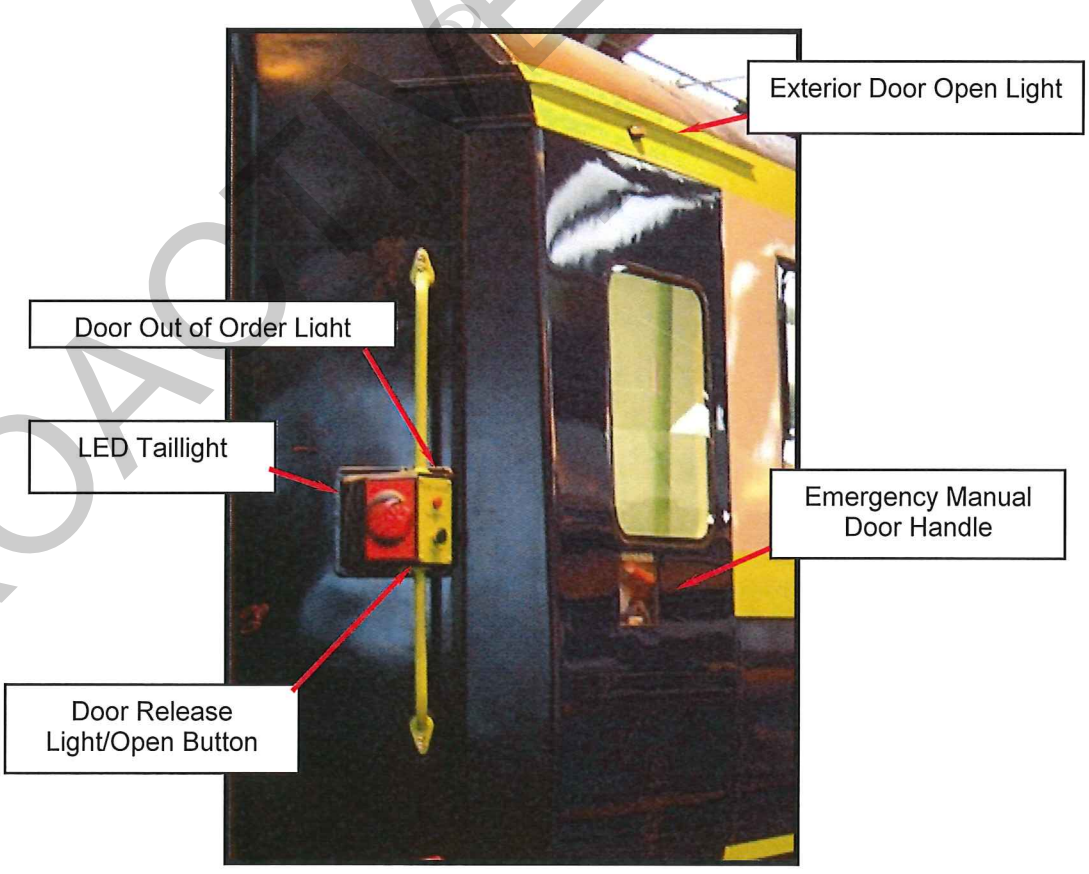
This electrical jumper is fitted between cars to trainline the low voltage circuits to operate doors, PA system, passenger information display, auto tunnel mode of HVAC system, help call, and train management alarms.

8.10 *Tranzlog Trainline AAR 27 Pin Electrical Jumper*

This electrical jumper is fitted between cars to trainline the Tranzlog Alarm circuits to locomotive .



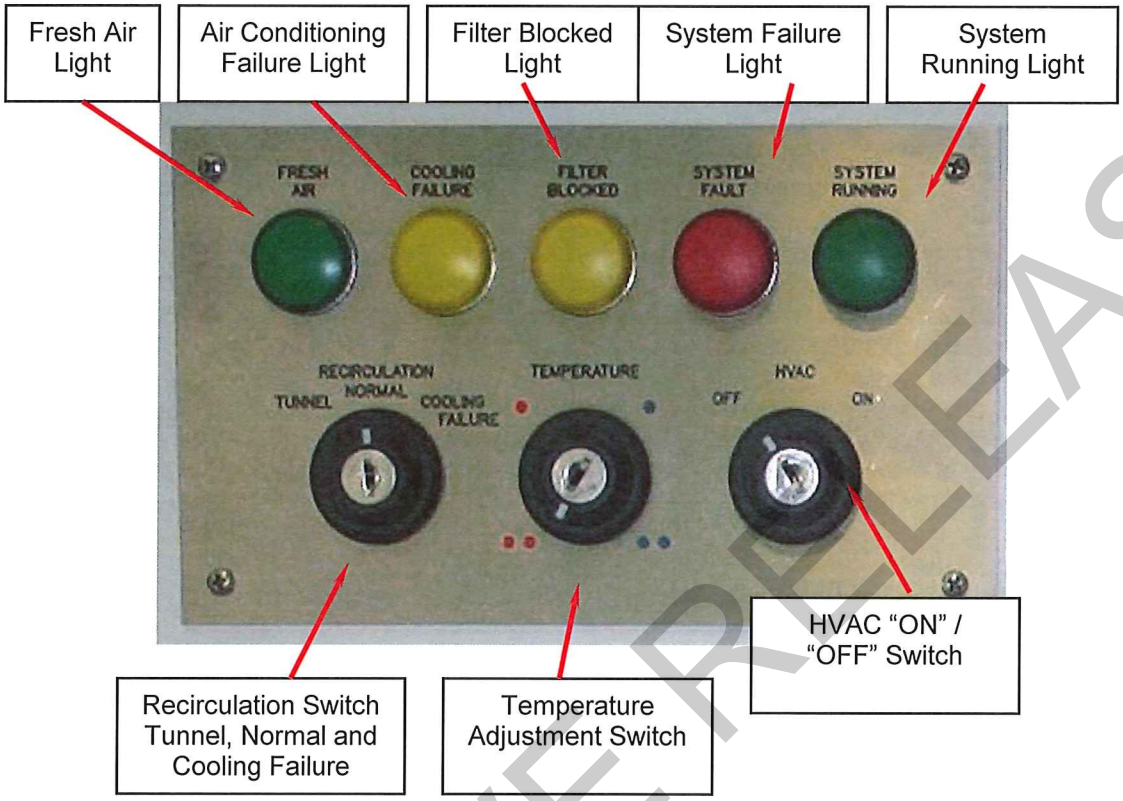
Trainline Electrical Jumpers and Air Hoses – Refer Section 8.0



External Door Area
Refer - Taillights section 8.5, Emergency Door Handle Section 5.5

9. Air Conditioning System

SE cars are fitted with Coolzone split air conditioning units (HVAC). The control panel is located in the electrical cabinet for each car. Controls are used for both heating and cooling.



9.1 Normal Operation

Using the HVAC key, move the on/off switch to "ON", a green indicator lamp should light (System Running). If no green lamp shows, ensure the generator is operating and check the position of circuit breakers feeding power to the HVAC system.

The switch marked "recirculation" controls the position of the 2 fresh air dampers in the HVAC unit, the switch has 3 positions:

Auto/Normal Should be set to this position normally.

In this position one of the fresh air dampers is open most of the time, except when travelling through Tunnels, at which time both fresh air dampers will be closed to prevent any external air from being drawn into the carriages.

When both the fresh air dampers are automatically closed the green **Fresh Air** light will turn off.

The signal for closing the fresh air damper comes from the GPS PID controller system in the SEG carriage.

Tunnel In this position both of the fresh air dampers will be closed so no fresh air is drawn into the carriage. When in this position the green Fresh Air light will not be illuminated.

This mode should only be needed if the train is operating through a long tunnel (such as Rimutaka Tunnel, Otira or Kaimai Tunnel) while on a charter service or if the PID system is not operating.

This mode should only be used for short periods of time, as the comfort level will decrease over time as the oxygen levels deplete and the carbon dioxide levels increase as a result of no fresh air intake.

Cooling Failure

In this position both the fresh air dampers will be open, allowing more fresh air to circulate through the carriage. While in this mode the amber **Cooling Failure** light will be illuminated.

This mode is to be used in the event of a cooling failure (see faults below) on summer days, hence allows the HVAC unit to circulate more cooler outside air through the carriage. Using this mode during winter will make the carriage less comfortable (colder).

The temperature control is pre-set and will not normally require adjustment by the Train Manager / Passenger Operators, however a "**temperature**" key switch provides 4 different temperature settings, 2 cooler (blue) and 2 warmer (red) settings. This switch provides a total variation in set temperature of 4 degrees Celsius from the coldest to the hottest setting.

If the above set up is completed and power is available, the HVAC unit supply fan should be running. Operation of the heating/cooling sectors is automatic, controlled by electrical/electronic equipment in the HVAC panel. The system will try to maintain whichever of the four set point temperatures is selected.

9.2 Air Conditioning Faults / Procedures

9.2.1 Fault Indicator

In the event a red light shows at the "Fault" indicator, the heating/cooling function will be disconnected, but the supply fan should still be running. The following system functions can cause a fault indication:

- Compressor high amperage (overload)
- Refrigerant high pressure
- Refrigerant low pressure
- Electrical heater battery over temperature

Such faults require action by maintenance staff at their depot. Temperature and/or pressure change within the control system may reactivate some or all functions automatically after a time but the reasons for the fault indication must still be investigated.

In the event of a **cooling** failure, turn the **"recirculation"** switch to "cooling failure" to open both fresh air dampers. The "amber" light will remain on while in the "recirculation" mode. Do not use this mode if heating is required, as the system will be bringing in more fresh air from outside, but it will not be cooled or heated. In all but the hottest conditions this should allow a journey or roster to be completed.

Book any fault indications in the carriage 54D repair book.

9.2.2 Filter Indicator

Advise maintenance staff by using the 54D repair book if the amber light marked "filter" activates. This indicates that the filter(s) require cleaning, even though the HVAC unit is still operational.

10. Park Brake and Airbag Systems

10.1 Park Brake

SE cars fitted with "S Ride" bogies have park brakes that are applied by springs when the park brake release cylinder is drained of air. They cannot be controlled from within the locomotive cab unless a loco set up to do this.

The S-Ride bogies are fitted with two spring applied park brake units per axle. These brake units are mounted on axles 2 and 3 (the inner axles) of each carriage.

The park brakes can be isolated individually if a fault occurs with a particular park brake unit, or as a carriage and set if the train is to be towed dead.

Park Brake Application and Release

The park brake is triggered automatically in the event there is insufficient air in the brake reservoir to achieve or maintain a complete service brake application. Thus it is normally enough to leave the car with the service brake applied. If the brakes bleed off over time, then the park brake will take over to hold the car secure.

For extra safety (i.e. against accidental release of the service brake during coupling of cars) The Car Park Brake may be Applied manually by turning to "Isolate" the Park Brake Isolation Cock By Carriage on the B side of the carriage. This exhausts the air from the Spring Brake chambers on all axles, allowing the internal springs to apply the Park Brake. The Rotowink will turn red and a park-brake applied alarm warning will be activated via the TMS illuminating on the switchboard and sounding in the carriages for 5 seconds; and the Tranzlog alarm will sound for 15 seconds in the loco cab.

The Park Brake must be released by returning the Park Brake Isolating Cock By Carriage to "In Service" position. This action re-admits air to the Spring Brake chamber, and re-compresses the Springs. The Rotowink will turn green and the park-brake applied warning be cancelled on the trainline.

Warning! Never use the Park Brake Isolation End1 or End 2 for normal park brake operation as this bypasses the warning system.

To Visually Check All Park Brakes Have Applied or Released:

With the independent brake on the locomotive fully applied and the automatic brake released, have someone walk along the train, checking that the blocks are either applied or released on the inner wheelsets only.

A check also of the Rotowink (red/green eyeball) indicator on the control box on one side of each car will indicate whether or not the particular car shows the correct park brake status. When the rotowink indicator is:

Green *The park brakes are released.*
Red *The park brakes are on.*

To Make An Individual Park Brake Inoperable On One Axle (Emergency Release of Park Brake):

If a fault develops with a park brake unit e.g. one unit will not release or a park brake air hose bursts, it is possible to make the affected park brake unit(s) inoperable. The two park brake units on a bogie are isolated using a common bogie park brake isolating cock.

Note: *If one park brake unit on an axle is to be made inoperable, the other park brake unit on the same axle will also have to be made inoperable.*

- *Isolate the park brake units on the bogie by turning the bogie park brake isolating cock to the isolated position. Located A side on Carriage.*

- *Manually release both park brake units on the axle by pulling on the 'Manual Release Lever' handle on each park brake unit until released.*
- *Place the Brake Cylinder Isolation Cock for that bogie in the 'isolated' position. Note that if this is not done a service brake application will reset the park brakes causing them to apply (Go On).*
- *Perform a brake application and release to confirm the brakes stay off.*
- *Note the car / consist is now running with one bogie cut out.*
- *Make an entry in the 54D journal about the park brake isolation*

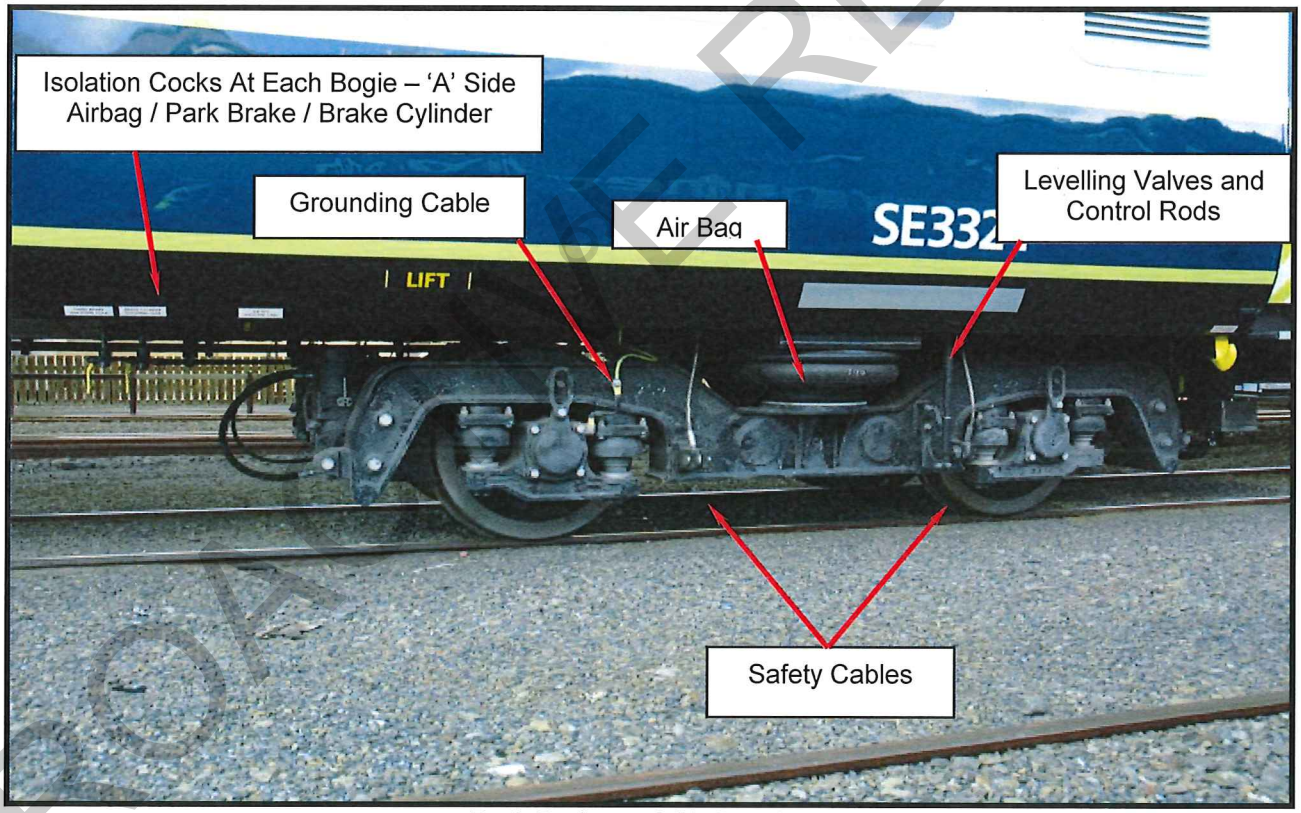
***NOTE:** There is no warning that these park brakes have been isolated. This is intentional so that normal TMS operation of the Park Brake Signal Fault is unaffected by having these park brakes isolated – that way, a fault with another park brake unit will turn the Park Brake Signal light on via the TMS.*

NOTE: to release all park brake units for moving without air, pull all the park brake release leavers until released.

DO NOT manually release the park brakes on a carriage set unless it is attached to a sufficiently large vehicle or a train which can hold it on the grade or chocked accordingly.

To Make The Park Brakes Operable Again On A Train:

With a locomotive attached and operating, all jumper cables connected, Brake Pipe /Main Reservoir hoses connected with air cocks open ("In Service Position") and all car circuit breakers turned 'on', Open all the "Park Brake Isolating Cocks By Carriage" ("In Service Position"). Check the Rotowink (red/green eyeball) indicator on the "B" side control box of each car is green and that the brake blocks are off the wheels.



Park Brake and Air Bag System

10.2 Air Bag System:

The air bag system is designed so that:

- If one airbag deflates, the opposite airbag will deflate to prevent the car leaning.
- If there is insufficient air in any airbag due to a problem with the air supply or a leak develops, *the white Air Bag Deflated white warning light will illuminate on the switchboard and the TMS alarm will sound for 5 seconds at each end of the carriage. The Tranzlog alarm will sound in the locomotive cab for 15 seconds.*

If a pair of airbags deflate:

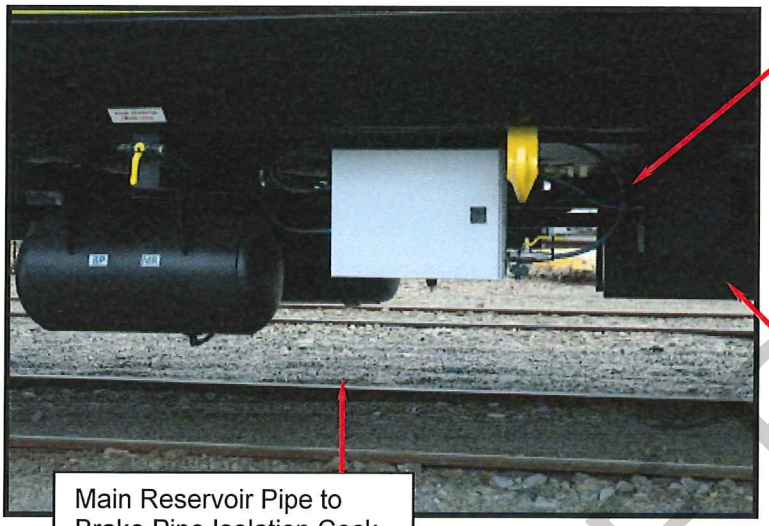
- *The white Air Bag Deflated warning light will illuminate on the switchboard and the TMS alarm will sound for 5 seconds at each end of the carriage. The Tranzlog alarm will sound in the locomotive cab for 15 seconds.*
- Stop and walk the train and find out which pair of air bags has deflated.
- Use the bogie air bag isolating cock to shut off the air supply to these airbags.
- Continue the journey at a maximum speed of 50 km/h.

11. Isolating Cocks

11.1 Main Reservoir Pipe to Brake Pipe (MR selection) Cock:

This is located on the inside of the Main Reservoir A side of the car.
This cock has three positions:

- Pointing towards MR - Normal setting.
- Pointing towards BP - Main reservoir connected to the brake pipe (for operation under special Bulletin or emergency recovery single pipe action).
- Vertical - Main reservoir is isolated.



Brake Equipment A side

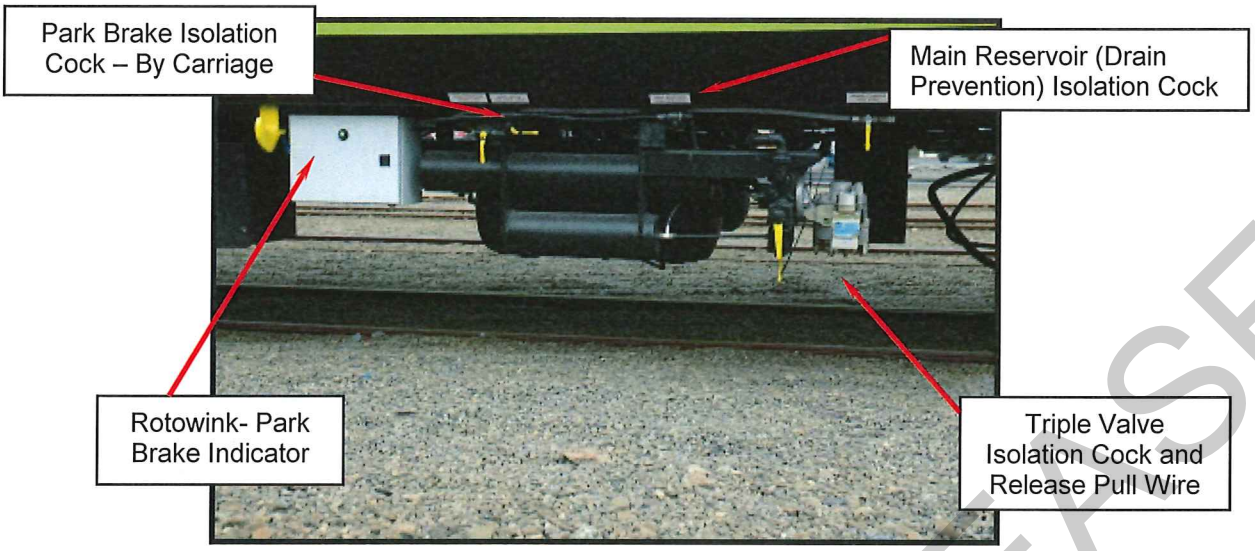
11.2 Main Reservoir No.1 and Main Reservoir No.2 Isolation Cock

This is located on the side of the Auxiliary Air Service box on the A side of the car.
The #1 main reservoir provides air to the brakes; the #2 reservoir provides air to the doors and the air bags.

11.3 Triple Valve Isolation and Main Reservoir (Drain Prevention) Isolation Cock

These two cocks are used to isolate the entire braking system on a car.
The Triple Valve Isolation Cock is located next to the triple valve.
The Main Reservoir (Drain Prevention) Isolation Cock is located to the left of triple valve..

NOTE: The Main Reservoir Drain Prevention Cock provides the air supply to the brake cylinders.
For normal operation, this cock must be left in the open position.



Brake Equipment 'B" Side

11.4 Release Pull Wire

The Release Pull Wire will NOT release the brakes if the Brake Pipe is charged, but will release the brakes completely on the carriage if the cars Brake Pipe pressure is below 100kPa.

11.5 Airbag Isolation cock

These are located on the A side of the car with one isolating cock for each bogie.
Only use the Air Bag Isolation Cock to cut the air supply to a bogie's air bags if its flexible hose to the bogie has failed or an airbag has burst.

11.6 Brake Cylinder Isolation Cock

There are four Brake Cylinder Isolation Cocks provided on the A side of the car.
Each Brake Cylinder Isolation Cock isolates the pair of brake cylinders on an axle.
These cocks are vented, so that any air trapped in the brake cylinders is exhausted when the cock is turned to the isolate position

11.7 Park Brake Isolation Cock – by Bogie

Each bogie has its own park brake isolation cock. Located on the A side of the car, near axles 2 and 3
Isolating this cock exhausts the air from the park brakes on its bogie and applies the park brakes on this bogie only.
These isolated park brakes cannot be released from the locomotive cab and the Park brake applied Tranzlog and TMS alarm will not sound will also not be illuminated on the switch board.

11.8 Park Brake Isolation Cock – by Carriage

The Park Brake Isolation Cock for the entire carriage is located above the brake equipment to the left of the triple valve on the B side of the car.
Isolating this cock exhausts the air from all the park brakes on the car and applies all the park brakes on this car.

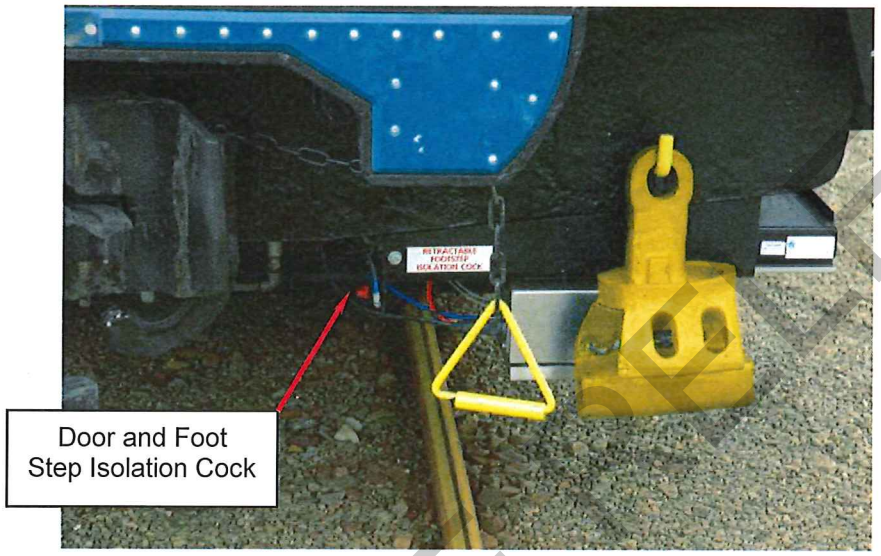
.

The Park Brake Applied light will be illuminated on the switchboard and the Tranzlog and TMS alarms will sound.

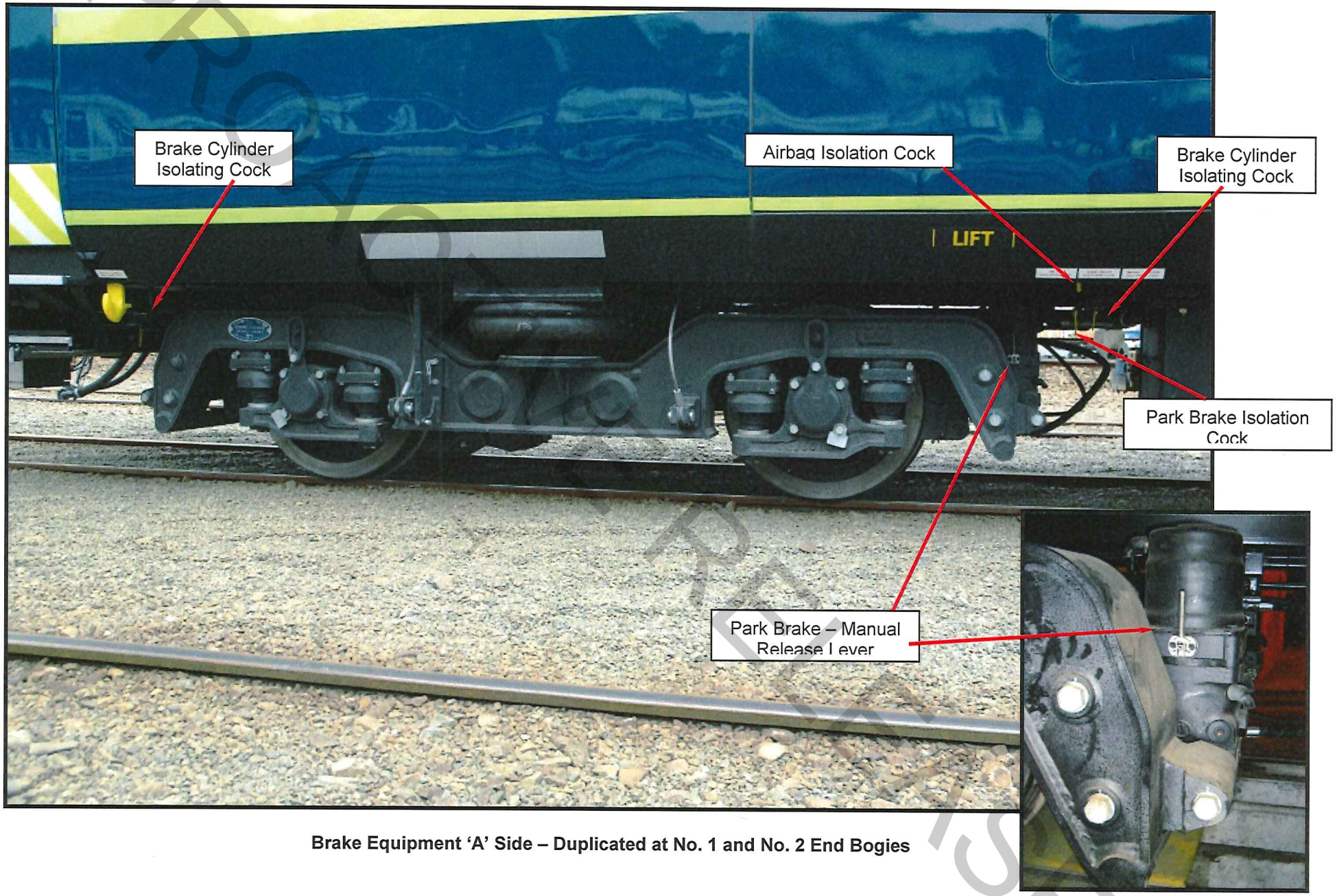
11.9 External Door Step Isolation Cocks

An isolation air cock is mounted behind each step assembly for isolating air to the door steps at that location, also maintenance personal have access to the ceiling cavity, which also allows the air supply to the individual doors and extendable steps to be isolated.

Should the footsteps need to be isolated then a cable tie MUST be used to hold step back.



Door and Retractable Footstep Isolation Cock



Brake Equipment 'A' Side – Duplicated at No. 1 and No. 2 End Bogies

12. Public Address System (PA system)

A microphone is located on the electrical cabinet of each SE car, which connects with the speakers throughout all cars in the consist. The PA is used to communicate with passengers particularly for safety critical information or instructions.

NOTE: The SEG car does not have a microphone located on the electrical cabinet due to the noisy environment.

12.1 Functions of the PA system

The PA or public address system can be used to advise passengers of:

- Emergency or safety information
- Critical passenger information such as notice of delay
- Specialised tour group announcements

NOTE: The PA system will remain operative even if the 230V power system fails.

12.2 Control of PA system

On each electrical cabinet is a 3-position switch, which controls the microphone and the Public Address system. It has the following positions:

Off The microphone is OFF, but the PA system will still relay train lined announcements from other carriages. This is the position the switch should be left in.

Train The wall-mounted microphone is activated and the announcement will be made to all carriages in this train.

Local The wall-mounted microphone is turned on, and the announcement will be made only to the local carriage.

The volume of the PA system has been pre-set. Please contact maintenance depot for adjustments.

12.3 Automated Announcements

The Passenger Information Display system is connected to the Public Address system to allow automated announcements (e.g. next station, regular safety announcements).

12.4 Hearing Loops

The SES carriage is fitted with a Hearing Loop, which allows persons wearing a hearing aid to hear the Public Address Announcements via the built in transformer in the hearing aid, rather than the actual audio announcement.

13. Passenger Information Display (PID) System

Each SE class carriage has two Passenger Information Displays, one located at each end of the saloon. These PIDs are controlled automatically (using Global Position System (GPS) waypoints) to display the next station on the Tranz Metro route. The GPS and the sign controller is located in the SEG carriage, and the information is trainlined to all of the PIDs in the consist.

The PID controller provides an automated audio announcement into the PA system.
In the event that there is a malfunction with the PID signs these can be turned off using the PID 24VDC circuit breaker.

The automated audio and visual messages are stored on a memory card and can be changed at any appropriate time. (not changed by onboard staff)

14. CCTV System

Each carriage is fitted with 4 CCTV cameras, 2 per saloon and 1 in each vestibule; a camera is also located in the generator room of the SEG. The footage from these CCTV cameras is stored on a Digital Video Recorder (DVRs) in each carriage. The CCTV DVRs are able to retain approximately 2 weeks' worth of operational footage.

There is a CCTV monitor located in the Train Managers compartment SES car. This monitor wirelessly receives live security camera footage from each carriage, to allow crew to monitor activity on the entire train.

The CCTV cameras and Digital Video Recorder is operated from the 24VDC battery backed power supply, hence security footage is still being recorded even in the event of main 230VAC supply failure.

Note: The monitor will not function in the event of main's 230VAC failure.

15. Smoke Detectors

There are 3 Smoke detectors fitted in each carriage. They are located in the centre of the saloon, and one in each vestibule (in the generator room for SEG) or in the toilets of the cars fitted with them.

These smoke detectors are powered via the on board 24VDC battery backed up circuits, when operational the LED's on the smoke detectors flash faintly.

If a smoke detector is activated it creates an audio alarm at the smoke detector as well as an alarm throughout the train, via the Train Management System, refer section 16.

16. Train Management System (TMS)

The carriages feature a Train Management System, which monitors the external doors/steps, on board smoke detectors and Emergency Brake buttons, and aid the crew quickly identifying any device in an "unsafe" state.

In the electrical cabinet of each carriage there is a Programmable Logic Controller (PLC) that is the heart of the Train Management System. The PLC monitors all the devices in that carriage and communicates with the carriages adjacent to it.

16.1 Train Management Alarm System

If the train goes into a non-safe state the Train Management System will sound an alarm throughout the train for 5 seconds, to alert the crew of the change of state. The Train Management System considers the following as non-safe states anywhere in the train:

- Activation of smoke detector
- Emergency brake button activated
- A door opens or step extends
- End of train not correctly detected
- *Airbag deflated*
- *Park Brake applied*

The TMS is able to distinguish a Train Crew commanded door release from other non-safe states. In the event a commanded door release is detected, a short 1-second alarm will be heard, to alert the passengers that the doors can be opened.

Once the Train Management System has detected a non-safe state, it will not signal the train safe again until:

- All external doors and steps are safely closed
- No emergency brake taps are activated
- No smoke detectors are activated
- End of train is correctly identified
- No help calls have been made from Wheelchair hoist position or toilet in SES (refer section 18.1)
- *Airbags are inflated*
- *Park Brake not applied*

The TMS guides the train crew to the location of the detected unsafe condition on the train.

16.2 TMS Guidance System

This PLC has a small screen on which fault messages are posted to help the crew to identify any device in an "unsafe" state.

In addition to the PLC screen there is also a Train Management/Help Point located on the electrical cabinet situated No. 1 end of every carriage, excluding the SEG which is mounted on the back saloon wall of generator room and on electrical cabinet generator room.

The TMS section of the panel has 3 lights, "Left", "This Car" and "Right"

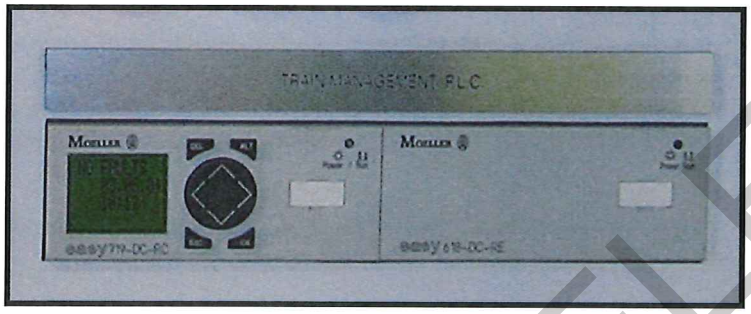
If a device goes into an unsafe state an audible alarm will sound throughout the train, and one or more of these lights will illuminate on each of the carriages TMS/Help Panels.

If the "Left" light illuminates it means the unsafe device is in a carriage to the left of you. Walk in the left direction until you reach a carriage with "This Car" illuminated.

If the "This Car" light illuminates it means the unsafe device is in the carriage you are in.

If the "Right" light illuminates it means the unsafe device is in a carriage to the right of you. Walk in the right direction until you reach a carriage with "This Car" illuminated.

The PLC screen in the electrical cabinet will also provide information to allow the crew to identify the cause of the alarm. In the event multiple alarms are occurring, then the screen will scroll through each of the faults.



Train Management Control Panel

Examples of the messages displayed on a PLC screen are shown below:

NO FAULTS 26.10.06 14:53	FAULT END 2 DIRECTION	OPEN DOOR OR STEP 2B CORNER
Train is in Safe State	Fault is in a carriage in the End 2 Direction.	Door or Step is open in this carriage at the 2B corner of carriage
FAULT: END OF TRAIN	DANGER: SMOKE ALARM THIS CAR	EMERGENCY BRAKE END 2
410/230VAC Trainline Plug is indicating it is closed but carriage is not at end of train	A Smoke Detector in this carriage is activated. It will be beeping.	Emergency Brake at End 2 of this carriage has been pressed.

Park Brake Applied and Air Bag deflated Fault signals

These faults are indicated by white/red lights located immediately below the Train Management control panel next to the battery charger:

Fault codes will be shown as scrolling through "Fault End 1 and Fault End 2 on screen .

Airbag Deflated

Park Brake Applied

16.3 *AAR Jumper Cables*

Sockets are located at each End of the SE carriages for the fitting of AAR (American Association of Railroads) Jumper Cables between the vans and the locomotive. Standard long AAR jumpers as carried on all locomotives are suitable for this purpose. The short AAR Jumpers as carried on DX variant locos are not suitable as they are too short to fit between the van and loco sockets.

Two pins are active in the van sockets which transmit the following TMS signals to the locomotive cab via Tranzlog:

- *Door Open or Step Extended (Train Safe)*
- *Air Bag Deflated*
- *Park Brake Applied*

When any of these signals are transmitted a bell alarm will sound within the cab for 15 seconds (general warning bell). The LE must slow the train and communicate with the TM to determine which alarm has activated and what further action to take. If the TM cannot be contacted then the LE will bring the train to a halt. TMS alarms within the train will also be activated, alerting the TM to the fault.

Because the alarm in the locomotive cab does not distinguish between fault types, the TM is responsible for relaying information about the fault to the LE by radio.

Correct responses to each fault type are:

Airbag deflation	=	*stop to inspect or reduce speed to below 50km/h*
Door fault	=	*stop train and inspect*
Park brake application	=	*stop train and inspect*

17. Help Points

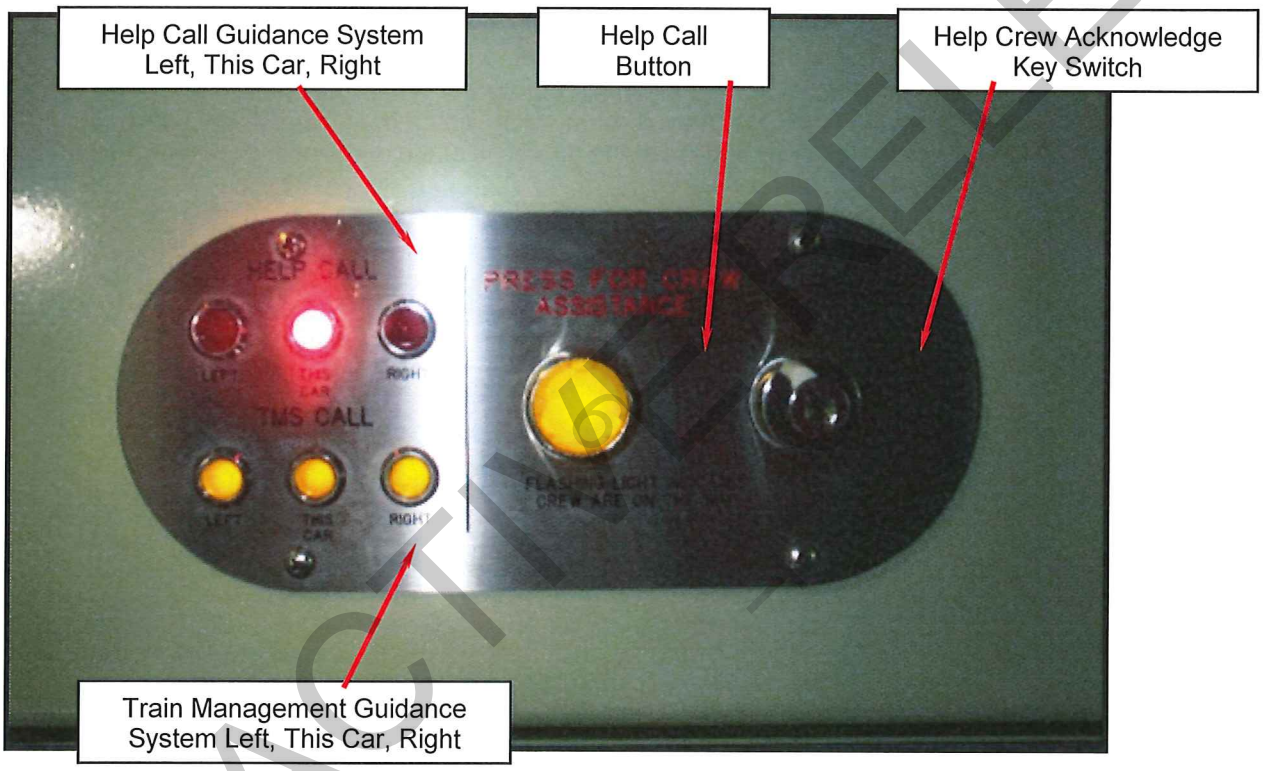
The Help Points in the carriages provides passengers with the ability to call for crew assistance.

The Help Points are located as follows:

SE carriage:
Electrical Cabinet No. 1 End of the carriage

SES carriage:
Electrical Cabinet No. 1 End of the carriage
Wheelchair Hoist Doors (internal and external)

SEG carriage:
Electrical Cabinet in Generator Room
Saloon - back wall of Generator Room



17.1 Help Call

If the Help Call button is pressed, that button will illuminate. It will also send an audible buzz throughout the train to notify the train crew a Help Call has been made.

The audio tone will be slightly different in each carriage; this helps the train crew find the help call.

Help Call in that carriage	-	On for 2 seconds
Help Call in No. 1 End Direction	-	On for 1 sec, off for 2 sec, on for 1 sec.
Help Call in No. 2 End Direction	-	On for 2 sec, off for 1 sec, on for 2 sec.

Once a Help Call has been received a crewmember may go to any Help Panel in the train, insert there door key and momentarily select the acknowledge position. This will cause the activated Help Call button in the train to start flashing, which provides feedback to the person requiring assistance that a crewmember is on the way.

The Help Panel will guide the crew to the help call with the use of 3 lights.

Left	Help Call is in a carriage in the left hand direction, walk in this direction until you find a carriage with "This Car" illuminated
This Car	Help Call has been activated in this carriage. The crewmember will have to look at each help call button to find the one illuminated.
Right	Help Call is in a carriage in the right hand direction, walk in this direction until you find a carriage with "This Car" illuminated.

To release a Help Call the Help Button just needs to be pressed in again to unlatch it.

NOTE: If multiple help calls are made the help guidance system will illuminate to indicate the direction of each help call. Therefore it is possible for all 3 guidance lights to illuminate in a central carriage.

17.2 Wheelchair Hoist Doors (internal and external) Help Buttons

The help buttons located internally and externally beside the Wheelchair hoist doors in the SES carriage prevents the train safe light from re-illuminating after a door open/close cycle has occurred. This ensures the crew attends to the operation of the doors and wheelchair hoist. (refer section 18.1 for details)

18. Wheelchair Systems

The SES car has two Ricon Wheelchair Hoists installed, one for each side of the carriage.

The wheel chair hoists are only to be operated by the Train Manager.

18.1 Wheelchair Hoist Door Help Button – Prevents Train Closed Signal

The internal and external help push buttons can be pressed at any time, and operate similar to a normal help button. ie Sends a help call throughout the train. The difference with these help buttons is, if the doors are released, then it will latch open to prevent the train closed light from illuminating, until the Train Manager attends the wheelchair hoist Help Call.

In order to get the train closed light, the Train Manager must unlatch the help button, by pressing the illuminated help button again. They must then use their door key, select the door control position, return the key to the central position and then remove the key. Generally this would be done as part of the required door open sequence.

18.2 Open Wheelchair Hoist Door

Unlike the other external doors, passengers are unable to open the wheelchair hoist door, even when the door is released.

To open the Wheelchair Hoist Door the Train Manager must put the door control key into the control key switch and turn to the door control position, then press the Local Open push button.

The Train Manager then has full access to the door control buttons on the panel. They may now release all the trains doors from this panel by pressing the "Release" button" (refer section 5.1)

18.3 Closing Wheelchair Hoist Door

The wheelchair hoist door will not respond to a train lined door close command To close the wheelchair hoist door insert door control key and turn to door control position, and then press the "Local Close" button.

To close the door insert door control key and turn to door control position, and then press the "Local Close" button. It is not possible to close other doors on the train from this position.

NOTE: As for the corner door control panels, it is possible to close the entire train except the local door by pressing the "Close" push button. When the door key is in the "Door Control" position it is possible to achieve the "Door Closed" light, even with the local wheelchair hoist door still open.

This door is fitted with obstacle detection in the closing cycle of the door, if the door experiences an abnormal obstruction, the door will re open and stay opened.

18.4 Operating Wheelchair Hoist

In order to operate the wheelchair hoist the Train Manager will first open the doors as per above then turn the door control key to the "Hoist" position; this provides power to the hoist.

NOTE: **DO NOT** operate both hoists at once.

Use the remote control attached to the Hoist to control the platform.

There are 2 operations available on the hoist remote:

1. Platform in and out,
2. Platform up and down.

The platform in and out function allows the platform to be folded away when not in use, or extended out ready to be loaded or unloaded. The wheelchair hoist door should not be open or closed unless the hoist platform is fully in its retracted position.
The platform up and down function allows the platform to be raised and lowered, allowing wheelchair "roll on roll off" service over the full range of platform heights.

The hoist has the ability to lift 364kg safely.

If 230VAC supply is not available (Generator not running) avoid using the wheel hoist if possible. Batteries only have the capacity to do 1 lift cycle without reducing the 4hr lighting emergency battery back up capacity below 4hrs.

It is possible to raise and lower the platform without power, but using the handle provided and pumping the platform up and down in a similar manner to a hydraulic jack.

18.5 Manual Operation Wheelchair Hoist

In the event the hoist becomes inoperable under its own power it maybe manually operated. Follow the manual operation decal mounted on hoist pump assembly.

18.6 Wheel chair positions

Two wheelchair passengers can be accommodated in the SES car where wheelchair-securing points are provided. The securing points are similar to retracting seatbelts and simply pull out and plug in around the passenger.

Wheel chair hoist door SES – Request button and door control

Wheel Chair Hoist – extended to Ground Level

19. Bike Access and Storage

Bike storage is allowed for in the SEG car generator room and space is provided here for other large luggage items.

There are no bike access or storage facilities on the SE or SES cars.

20. Emergency Equipment

Each saloon has an Emergency Exit Break Glass hammer to allow escape via the windows in the event that the doors are not accessible and/or functional.

One portable radio with battery charger is provided in the Train Managers compartment in the SES carriage.

Each carriage contains a secure Train Manager's area, which can be used to store emergency equipment as well as train crew's personal items.

- Wheel chocks - SEG – Generator room
- Cable ties for faulty steps – SES Train Managers compartment
- Ladder (mounted on end of the Generator)
- Fire Extinguisher every car No.1 End
- Window Hammers 2 per car - centre saloon A and B side

In the event of an emergency within a tunnel, where it is not possible to evacuate the train via the side doors, the carriage end doors are to be used.

Extreme care shall be taken when exiting the train without a platform.

The 54D repair book is located on the wall of the Train Managers compartment, SES car.

21. *Disabled Toilet Facilities*

A disabled toilet is provided in the SES Car. The toilet is large enough for persons in wheelchairs and is equipped with a baby change table.

The toilet is opened using labelled push buttons operating a motorised door. The door has collision detection and will close automatically after 20 sec.

Note: once the user is inside, the CLOSE button must be pushed. If the door closes automatically the VACANT light will stay illuminated. The CLOSE button should not be pushed from the inside when exiting the toilet otherwise the ENGAGED light will illuminate. The door can be released from the exterior key switch using a 601 Key.

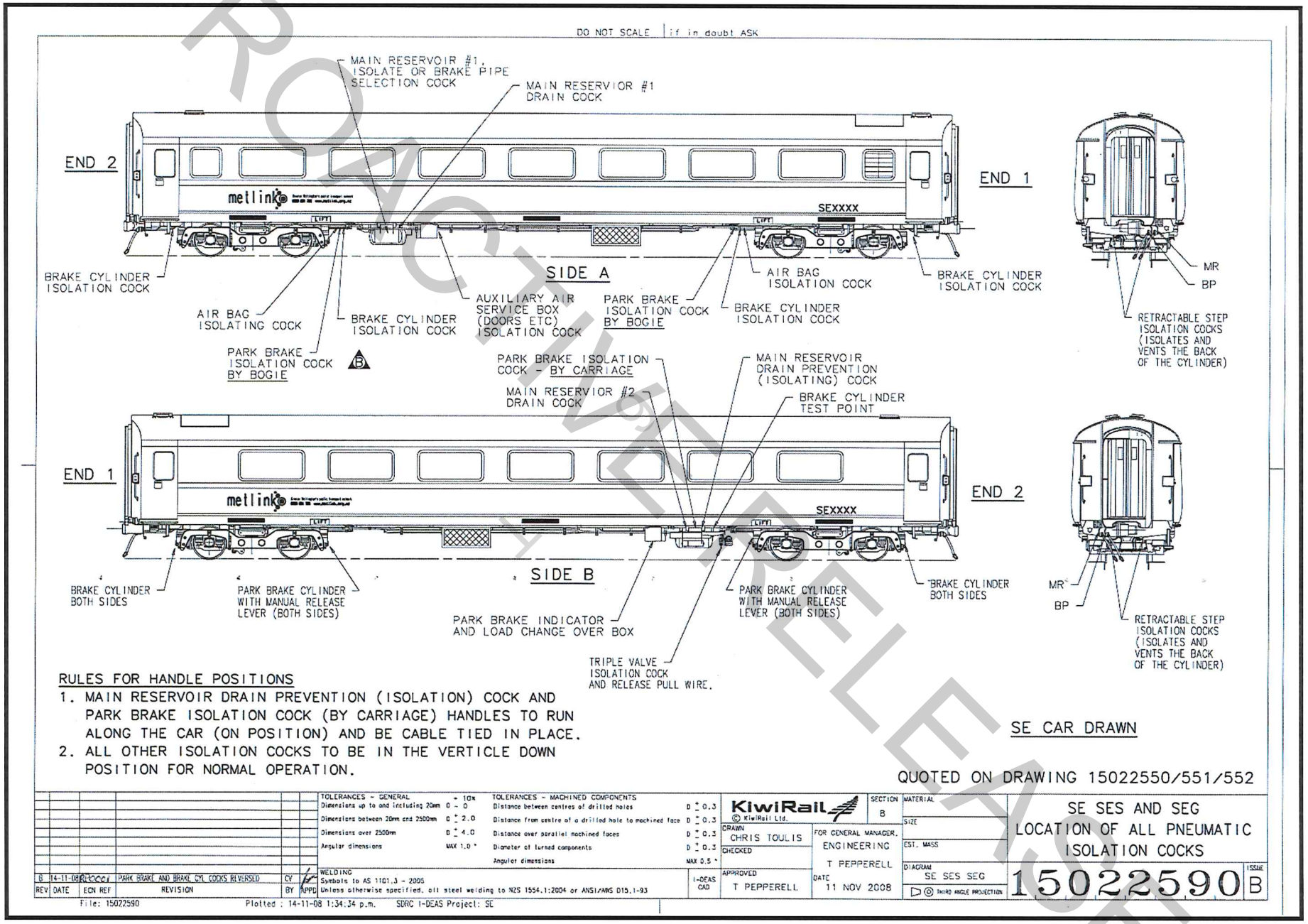
The Disabled toilet has a Help button installed under the left side of the vanity (within reach of the toilet). If the Help button is pushed it will alert the crew in the same way as the other Help Points (refer Section 17). A light in the ceiling immediately outside the toilet will also illuminate to assist the crew to determine whether help really is required within the toilet.

22. Operating Keys

For operating the SW Cars, 6 keys are required:

Key	Operates
S Key	Locking External Doors, Generator to Saloon, TM Compartment, Storage & Emergency Equipment Lockers
H Key	End Door Key – Bi fold doors at end of each consist
KN Key	Air Conditioning, Lights, PA (new AC Key)
AB Door Key	Door Key, Generator Emergency Reset
100 Key	Electrical Cabinet Locks, Emergency Brake Push Button Reset,
601 Key	*Disabled Toilet Door Control Key in SES*

23. Location of Isolating Cocks



MATANGI Electric Multiple Unit (EMU) Vehicles

Operator and Maintenance Manuals

Volume 2: Train Crew Manual

Part B: Operating Procedure

Revision Record

Revision	Date	Title or Brief Description
C	20 Sep 2011	All TMS screens are updated in Section 10.
		Amended in Section 10.4.1 and 10.4.2.
		Key description is updated in Part B Section 10.4.2.2.4.
		Description about Historical and Active Failure screen is updated in Section 10.4.2
		Description is updated in Section 10.4.7.
		Amended in Page 1-29 of Section 8.2.
		Amended in Section 7.1.4.
D	14 Feb 2012	Amended BC pressure value in Emergency mode as per ECR/M/0046 in Section 1.2.1.4.
	26 Jul 2012	Amended shutdown procedure as per ECR/M/0084 in Section 5 (Page B-16)
	28 Aug 2012	Updated Door Control Station operation as per ECR/M/0097 in Section 11.1.1.1.2 (Page B-63)
	10 Oct 2012	Updated coupling/uncoupling procedure in Section 13.1 ~ 13.2 as per ECR/M/0081 and Minutes(Matangi Coupling Exercise_Ref.No:1131600) (Page B-69~72)
	27 Aug 2013	Updated brake test as per ECR/M/0171 in section 1.2.1.4 (Page 5~6)
		Updated System Isolation Function as per ECR/M/0108 in section 7.1.6 (Page B-26 ~ 28)
	30 May 2014	Added Description in section 1.2.1.2 (Page B-4) Amended Description in Section 10.4 (Page B-45~52) Added Description in Section 10.4.9 (Page B-58). Changed Term from ER to Tranzlog in Abbreviations and Acronyms Table and Section 10.4.10 (Page B-59,60) Changed the turn off time from 10 minutes to 60 minutes in Section 8.1.4 and Section 8.1.5 (Page B-30) Replaced TMS screen shots in Figure B-1~4,19~21,29~41 (Page B-3,4,7,41,42,45~62) Amended Description in Section 9.1.1.1 (Page B-33) Amended Description in Section 9.1.1.3 (Page B-34) as per ECR/M/0305
		Updated door control station as per ECR/M/0153 in section 11.1 (Page B-62)
		Updated section 11.5.2.1 (Page B-67) according to ECR/M/0263
	02 Sep 2014	Updated route selection description in section 2.1 (Page B-9) & 9.1.1 (Page B-32) as per ECR/M/0328

		Replaced Figure B-12,13 (Page B-27,28) Amended Description in Section 10.4.1 (Page B-45~47) Changed Description in Section 10.4.2 (Page B-48, 49) due to duplicated contents with 10.4.1 Replaced Figure B-8, 9, 12, 13, 14 (Page B-20, 21, 27~29) as per ECR/M/0314
E	17 Jul 2015	Amended Section 13 (Page B-70~82), 10.2.2 (Page B-42) Added Description in Section 8.2 (Page B-30) as per ECR/M/0403

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Abbreviations and Acronyms

The use of abbreviations and acronyms shall be kept to a minimum, however will be used where deemed necessary. A list of abbreviations and acronyms is provided in the table below.

Acronym / Abbreviation Used	Definition
APBR	Actual powering braking
APU	Auxiliary Power Unit
AVAU	Automatic Voice Announcement Unit
BC	Brake Cylinder
BP	Brake Pipe
CANC	Cancel
CFC	Cross Feed Contactor
CM	Compressor Motor
COP	Central Operation Panel
DCU	Door Control Unit
DU	Display Unit
EB	Emergency Brake
EMU	Electrical Multiple Units
Tranzlog	Event Recorder
ERATime	Erased Time
GPS	Global Positioning System
HVAC	Heating, Ventilation, and Air Conditioning
ID	Identification
KMC	Kupe Mobile Controller
MC	Motor Car
MCB	Main Circuit Breakers
MDS	Main Disconnect Switch
MF	Major Failure
MOD	Mode
OP	Operation Panel
ROW	Right of Way
PA	Public Address
PB	Parking Brake
PI	Passenger Intercom
PIN	Personal Identification Number

Acronym / Abbreviation Used	Definition
TC	Trailer Car
TCK	Train Crew Key
TDL	Train Data Link
TMCS	Train Manager's Control Switch
TMK	Train Manager's Key
TMS	Train Monitoring System
SCP	Saloon Control Panel
SOP	Side Operation Panel
VVVF	Variable Voltage Variable Frequency
MRP	Main Reservoir Pressure.

1 Preparing A Train For Service

Before a train can be placed in service it must be inspected to ensure that all equipment functions correctly and safely. The following procedures are used to prepare a train for operation.

WARNING

BODILY INJURY. MAKE SURE THAT NO ONE IS WORKING UNDER OR NEAR THE TRAIN WHILE PREPARING THE TRAIN FOR SERVICE.

1.1 Exterior Train Preparation

Make an inspection of the train exterior, ensuring that:

a. All pneumatic cocks are at NORMAL position, with specific attention being made to Emergency Magnet valve isolating and Tranzlog isolating air cocks.

b. All equipment covers are properly secured.

c. There are no obvious fluid leaks or debris affecting the underside of train.

d. Couplings between coupled sets are correct.

e. End telescopic handrails are connected across opening and gang planks are in the raised position.

f. No door or window glass is damaged.

1.2 Interior Preparation

Board the train through the FRONT END DOOR or SIDE DOORS of the rear cab from track level and perform the following steps.

1.2.1 Inspection in rear driving cab

a. Use the train crew key to open the FRONT END DOOR and enter the cab.

b. TC cab check 54D repair book.

c. Ensure that all circuit breakers on MCB panel are in the ON (up) position.

d. Ensure that all override switches are secured in the NORMAL position (refer to clause 1.2.1.1).

e. Insert the Master Controller Key and turn switch to "on" position. Cab will power up.

f. Press the Pantograph Raise pushbutton on Operation panel #4 to raise the pantograph. Check that the pantograph on the MC roof rises.

g. Ensure that no failures are reported on TMS monitor (refer to clause 1.2.1.2).

h. Check cab lighting (refer to clause 1.2.1.3).

i. Perform communication system check.

j. Check that the Parking Brake Apply pushbutton LED light is illuminated.

k. Pneumatic Brake handle to No.3 position (release/recharge).

l. Perform brake test of an emergency push button in cab.

m. Press EMERGENCY pushbutton - Check pressure gauges to confirm that BP pressure decreases and BC pressure increases.

n. Reset EMERGENCY pushbutton - Check pressure gauges to confirm that BP pressure increases and BC pressure decreases.

o. Check operation of windshield wipers.

p. Check operation of horns.

q. Carry out Vigilance Cycle Test (refer to clause 1.2.1.5).

r. In cold weather, perform following:

   (1) Press Windscreen Demister pushbutton on operation panel #4 to test windshield heater function. The demister indicator should illuminate. Push the button again to turn the heater off.

   (2) Test cab heater by operating the Crew Foot Heater switch (Figure B-14) on operation panel #4.

s. Pneumatic Brake handle to No.2 position (Lap).

t. Move Power/Brake Handle to Max. Brake position, reverser handle to “Isolate” and remove the master controller key.

u. Press LAMP TEST button on operation panel #4 and ensure the following lamps are lit:

   (1) All Doors Closed indicator.

   (2) Parking Brake Applied indicator (embedded in the Parking Brake Applied pushbutton).

   (3) Demister indicator (embedded in Windscreen Demister pushbutton).

   (4) Hill Start Ready indicator (embedded in Hill Start pushbutton).

   (5) Passenger Emergency Handle Operation indicator

   (6) ROW indicator

   (7) Headlight Alert indicator.

   (8) Signal Alert indicator.

   (9) Vigilance light.

v. Move to the leading cab through the passenger saloon. When leaving the rear cab, close and lock the Cab to Saloon door.

w. Repeat the above steps in leading cab and perform a No. 1 Brake Test.

x. In MC cab check the emergency equipment bin.

NOTE

The brake test for KiwiRail Network requirements will be conducted from the leading cab.

1.2.1.1 Override Switches

Check switch status as per the following table:

Switches	Location	Status
Brake Loop Override Switch	Locomotive Engineer's Rear Panel	Normal/Sealed
Door Override Switch Car Isolation Switch (Trailer Car Only)		
Vigilance/Override Switch		
Trip Cock Isolation Switch		
Cleaning Switch	Left side of CCTV	Normal

1.2.1.2 TMS System Check

Perform the following steps to do a train system check in TMS:

a. Navigate to the Locomotive Engineer's screen, shown below.

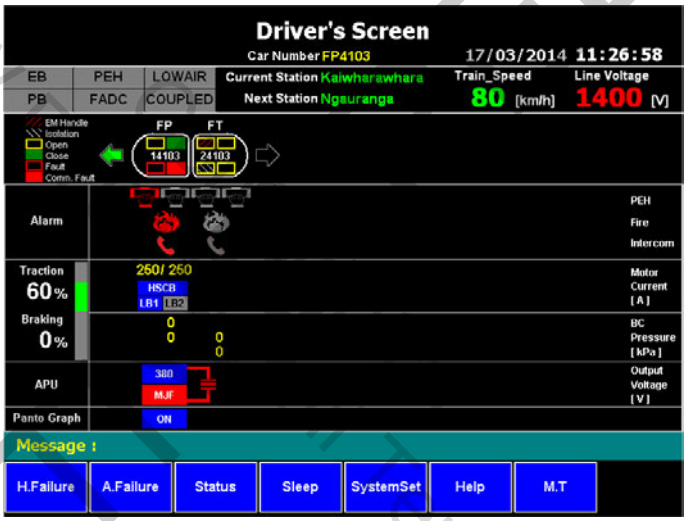


Figure B-1 Locomotive Engineer's Screen

b. Navigate to the Failure screen by pushing the Failure button. If there are no system failures, the screen will not change. If any failures have detected, the following view will be displayed.

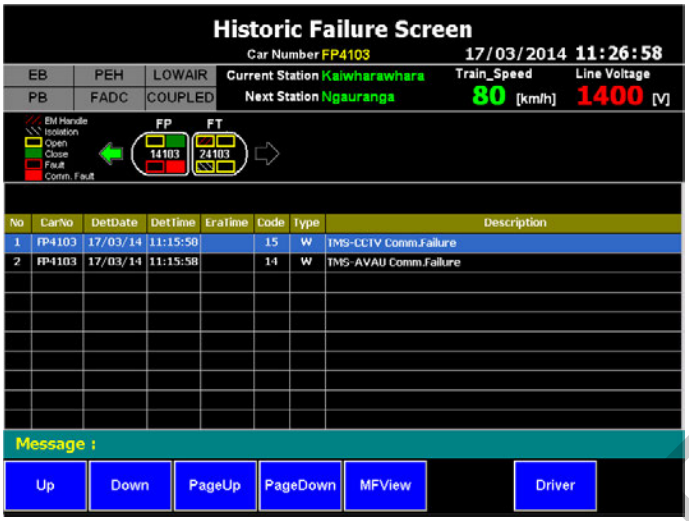


Figure B-2 Failure Check on TMS Screen

c. In the above figure, all failures are assigned an ERATime (Erased Time). This means that they have been cleared and the system is now operating normally. If there are failures that remain outstanding, the ERATime column will remain blank for these rows, and all active failures can be checked via Active Failure Screen.

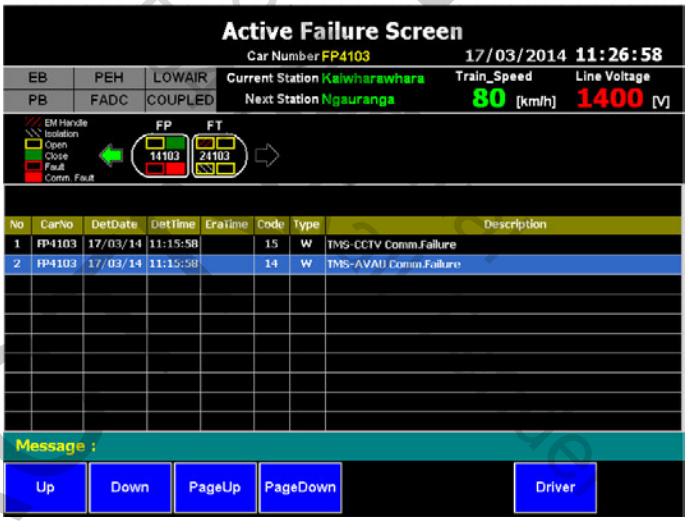


Figure B-3 ERATime Check on TMS Screen

1.2.1.3 Cab Lighting Check

Check cab lighting operation against the table below.

Action	Location	Function
Head Light / Ditch Light Switch	Operation Panel #6.	Switches Head Lights/Ditch Lights On / Off.
Head Light High / Low Beam Switch	Locomotive Engineer's Desk	Toggles Head Lights/Ditch Lights between High beam / Low beam
Taillights	External	Automatially switch 'Ón' in non active cab

1.2.1.4 Brake Test

The Locomotive Engineer should follow the steps below for testing the brakes:

a. Parking Brake

(1) Press Parking Brake Apply pushbutton on operation panel #4.

(2) Check that the Parking Brake Apply pushbutton LED illuminates.

(3) Press Parking Brake Release pushbutton on operation panel #4.

(4) Check that Parking Brake Apply pushbutton LED extinguishes.

b. No. 2 Brake Test – conducted when cutting in cab/changing cabs.

(1) Ensure that the Main Reservoir (MR) pressure gauge reads between 875 kPa and 975 kPa.

(2) Ensure the Parking Brake Apply pushbutton is illuminated.

(3) Move Power/Brake controller to "Off" position. Ensure that BC gauge decreases from maximum to 0 kPa. Check that the BP gauge reads 550 kPa.

(4) Move Power/Brake controller to Maximum Brake position. Ensure that Brake Cylinder (BC) pressure gauge reads 205 kPa in MC and 160 kPa in TC. Brake Pipe (BP) pressure gauge should read 550 kPa.

(5) Move Power/Brake controller to a brake position.

(6) Press Parking Brake Release pushbutton and that the Parking Brake Apply LED extinguishes.

c. No.1 Brake Test - Conducted for KiwiRail Network Requirements Pneumatic Brake

(1) After cutting cab "In" and performing a No. 2 Brake Test:

(2) Leave Parking Brake Applied Check that the Parking Brake Apply pushbutton illuminates.

(3) Change TMS to Brake screen.

(4) Rapidly move Power/Brake controller to Emergency Brake position. Ensure that BP gauge to 0 kPa and check that BC gauge reading increases to 245 kPa in MC and 185 kPa in TC.

(5) Move Power/Brake controller to "Off" position. Ensure that BC gauge decreases from maximum to 0 kPa. Check that the BP gauge reads 550 kPa.

(6) With pneumatic controller in charging position. Check that the BP pressure gauge reads 550 kPa.

(7) Move pneumatic controller to Vent position. Ensure that BP pressure gauge decreases to 0 kPa and BC pressure increases to 245 kPa in MC and 185 kPa in TC.

(8) Move pneumatic controller to the Release position. Check that the BP pressure gauge reads 550 kPa.

(9) Move Power/Brake controller to a brake position.

(10) Press Parking Brake Release pushbutton and that the Parking Brake Apply LED extinguishes.

d. No.1 Brake Test - Person on Ground Performing Brake Test

(1) Standing at opposite end of train to Locomotive Engineer request apply brakes.

(2) Locomotive Engineer will perform a brake leakage test then apply brakes.

(3) At external gauges when application is made Parking Brake will be "ON" and Brake Cylinder will register a higher pressure.

(4) Request release brakes (when Locomotive Engineers Pneumatic Brake valve stops venting) Brake Cylinder pressure will show "0".

(5) Request Parking Brake to be released – gauge will go to "OFF"

(6) Brake test finished.

Table B-1 Air Pressure Variables

Brake Position	MC	TC
Service Brake	205 kPa (± 15 kPa)	160 kPa (± 15 kPa)
Pneumatic Brake Vent Position	245 kPa (± 20 kPa)	185 kPa (± 20 kPa)
Emergency Brake	245 kPa (± 20 kPa)	185 kPa (± 20 kPa)

1.2.1.5 Vigilance Cycle Test

Conduct a daily check using the following procedure:

a. Depress and hold down the Vigilance Reset foot pedal. Reduce BC pressure below 120 kPa and select a direction.

b. Lift foot off Vigilance Reset foot pedal and using a stopwatch, begin timing. Audible alarm will sound after 10 ±2 seconds. Cancel audible alarm by pressing and hold down foot pedal.

c. Check that after 50 seconds ±3 the vigilance warning light in the cab illuminates. Allow the vigilance circuit to continue timing.

d. Check that after 60 seconds ±2 the vigilance audible alarm is sounding in the cab. Allow the vigilance circuit to continue timing.

e. Check that after 70 seconds ±2the vigilance penalty solenoid operates to dump the brake pipe. On Matangi EMUs, emergency brake status is shown on left top on TMS monitor as shown in below figure.

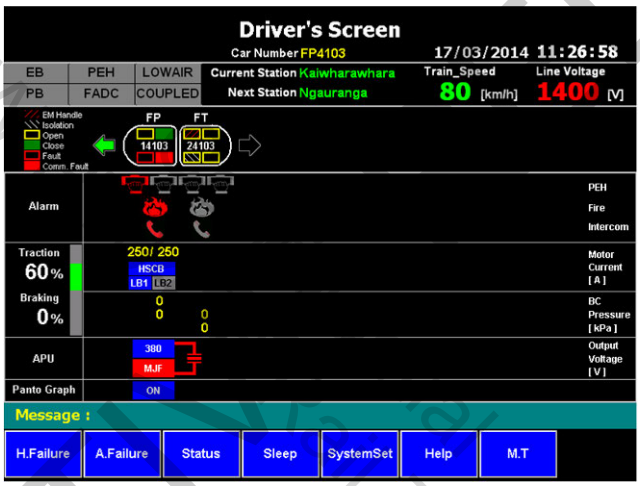


Figure B-4 Emergency Brake Status Check on TMS Screen

f. Depress the Penalty Brake Reset pushbutton and check that the system resets correctly.

1.2.2 Checks in the passenger saloon compartment

While proceeding to the leading driving cab, the Locomotive Engineer should check items and equipment in passenger saloon compartments against the equipment list in the table below.

Equipment	Status
All lighting and emergency lighting	Switched on
All passenger doors	Refer to clause 1.2.2.1 for door test
All cubicle doors	Properly closed and locked
All fire extinguishers	Properly placed
All straphangers	In satisfactory condition
All air-conditioning units	Functioning normally

While carrying out checks, perform door test (refer to clause 1.2.2.1 below).

1.2.2.1 Passenger Door Test

This procedure is used to check door operation on both sides of the train.

Step	Action	Status
1. At the doors adjacent to the rear cab		
1.1	Insert Train Manager key and select "Control".	RELEASE and OPEN pushbuttons for the Local Door to illuminate.
1.2	Press RELEASE pushbutton	Local Door opens and OPEN pushbuttons on other doors illuminate
1.3	Turn the Train Manager key to "Run" position and remove key.	
1.4	Repeat above steps for opposite side door.	
2. Perform the following steps throughout the train – open several doors:		
2.1	Press OPEN pushbutton	Local door opens and: • CLOSE pushbutton illuminates • Passenger Step Lights turn on • Bodyside Door Open indicator illuminates
3. At the doors adjacent to leading cab		
3.1	Insert Train Manager key and rotate to Control position	
3.2	Press ALL CLOSE pushbutton	All passenger doors except Local Door close and: • OPEN pushbutton illuminates • Passenger Step Lights turn off • Bodyside Door Open indicator extinguishes
3.3	Press CLOSE pushbutton	Local Door closes
3.4	Remove Train Manager key. Repeat close on opposite side	Push ROW
3.5	With leading cab now "cut in" ensure that door light is illuminated	

2 Preparing to Move the Train

Preparation requires inputting of the train's route information to ensure the correct messages are displayed at the destination signs.

Before continuing, confirm that all the checks of the exterior and interior have been done according to clause 1.

2.1 Setting Destination Signs for Route

Before starting to move the train, the Train Manager should enter the 3-digit Route Number into the COP. Once this has been done, check that both external LED signs and COP LCD display show the correct destination station name.

A route can be selected in certain location of COPs and they are shown in below tables.

When master key is off, COPs except middle car are configurable to set route code.

When master key is on, only COP in activated cab is configurable to set route code.

Train No.	Train #1	
Car	Car #1	Car #2
Master Key On/Off	Off	Off
COP Route Configurable	O	O
Master Key On/Off	On (ACR)	Off (TCR)
COP Route Configurable	O	X

<Single Unit>

Train No.	Train #1		Train #2	
Car	Car #1	Car #2	Car #1	Car #2
Master Key On/Off	Off	Off (ICR)	Off (ICR)	Off
COP Route Configurable	O	X	X	O
Master Key On/Off	On (ACR)	Off (ICR)	Off (ICR)	Off (TCR)
COP Route Configurable	O	X	X	X

<Multiple Units>

3 Line Operation

A complete description of cab controls and indicators is provided in Part A.

3.1 Car Acceleration / Deceleration

The Power/Brake Controller Handle controls car acceleration and braking. Moving the handle forward causes the vehicle to accelerate. Moving the handle backward applies the brake.

The Power/Brake Handle has following positions:

- Maximum Power
- Minimum Power
- Off
- Minimum Brake
- Maximum Brake
- Emergency Brake

3.2 Departure

Before moving the train, Locomotive Engineer should confirm that all doors are closed and locked, using the TMS monitor and with all Doors Closed lights showing in the cab.

When departing from a station the Locomotive Engineer should not attempt to move the vehicle until the ROW signal is received.

3.3 Traction Interlocks

Any of the following conditions will disable power to the traction units:

- Opening/Unlocking of any passenger doors
- Triggering of trip cock
- Low Brake Pipe Pressure
- Application of Electro-Pneumatic emergency brake

When power is disabled due to any of the conditions listed above, follow the instructions in the table below.

Reason	Remedial Action
One or more passenger doors are opened or unlocked	Close & lock the doors Move Power/Brake Handle out of "Powering" position and then back to "Powering" position.
	If the failure cannot be cleared, the Locomotive Engineer can use the Door Override Switch to allow the train to be moved to the nearest station for maintenance
Trip Cock Operated	Move Power/Brake Handle to "Brake" position Reset the trip cock by pressing Trip Cock Reset Pushbutton, then move the Power/Brake Handle away out of "Powering" position and then back to "Powering" position.
Low Brake Pipe Pressure	After resolving the cause of the pressure loss, move the Power/Brake Handle away out of "Powering" position and then back to "Powering" position.

3.4 Emergency Brake

Emergency braking can be initiated either manually by the Locomotive Engineer, or by another train crew member or passenger; or automatically by a train system.

3.4.1 Causes of Emergency Brake

3.4.1.1 Emergency Brake by Locomotive Engineer

When an immediate application of the emergency brake is required, the Locomotive Engineer can apply the emergency brake manually in any of the following ways:

- Moving the Power/Brake Handle to the EMERGENCY position.
- Depressing the Emergency Pushbutton on Operation panel #4.
- Depressing the Emergency Pushbutton on Operation panel #7.
- Reducing BP Pressure using the Pneumatic Brake Controller on control desk.
- Emergency brake cock under Train Manager's seat in cab.

3.4.1.2 Automatic Emergency Brake

a. Over-Speed

When train speed exceeds 115 km/h an audible alarm will sound. If speed remains above 115 km/h for 10 seconds, the Tranzlog unit will apply the penalty emergency brakes. (Overspeed reduced to 55 km/h in the event of Air Suspension failure.)

b. Vigilance System

The Tranzlog unit applies the penalty emergency brake based on a pre-programmed vigilance cycle. Locomotive Engineers must respond regularly as requested by the vigilance system to avoid application of the penalty emergency brake.

c. Passenger Emergency

Operating the Passenger Emergency Valve handle in the passenger saloon will activate the passenger emergency function.

In the cab an audible alarm and Passenger Emergency Handle 'operated' on TMS will be displayed.

The Locomotive Engineer will immediately commence an emergency brake application to bring the train to a stop.

d. Low MR Air Pressure

Insufficient MR air pressure (below 650kPa) will apply the emergency brake.

e. Brake System Failure

Any major fault in the brake system will apply the emergency brake.

f. Trip Cock

The trip cock will apply the emergency brake when train attempts to pass a signal at 'Stop' fitted with a Train Stop.

3.4.2 Recovering from Emergency Braking

a. Emergency Brake Application triggered using Power/Brake handle.

Move the Power/Brake handle away from Emergency position to charge the brake pipe and release the emergency brake.

b. Emergency Brake Application triggered by Emergency Pushbutton.

Twist to release the Emergency pushbutton to charge the brake pipe and release the emergency brake.

c. Emergency Brake Application triggered by Pneumatic Brake Controller.

Use the brake controller to charge the brake pipe and release the emergency brake.

d. Penalty Emergency Brake Application by Vigilance System.

Penalty emergency brake application by Vigilance System (Tranzlog) can only be reset after 47 seconds, if penalty occurred at a speed in excess of 4 km/h. To reset the penalty brake, press the Penalty Reset pushbutton on Operation panel #6.

If train is stationary or speed is under 4km/h penalty reset can be accomplished after a 5-second wait.

e. Penalty Emergency Brake Application – Tranzlog overspeed

Locate cab where penalty application has occurred. To reset, press the Penalty Reset pushbutton on Operation Panel #6.

f. Passenger Emergency Brake – Override Foot Pedal

In the saloon when the Passenger Emergency Valve handle is 'pulled', in the cab an audible alarm and Passenger Emergency Handle 'operated' on TMS will be displayed.

The Locomotive Engineer shall immediately commence an emergency brake application to bring the train to a stop.

The system is designed to automatically apply an emergency brake application 3 seconds after the Passenger Emergency Valve handle is 'pulled'.

In the event that the train will stop inside a tunnel or on a bridge the Locomotive Engineer can depress and hold down the Override Foot pedal. This action temporarily prevents the emergency brake application allowing the Locomotive Engineer to immediately stop the train clear of the tunnel or bridge. The Override Foot pedal shall not be used for extended distances.

If the Override Foot Pedal is not depressed within 3 seconds then an emergency application of the brakes will occur bringing the train to a stop. The Passenger Emergency Valve will need to be reset to allow the train to be moved to an appropriate and safe stopping place.

The audible alarm is suppressed while the foot is on the pedal.

Use of the foot pedal is recorded in Tranzlog and checked for use during random downloads.

g. Low MR Pressure

   Wait until MR pressure rises above 670 kPa.

h. Trip Cock

   Reset the trip cock using Trip Cock Reset pushbutton in the driving cab.

3.5 Hill Start

The Hill Start feature prevents the train from rolling backwards when starting on a steep gradient. To start on gradient, follow the procedure below:

a. To confirm the train is stationary, move the Power/Brake control handle to "Brake" position between MIN and MAX braking.
b. Press the Hill Start pushbutton on the Locomotive Engineer's desk.
c. Wait until the pushbutton illuminates.
d. Move the Power/Brake control handle to the "Powering" position.
e. The Hill Start feature is reset automatically as soon as the train begins to move.

3.6 Normal Operation, Passenger Doors

3.6.1 Arriving at a Station

When approaching a station, the Train Manager should follow the steps listed in the table below to allow passengers to open and close doors (for detailed operation refer to Section 11.)

Step	Action by Train Manager / Door Status
1	When the train reaches a station and stops, insert the Train Manager Key (TMK) into the Train Manager's Control Switch (TMCS) on the door control station.
2	Turn TMCS to 'Control' position
	At the Local Door occupied: RELEASE and OPEN pushbuttons will illuminate. Other Doors: Doors remain de-activated.
3	Press the RELEASE pushbutton on the door control station.
	At the Local Door occupied: Door Opens. Other Doors on the same side of the train only: OPEN pushbutton will illuminate.

3.6.2 Before Leaving a Station

Before leaving a station, the Train Manager should follow the steps listed in the table below:

Step	Action by Train Manager / Door Status
1	Ensure that all passengers who wish to alight/board have done so.
2	Press All Doors Close pushbutton.
	Local Door occupied: Door remains open. Other Doors: Doors close and do not respond to passenger's Door Open pushbutton.
3	Ensure all doors closed except local door. Press CLOSE pushbutton on the door control station.
	Local Door occupied: Door closes. Other Doors on the same side of the train only: Doors remain closed and de-activated.
4	Press ROW pushbutton to signal to the Locomotive Engineer to start the train.
5	Remove TMK from Train Manager's Control Switch.

NOTE

Even when all doors have closed and the Door Closed lamp is illuminated in the Cab, the Locomotive Engineer should not attempt to move the train until the ROW signal has been received.

4 Changing Driving Cab

Follow the procedure below to change the driving cab.

a. Stop the train.

b. Apply Parking brake.

c. Move the Power/Brake control handle to the "Max. Brake" position; move the reverser handle to "Isolate"; turn anti-clockwise and remove the master controller key.

d. Pneumatic Brake handle to the No. 2 (lap) position.

e. Warning Lamp test to ensure cab cut 'Out' correctly.

f. Turn Radio 'Off'.

g. Switch off all reading lights and the cab light.

h. Check taillights are illuminated.

i. Proceed to opposite cab through passenger compartments or along platform.

Upon arrival at the opposite cab:

a. Insert the Master Controller Key and turn switch to 'On' position.

b. Move the reverser handle to either the "FOR" or "REV" position.

c. Move Pneumatic Brake handle to the No. 3 position (release/recharge).

d. No.2 Brake Test.

e. Release Parking brake.

f. Radio turned 'On' and correct channel selected.

g. Check headlights / ditch lights are illuminated.

h. The Locomotive Engineer can now control the vehicle from the active cab.

5 Shutdown Procedure

When stabling a train, follow the procedure below.

a. Drive the train to the designated location for stabling.

b. Ensure that all doors are closed/locked with all door closed lamp indication in cab side (Operation Panel #6) and no passengers remain on board.

c. Move the Power/Brake handle to 'Max, Brake' position, reverser handle to 'Isolate'.

d. Apply Parking Brake

e. Pneumatic Brake handle to the No.2 position (Lap).

f. Radio turned 'Off'.

g. Press the Pantograph Lower pushbutton on Operation panel #4.

h. Press the Stabling pushbutton on Operation panel #6.

i. Turn anti-clockwise and remove the Master Controller key.

j. Ensure the train was stabled properly and leave the Driving cab.

k. Record and report repairs in 54D.

NOTE

If any door is in open condition when stabling button is pressed at first, the opened door will be closed but the train will not be stabled. To complete the stabling process, it is required to press the stabling pushbutton AGAIN with all door closed lamp on.

6 Bogie Operating Procedures

6.1 Preparing the System for Service / Inspection

a. Check the wheels to make sure that they do not have any flat spots or visible cracking.

b. Check the air springs to make sure that they are inflated.

Figure B-5 Release Device on Motor Bogie

Figure B-6 Release Device on Trailer Bogie

6.2 Preparing to Move the Train

If there is a failure in the parking brake release circuit, the parking brakes can be released manually using the release device handle. The pull-handles are located on the bottom of the side frame of each bogie.

To release the parking brakes at the effected bogie:

a. Isolate Brake Cylinder (BC) and Park Brake (SPBC).

b. Manually pull the handle/s approximately 100 mm, ensuring a ‘clunk’ noise is heard.

c. ‘Open’ Brake Cylinder only.

d. Record 54D.

NOTE

Only one bogie per set should have park brakes released at any given time.

Figure B-7 External Park Brake and BC Gauges Applied/ Released

7 Traction System Operating Procedures

7.1 Preparing the System for Service / Inspection

Before a train can be placed in service it must be inspected to ensure that all equipment functions correctly and safely. The following procedures are used to prepare the traction system for operation.

If any of the following conditions are not met, the traction system cannot be operated:

a. Vehicle and traction system supplied with control power (DC 110 V, +10%, -30%)
b. No major or minor failure is present.
c. The main switch in MDS box is set to normal position.
d. Pantograph is raised.
e. Line voltage is over 1000 V.
f. Emergency and parking brakes are released
g. System isolation button is not activated.

7.1.1 Start Operation of Traction System

To begin operation of the traction system the train crew must take the following steps:

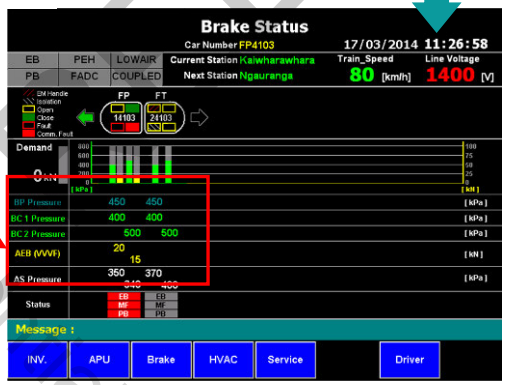
	Locomotive Engineer Activity
Step 1	Supply control voltage to the train by using the key switch in the master controller.
Step 2	Supply high-voltage power to the vehicle by using the ‘Pantograph Raise’ button after vehicle has been turned on.
Step 3	Check the operation of brake system.
Step 4	Set the Reverse Switch on the master controller to either ‘FORWARD’ or ‘REVERSE’ position.
Step 5	Set the Power/Brake handle on master controller to either ‘POWER’ or ‘BRAKE’ position.

Step 1

Push
'Pantograph Raise'
button

Step 2

Confirm brake
System operation

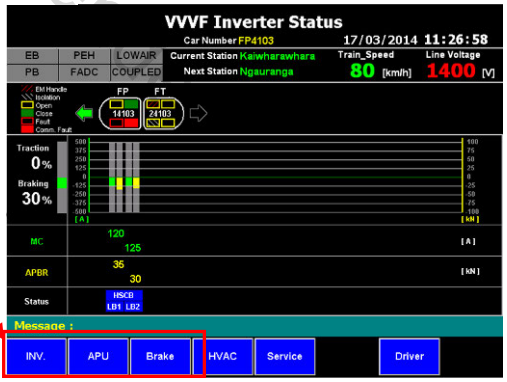


Brake Status on display unit

Step 3

Step 4

Confirm VVVF
Inverter Status



VVVF Inverter status on display unit

Step 6

Moving the
Powering/
Braking
Handle

Step 5

Figure B-8 Start Operation Flow Chart

7.1.2 Ceasing Operation of Traction System

To cease operation, the train crew should do the following activity.

	Locomotive Engineer Activity
Step 1	Use the brake to stop the train from moving.
Step 2	Set the Power/Brake handle to the 'MaxF' brake position and the Reverse Switch to the 'ISOLATE' position.
Step 3	Check the open status of line breakers 1 and 2 on the VVVF Inverter Status page of TMS display unit. (see Step 3 in Figure B-9)
Step 4	Push the 'Pantograph Lower' button to disconnect the high voltage power supply.

Figure B-9 Stop Operation Flow Chart

7.1.3 Powering (Forward/Reverse) Operation

In order to begin powered operation in Forward/Reverse, the train crew should perform the following steps:

	Locomotive Engineer Activity
Step 1	Supply control voltage to the train. by using the key switch in the master controller.
Step 2	Supply high voltage power to the train by using the 'Pantograph Raise' button after vehicle has been turned on.
Step 3	Check the operation of brake system.
Step 4	Set the Reverse Switch on the master controller to the 'FORWARD' or 'REVERSE' position.
Step 5	Set the powering/braking handle on the master controller to the 'POWER' position. The tractive effort of the train is governed by the position of the Power/Brake handle when in the 'POWER' position.
Step 6	To cease tractive effort, set the Power/Brake handle on the master controller to the 'OFF' position.

Step 1, 2 and 3 flow chart is same with Figure B-8.

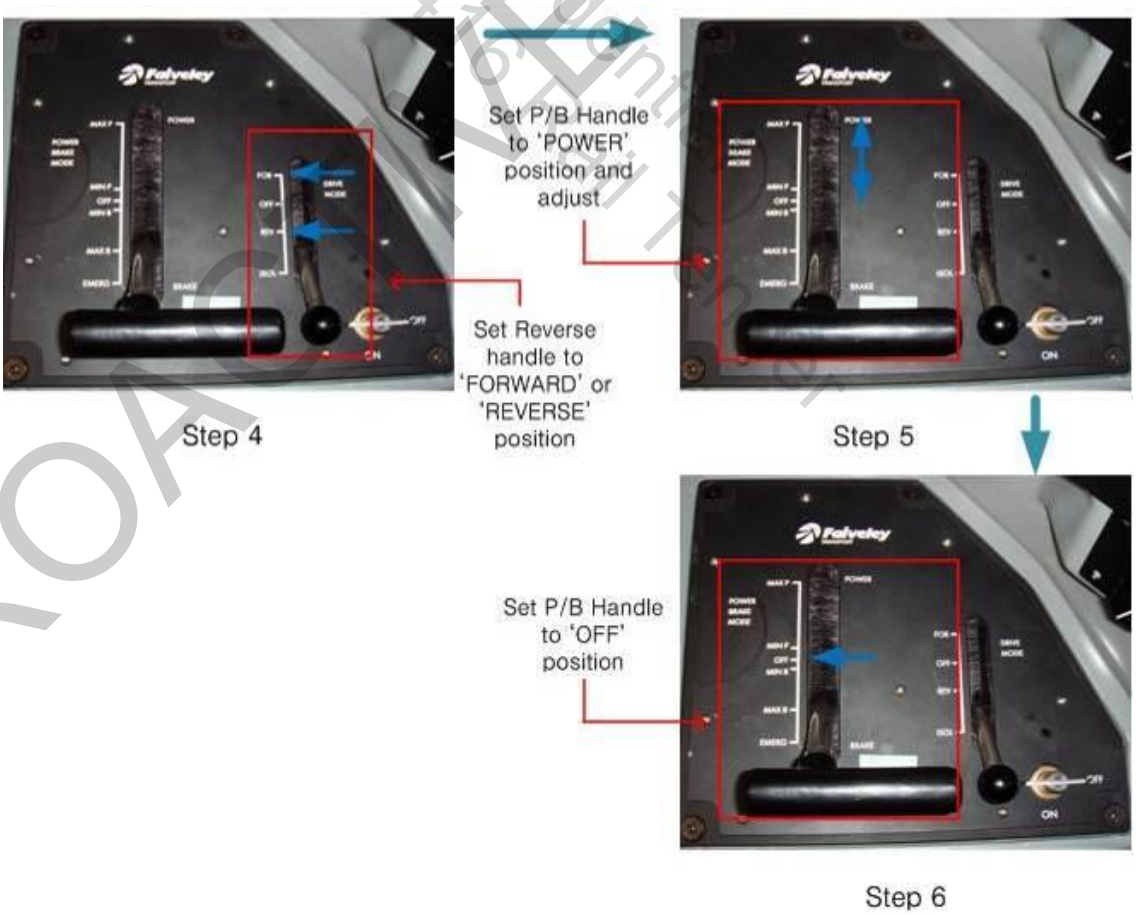


Figure B-10 Powering (Forward/Reverse) Operation Flow Chart

7.1.4 Dynamic Braking Operation

WARNING

IN THE EVENT OF DYNAMIC BRAKE FAILURE DURING BRAKING, A REDUCTION IN BRAKING EFFORT LASTING UP TO 3 SECONDS WILL OCCUR AS BRAKE CYLINDER PRESSURE AUTOMATICALLY BUILDS UP TO ACCOMMODATE THE LOSS OF DYNAMIC BRAKING. AS A RESULT, IT IS REQUIRED THAT DRIVERS DRIVE DEFENSIVELY.

WHEN APPROACHING A STATION OR SIGNAL DISPLAYING A STOP ASPECT, DRIVERS SHOULD BE BRAKING AT 60-80%, WITH A TRAIN SPEED OF NO MORE THAN 50KPH ON APPROACHING THE PLATFORM RAMP.

THIS TECHNIQUE ENSURES SUFFICIENT BRAKING EFFORT IS IN RESERVE IN THE EVENT THAT A DYNAMIC BRAKE FAILURE OCCURS.

WARNING

IT IS IMPORTANT THAT LOCOMOTIVE ENGINEERS REVISE THEIR DRIVING STYLE TO THE PREVAILING TRACK CONDITIONS. IN POOR ADHESION CONDITIONS IT IS LIKELY THAT STOPPING DISTANCES WILL INCREASE AS THE VEHICLE AUTOMATICALLY CONTROLS BRAKING ON EACH AXLE TO PREVENT ANY WHEEL SLIDES FROM OCCURRING. THE TRACTION SYSTEM PROVIDES A DYNAMIC BRAKE FUNCTION WHEN IN SERVICE BRAKE MODE.

To operate the dynamic brake, the Locomotive Engineer should perform the following steps:

	Locomotive Engineer Activity
Step 1	Set the Power/Brake handle on the master controller to the ‘BRAKE’ position while the train is in motion.
Step 2	Dynamic brake force is applied according to the position of Power/Brake handle in the ‘BRAKE’ position.
Step 3	To remove dynamic brake force, set the Power/Brake handle on the master controller to the ‘OFF’ position.

NOTE

The operating range of the dynamic brake is from 11 km/h to maximum speed of vehicle.

NOTE

When the emergency brake is applied, the dynamic brake function is not used.

Figure B-11 Dynamic Braking Operation Flow Chart

NOTE

Brake Cylinder pressure will automatically rise and then fall as dynamic brake commences.

7.1.5 Boost Function

The traction system provides a boost function, which can be used if a train requires more power than is usually available e.g. in the case of a hill-start or to perform a rescue.

To operate the Boost function, the Locomotive Engineer should perform the following steps:

	Locomotive Engineer Activity
Step 1	Set the Reverse Switch on the master controller to the 'FORWARD' position.
Step 2	Push the 'RECOVERY BOOST' button on the control panel in the active cab.
Step 3	Set the Power/Brake handle on the master controller to the 'POWER' position.

Tractive effort is increased from 0km/h to 5 km/h when using the Boost function.

In order to repeat the boost function, the vehicle must be stopped and the 'RECOVERY BOOST Button' pushed again.

7.1.6 System Isolation Function / HSCB Reset Function

The system isolation function should not be operated under normal operation, this is for use during maintenance activities. In emergency situations, the pantograph down push button is to be used to protect the traction system.

In any case that system isolation function has been applied, to reset the traction system the crew must reset the System Isolation button and push the HSCB reset button.

When the HSCB reset is applied, the isolation status of traction system is released.

In order to use the system isolation function and HSCB reset function, the Locomotive Engineer should perform the following steps:

- System Isolation Function

	Locomotive Engineer Activity
Step 1	Push the 'SYSTEM ISOLATION' button on the control panel in the active cab.
Step 2	Confirm the isolation status of the traction system on the VVVF inverter status screen of the TMS monitor Check that HSCB, LB1 and LB2 are released (status colour changes to dark gray)
Step 3	Set the Power/Brake handle to 'Max Brake' position and set the Reverse Handle to 'OFF'

- HSCB Reset Function

	Locomotive Enginer Activity
Step 1	Reset the 'SYSTEM ISOLATION' button on the control panel in the active cab.
Step 2	Push the 'HSCB RESET' button
Step 3	Set the Reverse Handle to 'Forward' or 'Reverse' position.
Step 4	Set Power/Brake handle to 'Max Brake' position
Step 5	Confirm the release of system isolation status using the VVVF inverter status screen of TMS monitor. Check that HSCB, LB1 and LB2 are closed (status colour changes to blue)

NOTE

If the master controller is set in forward/reverse after applying the system isolation, the train may move suddenly when the HSCB reset is applied. To prevent this, after applying system isolation, the Locomotive Engineer must set the brake to the 'MAX' position.

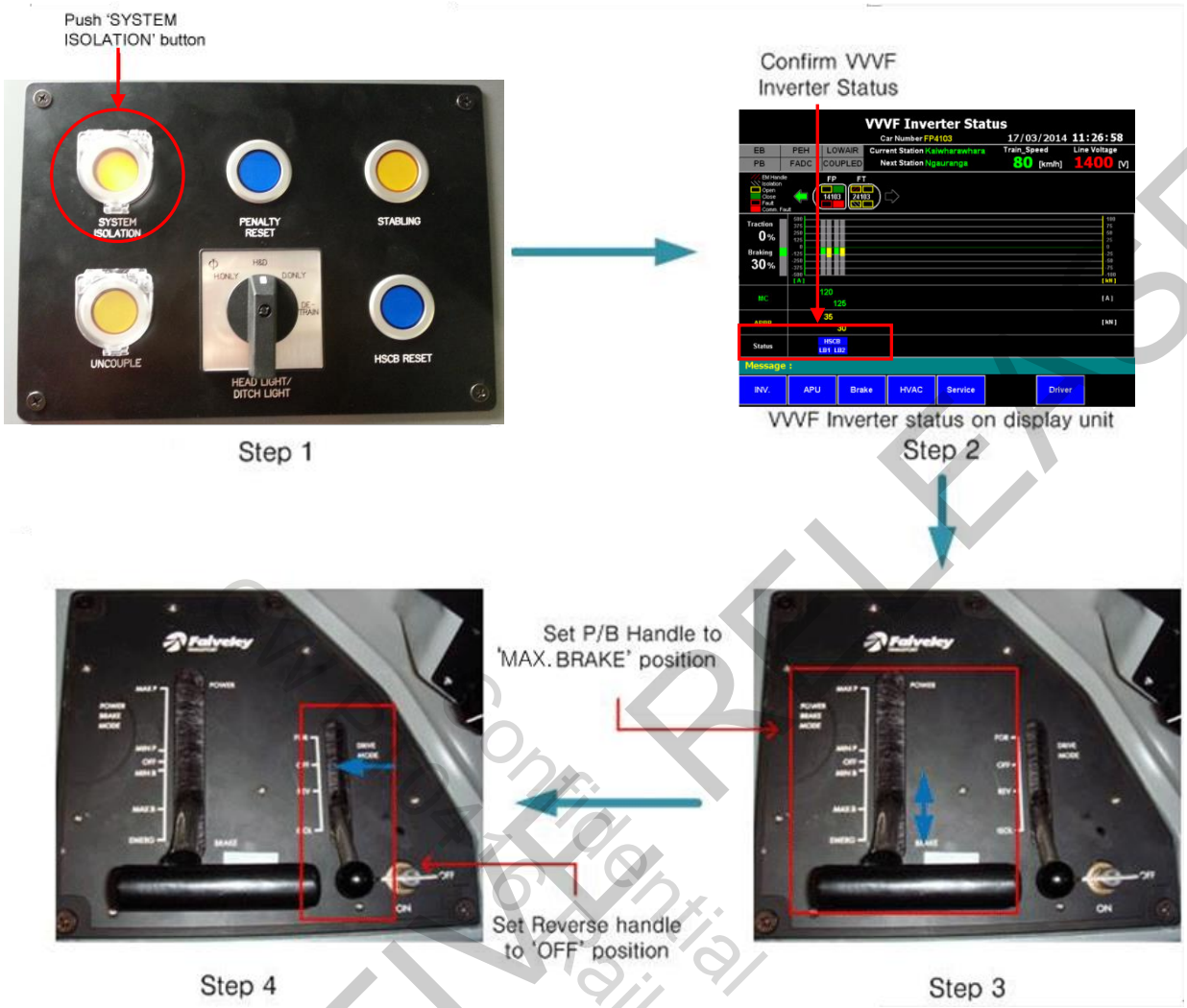


Figure B-12 System Isolation Function Operation Chart

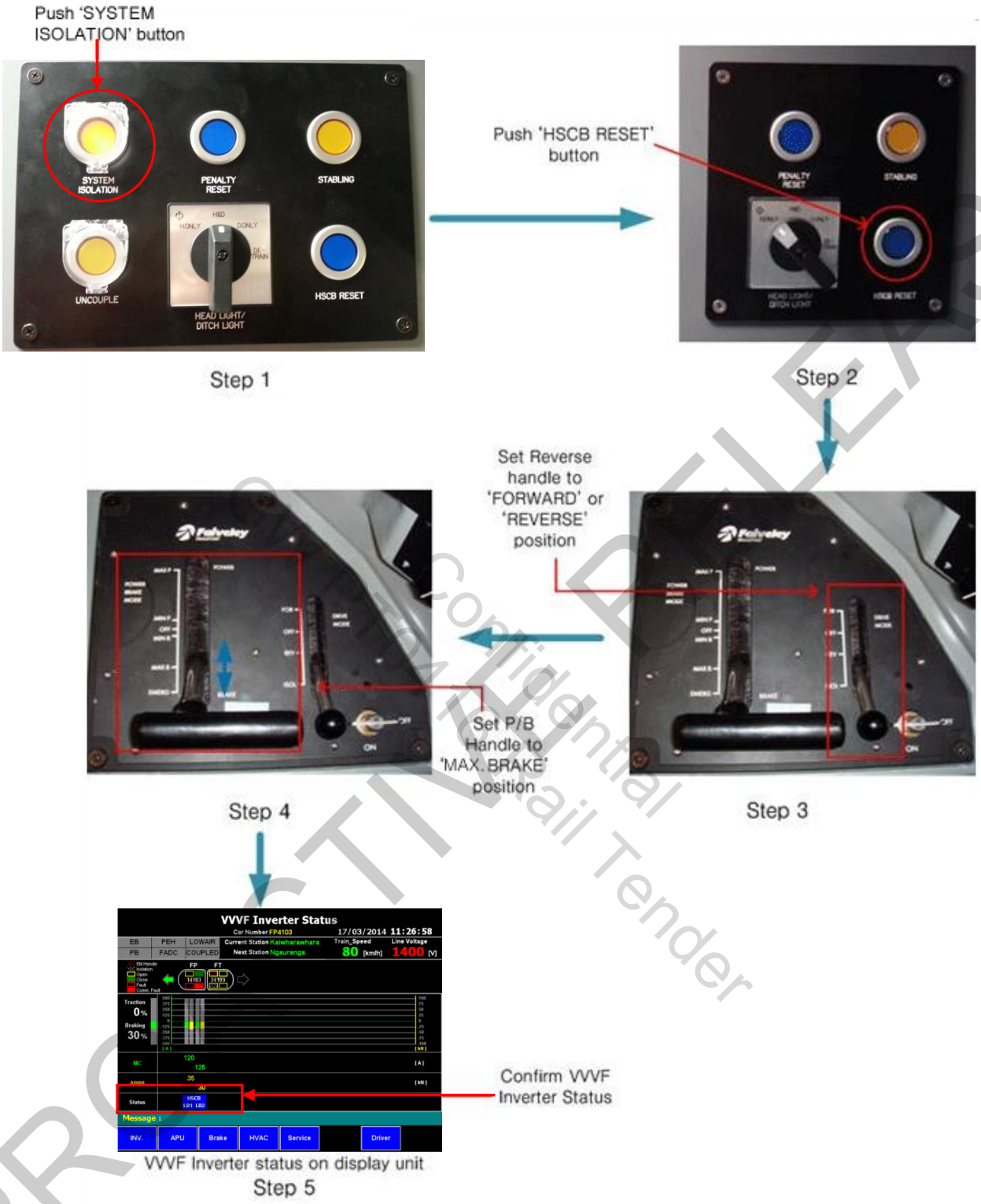


Figure B-13 HSCB Reset Function Operation Chart

8 Operating Procedures for Heating, Ventilation and Air Conditioning

8.1 Cab HVAC Operation

8.1.1 "FAN SPEED" Rotary Switch

The "FAN SPEED" rotary switch is located on Operation panel #4 and controls air flow into the Cab. The 2 possible operating states are:

1. "LOW SPEED"
2. "HIGH SPEED"

8.1.2 "CAB TEMP & MODE" Rotary Switch

The "CAB TEMP & MODE" rotary switch is located on Operation panel #4 and is used to control Cab temperature. The 7 possible operating states are:

1. "OFF" – HVAC "off"
2. "Ventilation" – Circulated air only (not conditioned air)
3. "AUTO" – Conditioned air that is within the set temperature range of 22ºC - 27ºC depending on external air temperature
4. "-2" – Conditioned air that is 2ºC colder than the set temperature. (AUTO mode with temperature offset)
5. "-1" – Conditioned air that is 1ºC colder than the set temperature. (AUTO mode with temperature offset)
6. "0" – Conditioned air that is same as the set temperature. (AUTO mode without temperature offset)
7. "+1" – Conditioned air that is 1ºC warmer than the set temperature. (AUTO mode with temperature offset)
8. "+2" – Conditioned air that is 2ºC warmer than the set temperature. (AUTO mode with temperature offset)

Figure B-14 "CAB TEMP & MODE" Rotary Switch

8.1.3 "CREW FOOT HEATER" Rotary Switch

The "CREW FOOT HEATER" rotary switch is located on Operation panel #4 and is used to control heat output from the Crew Foot Heater. The 3 possible operating states are:

1. "OFF" – No heat output
2. "HALF" – Output of half the maximum available heat capacity
3. "FULL" – Output of maximum available heat capacity

8.1.4 Cab HVAC Unit Shut-down

The Cab HVAC Unit can be shut down by rotating the "CAB TEMP & MODE" switch to the "OFF" position.

Alternatively, the Cab HVAC Unit will automatically shut down 60 minutes after the Master Control Key has been removed.

8.1.5 Non-Active Cab HVAC Operation

The Cab HVAC Unit in a non-active Cab can be operated temporarily using three switches located on Operation panel #4:

- "FAN SPEED" rotary switch
- "CAB TEMP & MODE" rotary switch
- "CREW FOOT HEATER" rotary switch

The Cab HVAC Unit in a non-active Cab will automatically shut down after 60 minutes, unless the cab is subsequently activated.

The Cab HVAC in a non-active Cab can be restarted for another 60 minutes by operating the "CAB TEMP & MODE" rotary switch to "OFF" and then back to the required operating position.

8.2 "F/A DAMPER CLOSE" Momentary Push Button and Lamp

"F/A DAMPER CLOSE" (Fresh Air Damper Close) momentary push button and lamp is located on Operation panel #4.

When "F/A DAMPER CLOSE" is operated, all Fresh Air Dampers on the train will immediately close to prevent the flow of external air into the interior of the vehicle. Heating and Cooling functions are not affected by "F/A DAMPER CLOSE" because they use only recirculated air. The HVAC Control Unit will send a signal to the TMS when Cab and Saloon Fresh Air Dampers are closed.

"F/A DAMPER CLOSE" should be operated by the Locomotive Engineer when entering a tunnel or passing an external fire.

The Fresh Air Dampers will automatically re-open 5 minutes after "F/A DAMPER CLOSE" has been operated. If the Fresh Air Dampers need to be opened immediately, the Locomotive Engineer must press the "HVAC RESET" pushbutton.

The TMS screen will illustrate when the F/A Damper is closed.

<u>The above procedure should be enabled at the units without the master key switch after uncoupled.</u>

8.3 "HVAC RESET" Push Button and Lamp

The "HVAC RESET" pushbutton and lamp is located on Operation panel #7.

When a fault occurs on a system, an alarm will be sent to the TMS and the affected HVAC Unit will go into the applicable fault operation mode. Operation of "HVAC RESET" will reset the all HVAC Units. "HVAC RESET" will illuminate YELLOW during operation of the push button.

If the fault continues to re-occur, the Locomotive Engineer can attempt to reset the fault a maximum of three times using "HVAC RESET". After the third attempt the system of the affected HVAC Unit will automatically become isolated. The "CAB ISOLATION LIGHT" or "SALOON ISOLATION LIGHT" will then illuminate RED on the affected HVAC Control Panel.

The status of all HVAC Units on the train will be displayed on the TMS.

8.4 Complete Loss of Auxiliary Power

If auxiliary power supply is lost, the HVAC Control Unit will automatically enter "EMERGENCY" Mode.

Train crew should initiate emergency evacuation procedures if auxiliary power is lost.

8.4.1 Cab HVAC Unit

Cab HVAC Unit will automatically turn off and no HVAC will be provided to the Cab area.

8.4.2 Saloon HVAC Unit

Saloon HVAC Unit will automatically set to "Emergency" Mode: Saloon Fresh Air Dampers are opened and Saloon Return Air Dampers are closed. There will be no heating or cooling provided. Power is supplied to the Saloon HVAC Unit from the vehicle batteries and operation in this mode is restricted to 90 minutes.

NOTE

Refer Section D: 1.7.3 Saloon Ventilation – Detrainment Required.

8.5 Shut-down Procedure

Cab and Saloon HVAC Units can be shut down by using the "STABLING" pushbutton.

9 Operating Procedures of Communication System

9.1 PA / PIS System

9.1.1 Central Operation Panel (COP) USER interface

The PIS system can be set up by the Train Manager from COPs except middle (ICR) car in case of multiple units prior to departure without activating a cab. If the Locomotive Engineer has activated the leading driving cab then PIS set up or alterations to the route will be from this driving cab only.

* Refer section 2.1

9.1.1.1 Route selection

The Train crew must follow the Route selection procedure as described below in order to set up the PA/PIS system prior to train departure.

a. Press the 'MOD' button on the COP and the following list will be displayed on the LCD screen:

1. ROUTE SELECT 2. STAT. ANNOUNCE 3. MESSAGE SELECT

[MODE menu]

b. Select 1. ROUTE SELECT by using ▲▼ buttons, then press the "ENT" (ENTER) button. The following list will be displayed:

ROUTE SELECT DIR : 0 DEST : 9 TYPE : 0

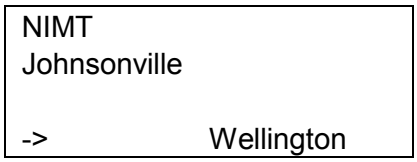
c. Using the ▲▼ buttons, move cursor to the row you wish to modify and press "ENT".

ROUTE SELECT DIR : 0 DEST : 9 TYPE : 0

d. Use the ▲▼ buttons to change the numerical value.

ROUTE SELECT DIR : 1 DEST : 9 TYPE : 0

e. Press the "CANC" (CANCEL) button to return to the default display. Details of the route you have selected will be displayed:

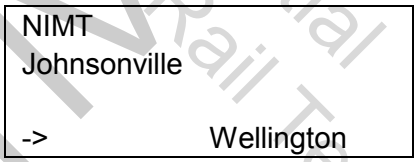


- As soon as the route is selected, the PA/PIS system will automatically display the name of the destination on both the interior and exterior PID signs. Interior PID signs keep displaying destination until train leaves exit way point of departing station.
- If the train follows a route that is different from the one selected above, there are two possible outcomes:
  - Case 1

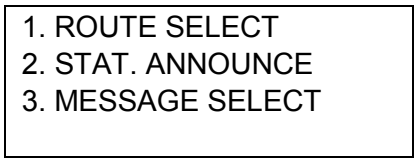
    If the train runs within a segment of route that is shared by other routes, the PA/PIS system will not know whether or not the train is on correct route. In this case the destination sign may be displayed incorrectly.
  - Case 2.

    If the train is within a dedicated route, PA/PIS system compares GPS data with the trace of the selected route. The system will then determine that the train is not on the selected route. It will change the destination signs to display the last station of the actual route the train is running on.

9.1.1.2 Manual Station Announcement

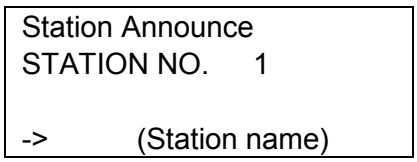


a. When the above screen is displayed, Press the "MOD" (MODE) button on the COP. The following list will be displayed:



[MODE menu]

b. Using the ▲▼ buttons, move cursor to 2. STAT. ANNOUNCE and press "ENT".



c. Use the ▲▼ buttons to search for a station number, then press the "ENT" button. The selected message will then be played back through the interior speakers and shown on the PIB display.

d. Press the "CANC" (CANCEL) button to return to the default display.

NIMT Johnsonville -> Wellington

9.1.1.3 Volume Setting

In accordance with M2ND-1.26 microphone volume adjustment can only be made through COP's maintenance menu. Volume control on COP default screen is not available.

9.1.1.4 Manual Message Announcement

NIMT Johnsonville -> Wellington

a. When the above screen is displayed, press the "MOD" (MODE) button on the COP. The following list will be displayed:

1. ROUTE SELECT 2. STAT. ANNOUNCE 3. MESSAGE SELECT

[MODE menu]

b. Using the ▲▼ buttons, move cursor to 3. MESSAGE SELECT and press "ENT". The following list will be displayed:

Manual msg. (1) 1. Welcome 2. No smoking 3. No eating

c. Use the ▲▼ buttons to select a message, then press "ENT". The selected message will be played back through the interior speaker and display on the PIB. Press the "CANC" (CANCEL) button to return to the default display.

NIMT Johnsonville -> Wellington

9.1.2 Manual PA Announcement by Crew in Cab

A manual PA announcement to passengers can be made by the crew in cab area, using the COP handset. To make a voice announcement over the interior speakers, the procedure is as follows:

Figure B-15 Manual PA announcement using COP

Press interior "IN" button on COP/SOP.

To perform an interior announcement, press and hold the "PTT" button while holding the handset.

Broadcasting will end when the "IN" button is pressed.

- If the button is released before 30 seconds have passed, Manual PA announcement Mode will be automatically released.
- While a PA announcement is being made, the "IN" indicator on all COPs and SCPs will illuminate until the announcement has ended.

9.1.3 Manual PA announcement by Train Manager in the passenger area

A manual PA announcement to passengers can be performed by Train Manager from the passenger area.

To make a voice announcement over interior speakers, the procedure is as follows:

Figure B-16 Manual PA announcement by SCP

To make an interior announcement, press and hold the "PTT" button while holding the handset.

Broadcasting will end when the "IN" button is pressed.

- If the button is released before 30 seconds have passed, manual PA announcement Mode will be automatically released.

9.1.4 Priority Order of Manual PA Announcements

In case of competing priority 2 announcements, the announcement made first is given higher priority. Newly attempted announcements cannot override announcements that are in progress.

- If, for example, a crew member in the cab tries to make a PA announcement while the Train manager is making an announcement from the passenger saloon, the Train manager's announcement from the saloon will be muted due to its lower PA priority.

9.1.5 Crew Communication and Passenger Intercommunication

The table below shows the interrelationship of: cab to cab, cab to PI, SCP to PI, cab to SCP and SCP to SCP communications It shows whether each attempt is possible when a corresponding communication is already taking place. 'O' represents an attempt that is allowed while 'X' represents an attempt that is disallowed:

- If a passenger presses the PI call button while another passenger is already communicating with crew, the attempted call will be queued and then connected when the preceding call has finished.
- This is always possible, except when the COP of the leading Cab is already in use for inter-communication.

9.1.5.1 Crew Intercommunication between Cab and Cab

Crews in different cabs can call each other using the "C_C" button on the COP/SOP. In the cab that receives the call, communication is initiated by pushing "C_C" button.

If a crew member presses the "C_C" button on his crew communication panel, the "C_C" indicator flashes to advise other crew members of the request for communication. When the call is answered, the indicator illuminates steadily.

The "PTT" button should be pushed to initiate conversation, and released when listening to the other person.

To end the call, the "C_C" button must be pressed a second time. This will turn off the "C_C" indicator.

While a call is in progress, the Locomotive Engineer in the other cab can see the calling condition but cab-to-cab and cab-to-train manager calls cannot be attempted.

9.1.5.2 Crew Intercommunication Between Cab and Passenger Area (Train Manager)

The "C_C" button on the COP/SOP and "C_C" button on the SCP can be used to call each other. The calling method is identical to cab-to-cab call.

In order to end the call, the "C_C" button is pushed.

While a call is in progress, the calling status will be indicated on all other COPs, SOPs and SCPs but new calls (cab-to-cab or cab-to-train manager) cannot be attempted.

9.1.5.3 Intercommunication Between Crew and Passenger

In order to activate the Passenger call, the passenger should first initiate the call by pressing the "PI" button on the PI panel. The call can only be responded to on a COP, SOP or SCP. This means that there is no priority in responding to the PI call.

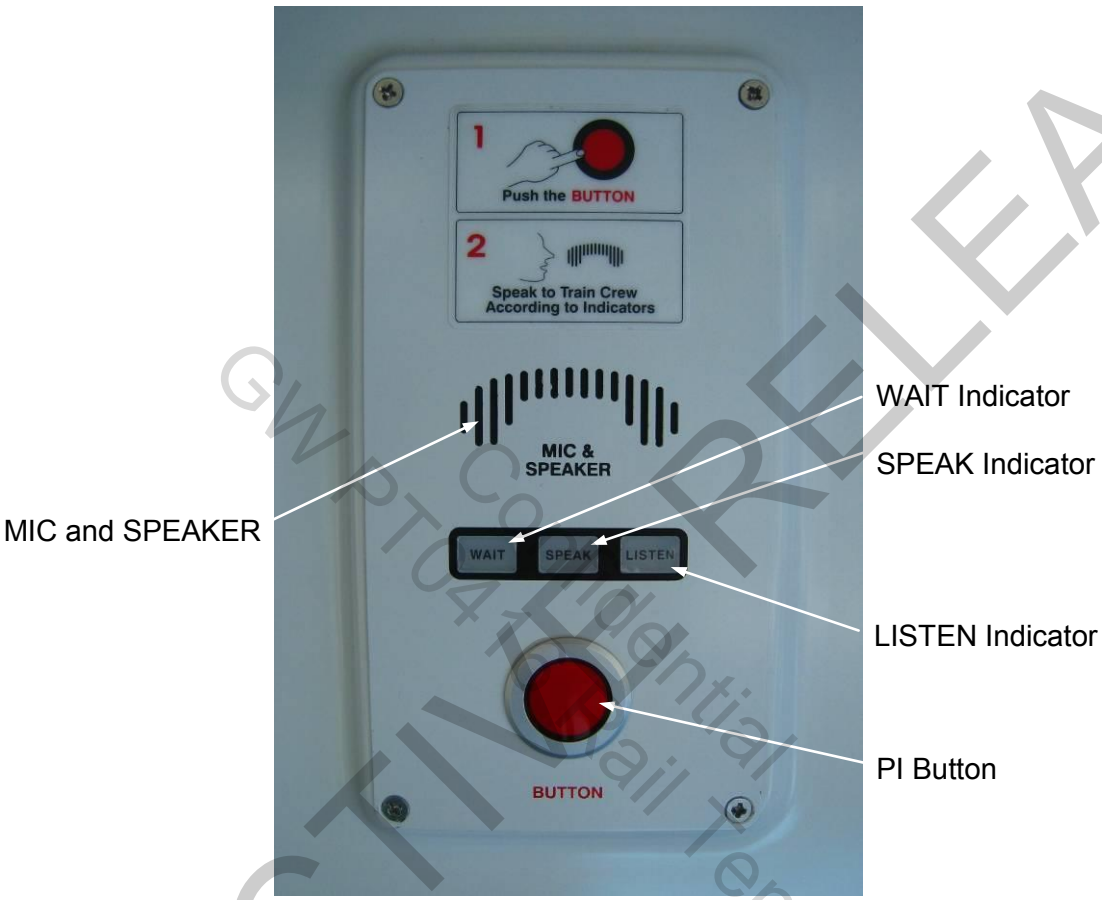


Figure B-17 Intercommunication by Passenger Intercom (PI)

If a call is initiated from a PI, crew intercom units will make a beeping sound, and the "PI" lamp will flash. When a crew member responds to the call by pressing the "PI" button, the connection will be made and the lamp will illuminate steadily. When the crew member presses the "PTT" button to speak to the passenger, the "LISTEN' indicator on the PI will be lit. When the "PTT" button is released, the "SPEAK" indicator will illuminate and the passenger can talk to the crew. During the conversation between a crew member and a passenger, another PI's requests for call will be queued. When a call has been queued, the "WAIT" indicator on the PI panel will illuminate.

To terminate a passenger call, the crew member should press the "PI" button on the crew panel. "PI" indicators on all crew communication panels will then extinguish.

Only crew can control PI communication. The call can only be heard by those crew members that are involved in the call; and by the passengers near to the PI from which the call was initiated.

9.1.6 Intercommunication Protocol Between Crew

To avoid confusion with use of the PA system for communication between onboard crew the following protocol will be applied:

- Train Manager to Locomotive Engineer — crew to crew
- Locomotive Engineer to Train Manager — crew to crew
- Train Manager to Passenger Operator — PA announcement
- Passenger Operator — PI Button on Passenger Intercom

NOTE

Locomotive Engineer is not to initiate or answer a crew to crew call while train is in motion.

9.2 Train Radio

Train Radio will be operated as per KiwiRail operating procedures.

9.3 CCTV

9.3.1 CCTV Monitor Graphic User Interface (GUI)

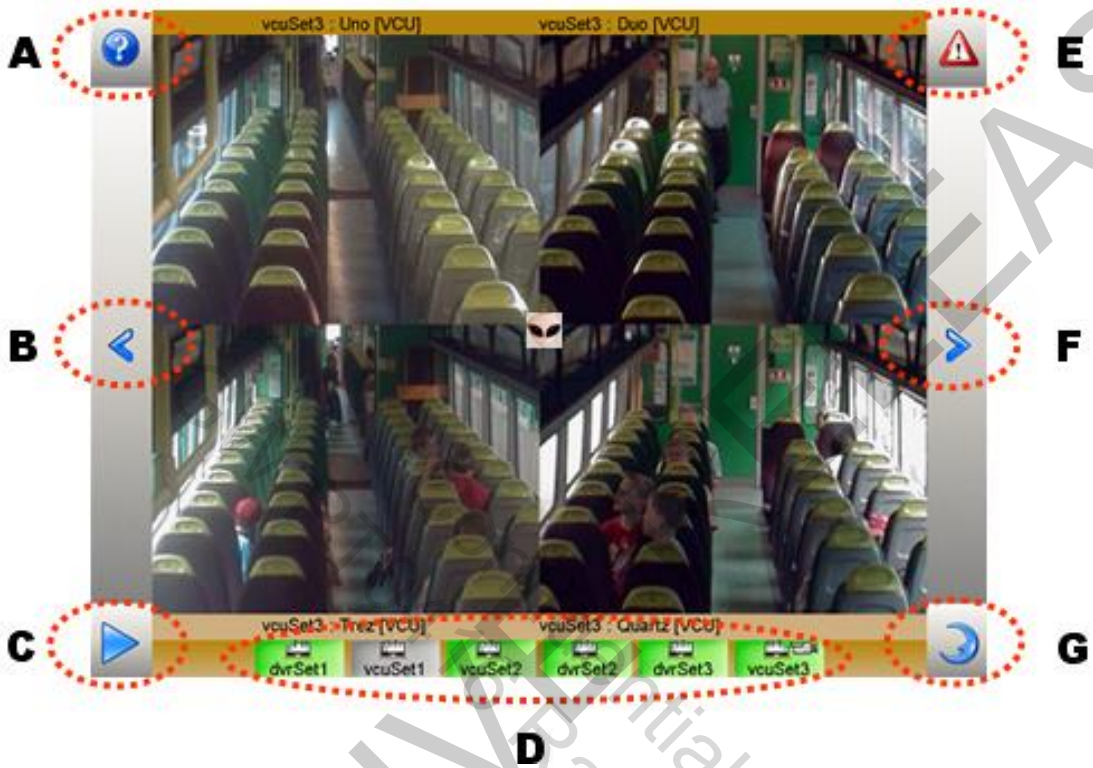


Figure B-18 CCTV Monitor GUI Icons

Item	Icon Name	Function/Description
A	INFORMATION	Provides information and configurable parameters such as sequential time interval, monitor brightness etc.
B	STEP BACKWARD	Clicking this icon moves to the previous set of camera images.
C	START/PUASE (Auto Sequence)	Toggles sequence modes between auto and manual.
D	CAR SELECTION	Displays the camera images in a specific car, when the car is selected.
E	ALARM EVENT	Shows triggered events manually.
F	STEP FORWARD	Clicking this icon moves to the next set of camera images.
G	SLEEP MODE	Turns screen blank.

10 Operating Procedures for the Train Monitoring System

10.1 Operation Modes of the Display Unit

The Display Unit has 2 modes of operation:

- Train Crew Mode
- Maintenance Mode

Maintenance mode is restricted. Maintenance mode includes wheel diameter setting and system time setting. Only maintenance staff can access this mode, using a password.

10.2 Display Unit Monitor

10.2.1 General Layout

The screen has four areas, displaying the following information:

1. Title Bar
2. Display Area
3. Failure Message Area
4. Navigation Keys

Figure B-19 General Layout Screen

10.2.2 Display Unit Area Details

10.2.2.1 Title Bar

Figure B-20 Title Bar of the General Layout Screen

The title bar displays the following information, from left to right:

① Unit Number

② Screen Name

③ Current Time and Date

- When unit in wi-fi area, the icon will be displayed

 Train in wi-fi area

 Train out of wi-fi area

- When CCTV sends TMS data to Server, the icon will be displayed.

 Data sending

10.2.2.2 Display Area

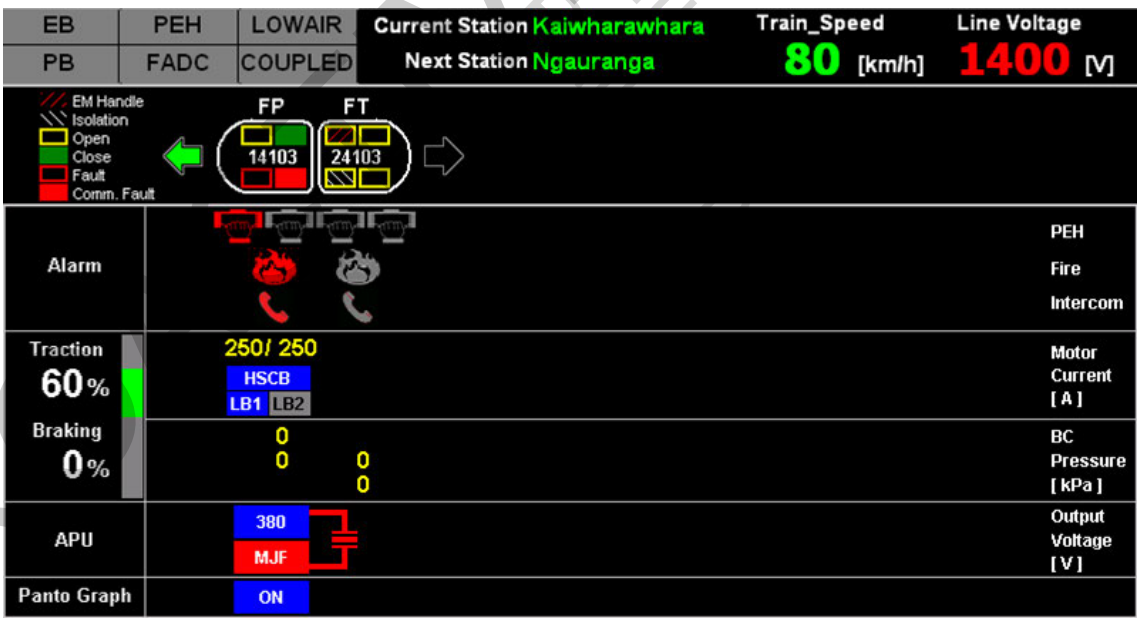


Figure B-21 Display Area of the General Layout Screen

The main display provides information as shown above. Different touch buttons will appear on the screen to navigate around the screen.

10.2.2.3 Failure Message Area

Figure B-22 Failure Message Area of the General Layout Screen

If any failure occurs, detailed information of failure is presented in this area. If there are many failures, only the latest failure will be shown.

10.2.2.4 Navigation Keys

The Locomotive Engineer can change the screen using the Navigation keys.5 types of navigation keys are displayed on the screen.

The following screen keys are displayed on the <Driver's Screen>. They are used to navigate to the <Historic Failure Screen>, <Active Failure Screen>, <Status Screen>, <System Set Screen>, <Help Screen>, <Maintenance Screen> and <Sleep> mode respectively.

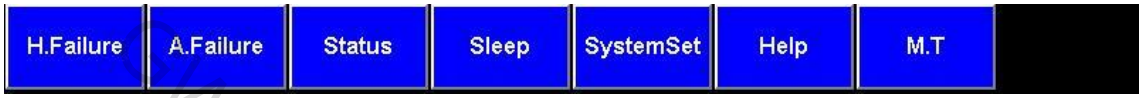


Figure B-23 Main Screen Keys

The following screen keys are displayed on the <Failure Screen>. they are used to control the list of failures that is displayed. If a Major Failure exists, a more detailed description can be shown by pressing the <MFView> Key.

Figure B-24 Failure Screen Keys

The following screen keys are displayed on the <Status Screen>. They are used to navigate to the <VVVF Inverter Status>, <APU Status>, <Brake Status>, <HVAC Status> and <Service Status> screens respectively.

Figure B-25 Status Screen Keys

The following screen key is displayed on the <Help or Maintenance Screen>. It is used to navigate back to the <Driver's Screen>.

Figure B-26 Help / Maintenance Screen Keys

When TMS is entered into the sleep mode, none of buttons are displayed. And user's screen touch is bound to awake the TMS display.

Figure B-27 Sleep Mode

10.3 Initializing the Display Unit

10.3.1 Getting Started

The Display Unit is initialized when the train is powered up.

Figure B-28 Warm-up Screen

The Above screen is displayed as the system initializes. The TMS will display "Driver Screen" within 1 minute following power-up.

10.4 Checking Information from the Operational Screen

10.4.1 Driver's Screen

In case single of single operation, the driver's screen will be displayed as follows. The driver's screen can display 1-4 set configuration when train lined:

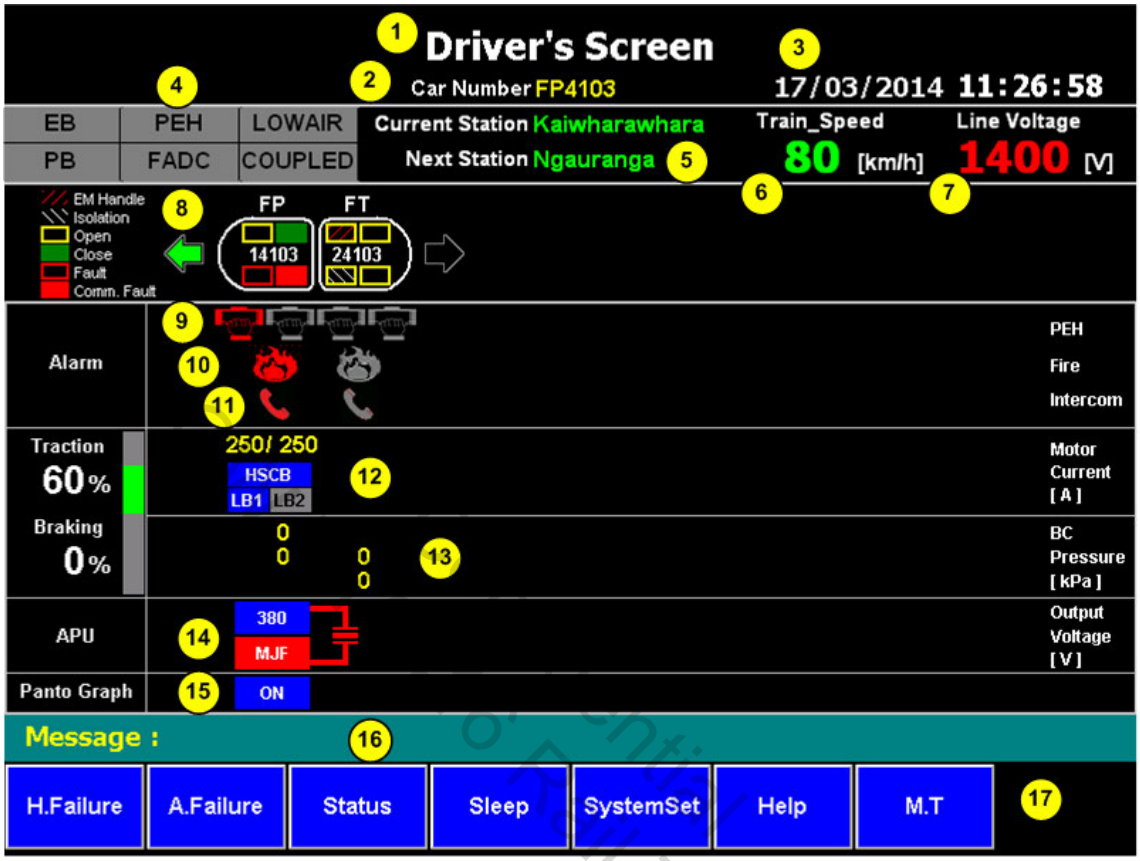


Figure B-29 Driver's Screen

The displayed items are as follows:

1. Screen name
2. Car Number
3. Time/Date
4. Main status indication (EB:Emergency Brake, PB:Parking Brake, PEH: Passenger Emergency Handle, FADC:Fresh Air Damper Closed, LOWAIR:Low Air Pressure, COUPLED:Intermediate Cab Relay)

EB Emergency Brake is applied

EB Emergency Brake is released

When parking brake is applied, the colour of "PB" changes to red.

PB Parking Brake is applied

PB Parking Brake is released

When passenger emergency handle is applied, the colour of "PEH" changes to red.

PEH Passenger Emergency Handle is applied

PEH Passenger Emergency Handle is released

When fresh air damper is closed, the colour of "FADC" changes to red.

FADC Fresh Air Damper is closed

FADC Fresh Air Damper is not closed

The main reservoir pressure is under 750Kpa and the state of the vehicle is forward or reverse. In this case the colour of “LOWAIR” changes to red.

LOWAIR ARP is low

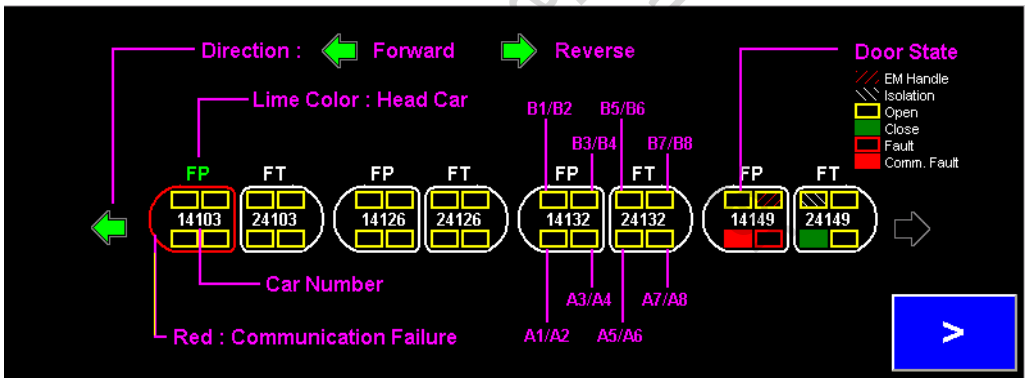
LOWAIR ARP is normal

When COUPLED is applied for couple, the colour of "COUPLED" changes to red.

COUPLED Unit is coupled

COUPLED Unit is uncoupled

5. Station name (from AVAU through serial link)
6. Train Speed
7. Line Voltage
8. Configuration, Activation Cab and Door Status, Forward/Reverse, TDL (Train Data Link), Communication Error



9. Alarm : Passenger Emergency Handle status

 Passenger Emergency Handle is activated

 Passenger Emergency Handle is not activated

10. Alarm : Faire detection status

 Fire is detected

 Fire is not detected

11. Alarm : Passenger Intercom call status

 Passenger Intercom call is requested

 Passenger Intercom call is not requested

12. VVVF Inverter motor current
13. Brake Cylinder Pressure
14. APU status (AC output voltage etc)

 APU OK, AC output voltage (380V) display

 APU Major Failure

 APU Off

 Cross Feed Contactor is operated

 Cross Feed Contactor is not operated

15. Pantograph status

 Pantograph is raised

 Pantograph is lowered

16. Failure Message Display
17. Button panel for changing screens

To activate screen sleep mode press<Sleep> button. To reactivate screen press anywhere on the screen

10.4.2 Alarm and Failure Detection Example of Driver's Screen

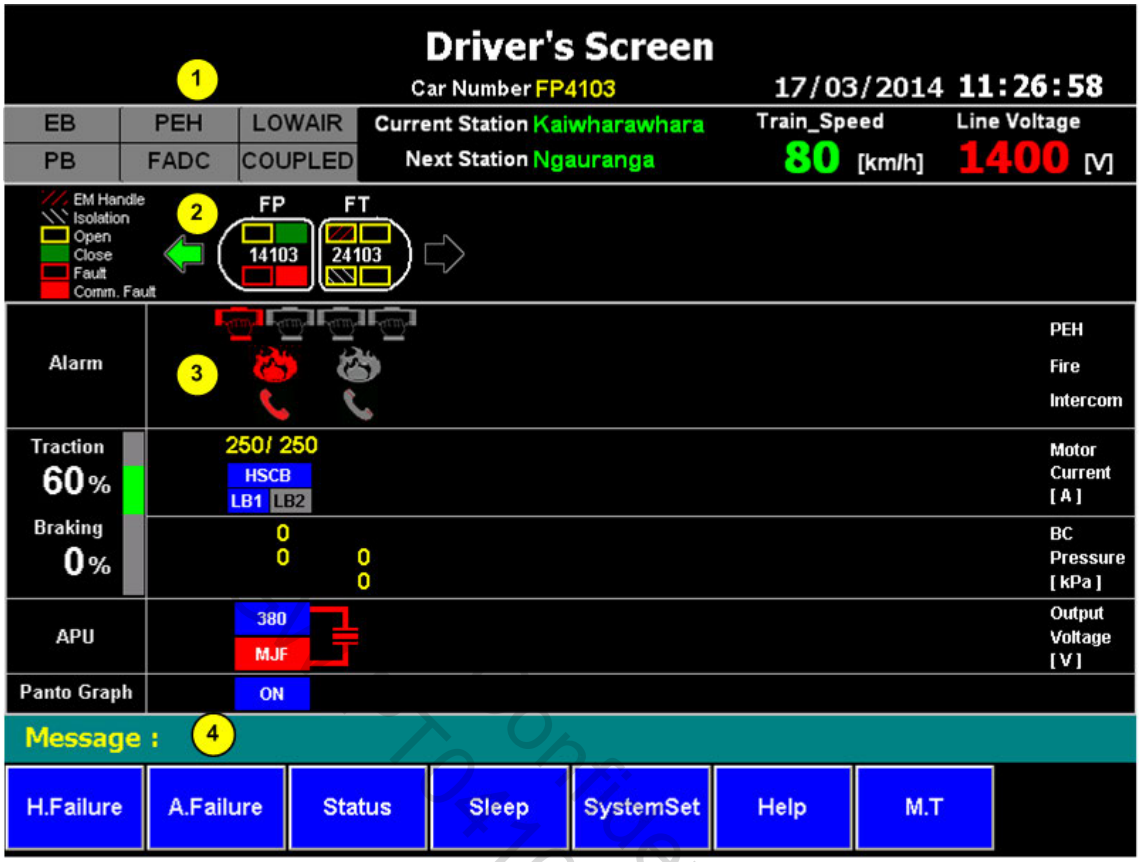


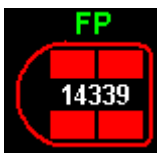
Figure B-30 Alarm and Failure Detection Example of Driver's Screen

In case of alarm or failure detection, Alarm icons or Failure messages will be displayed on driver's screen as shown in the above Figure.

1. General event display for driver:
   - EB(Emergency Brake) status display
   - PB(Parking Brake) status display
   - PEH(Passenger Emergency Handle) status display
   - FADC(Fresh Air Damper Closed) status display
   - LOWAIR(Low Air Pressure) display
   - Couple status display

2. TMS communication status display:

   When Train Data Link error has occurred, the colour of car changes to red.



FP(4339) has communication error

3. Alarm display:
   - Passenger Emergency Handle
   - Passenger Intercom Call
   - Fire Detection

4. When a major event and failure is detected, the message windows will display detected event.

10.4.3 Historic Failure Screen

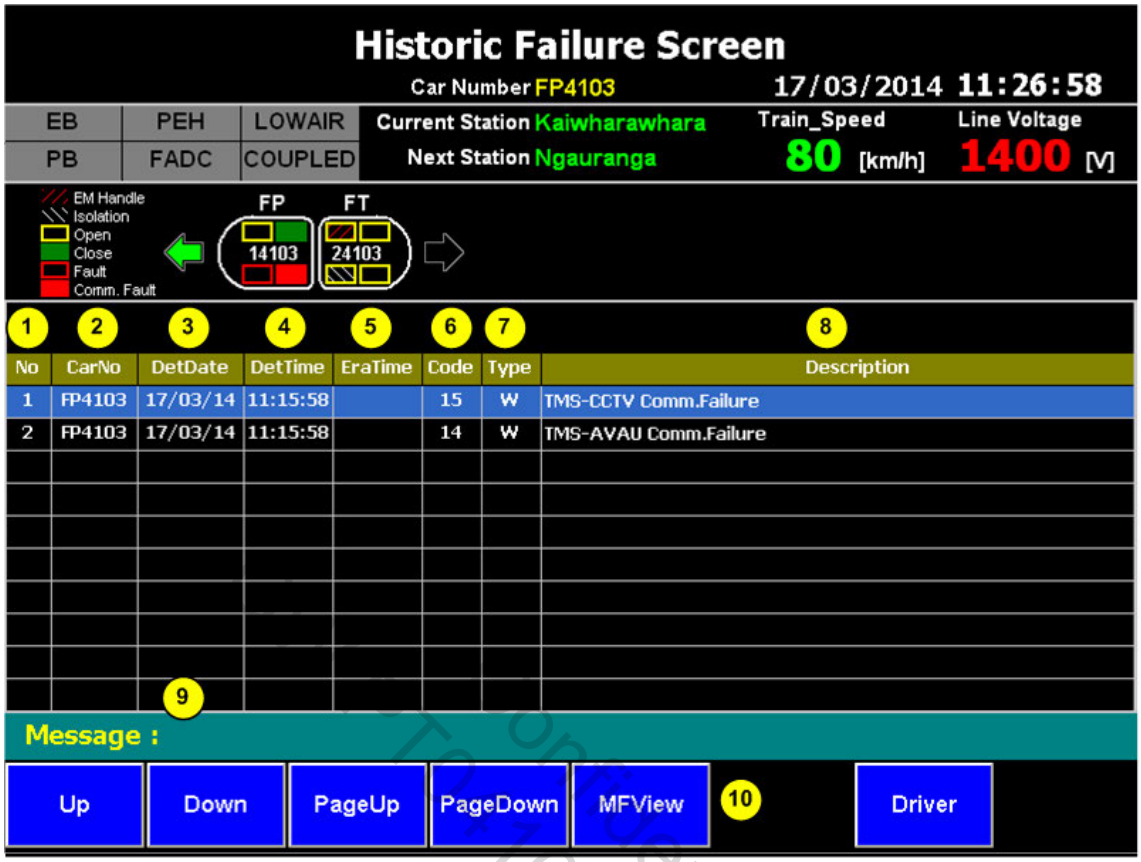


Figure B-31 Failure Screen

If any failure is detected by TMS, failures are listed by time in this screen. Maintenance Staff and Locomotive Engineer can check the failure history using this screen.

1. No: List number - The most recent Failure is displayed in the top line.
2. Car No. : FP4339, FT4339
3. DetDate: detected date of Failure
4. DetTime: detected time of Failure
5. EraTime: erased time of Failure
6. Code : Failure Code (refer to failure list)
7. Type: Failure type

   M: Major Failure

   W: Warning Failure (except the MF)
8. Description: Failure description
9. Failure message window
10. Navigation keys for searching

10.4.4 Active Failure Screen

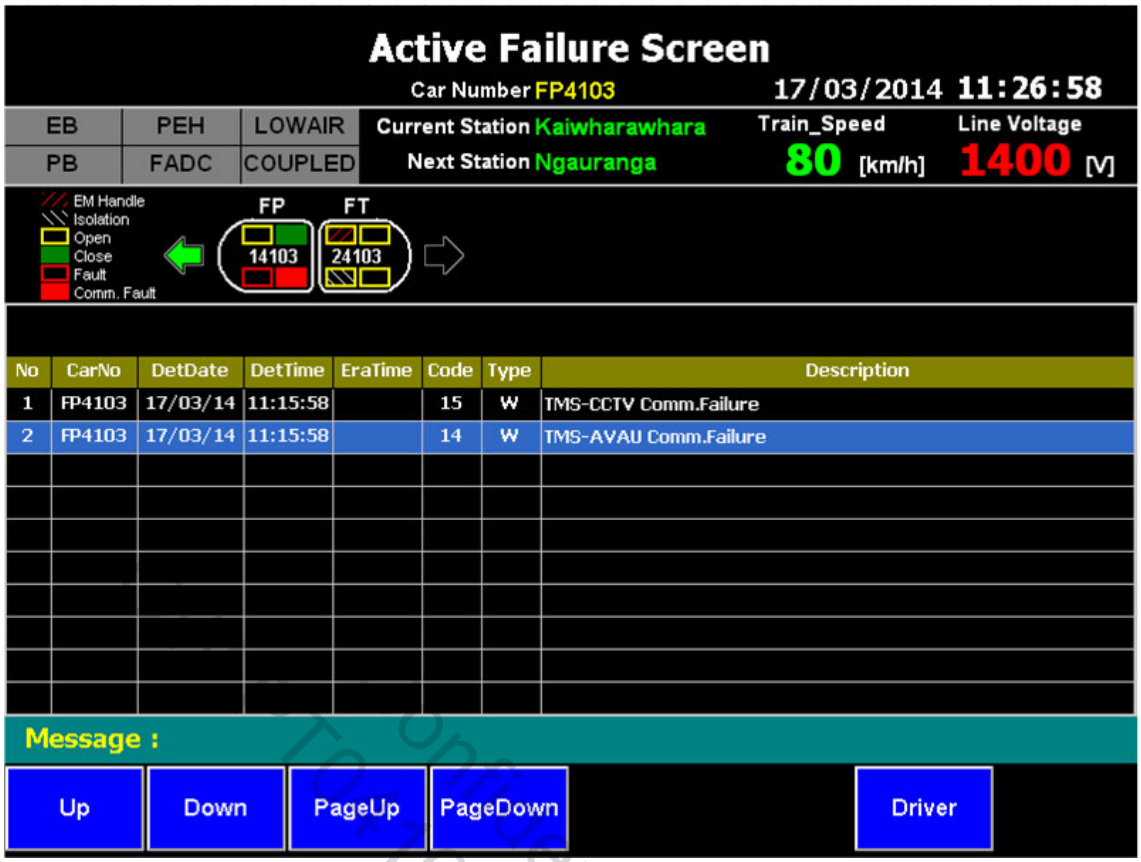


Figure B-32 Active Failure Screen

In this active failure screen, all active failures are described. When TMS detects no failure, Blank will be displayed.

10.4.5 MF View Screen

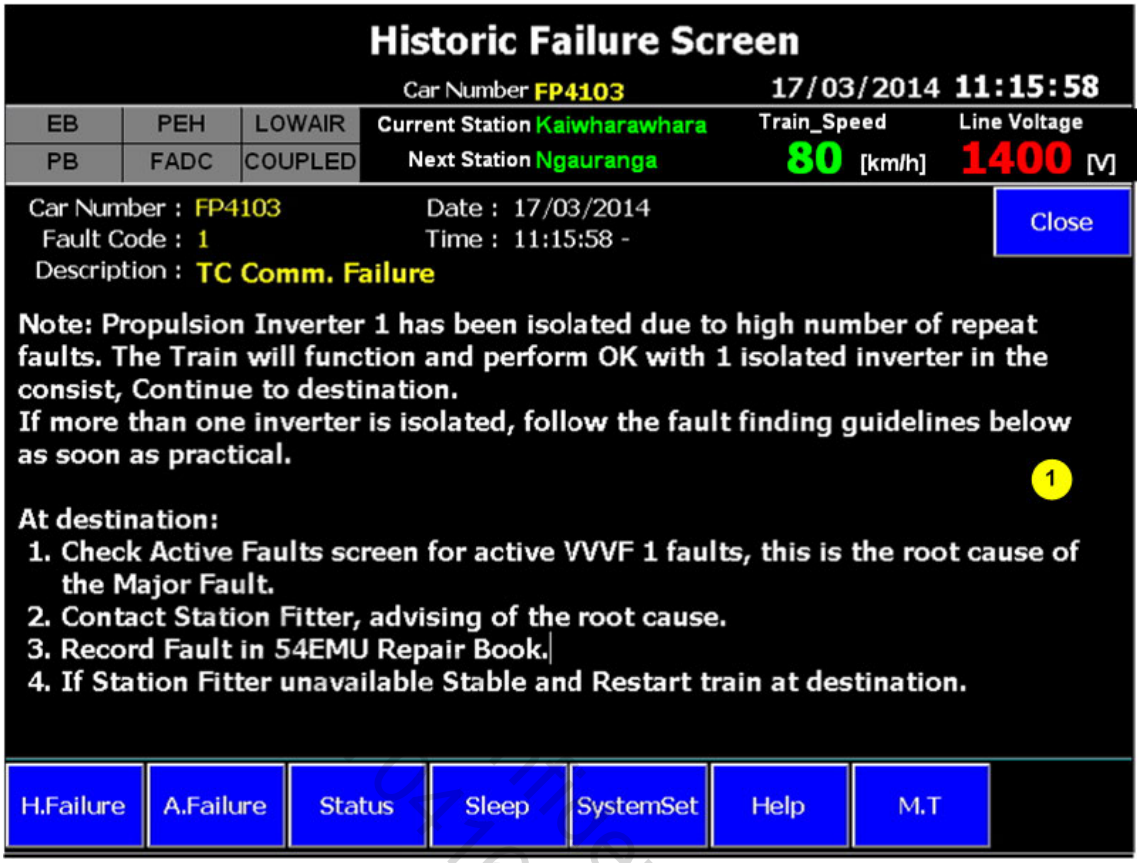


Figure B-33 MF View Screen

In case of a Major Failure (MF), Maintenance Staff and Locomotive Engineer can select the Failure and press 'MF View' button. The help guide for Major Failure will then be displayed.

1. Major Failure View.

When the cab is activated, if Train Monitoring System has one or more failures which were not cleared, Train Monitoring System will display MFView Screen automatically. All active failures should be checked by pressing the <Next> button. Once all failures are checked the Train Monitoring System will display the Driver Screen and Display Unit will operate normally.

10.4.6 VVVF Inverter Status Screen

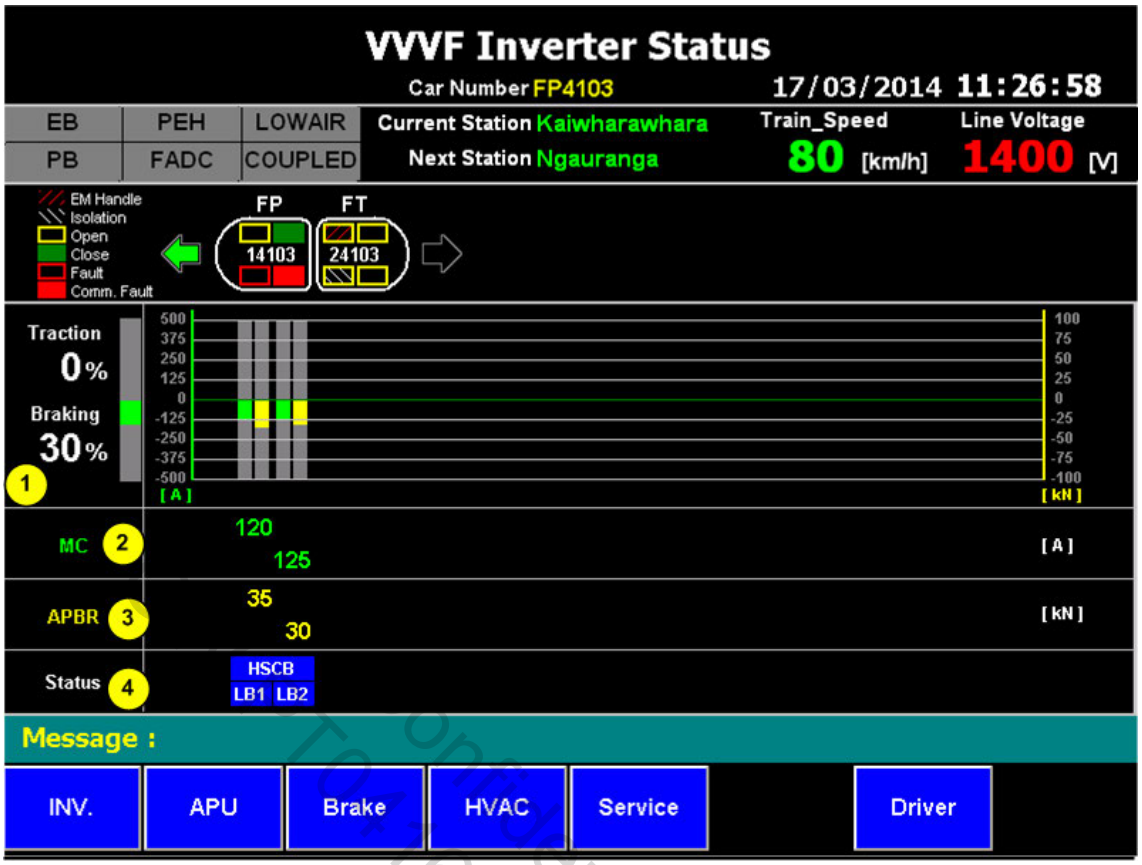


Figure B-34 VVVF Inverter Status Screen

The VVVF Inverter data is shown in VVVF Inverter Status screen. Detailed items are represented as follows:

1. Powering/Braking command
2. Motor Current : Motor effective current is displayed by text and graph.
3. Actual powering/braking (APBR), (-100[kN] ~ +100[kN]) is displayed by text and graph
4. Status of VVVF Inverter.

High Speed Circuit Breaker is on

High Speed Circuit Breaker is off

Line Breaker 1 is on

Line Breaker 1 is off

Line Breaker 2 is on

Line Breaker 2 is off

10.4.7 APU Status Screen

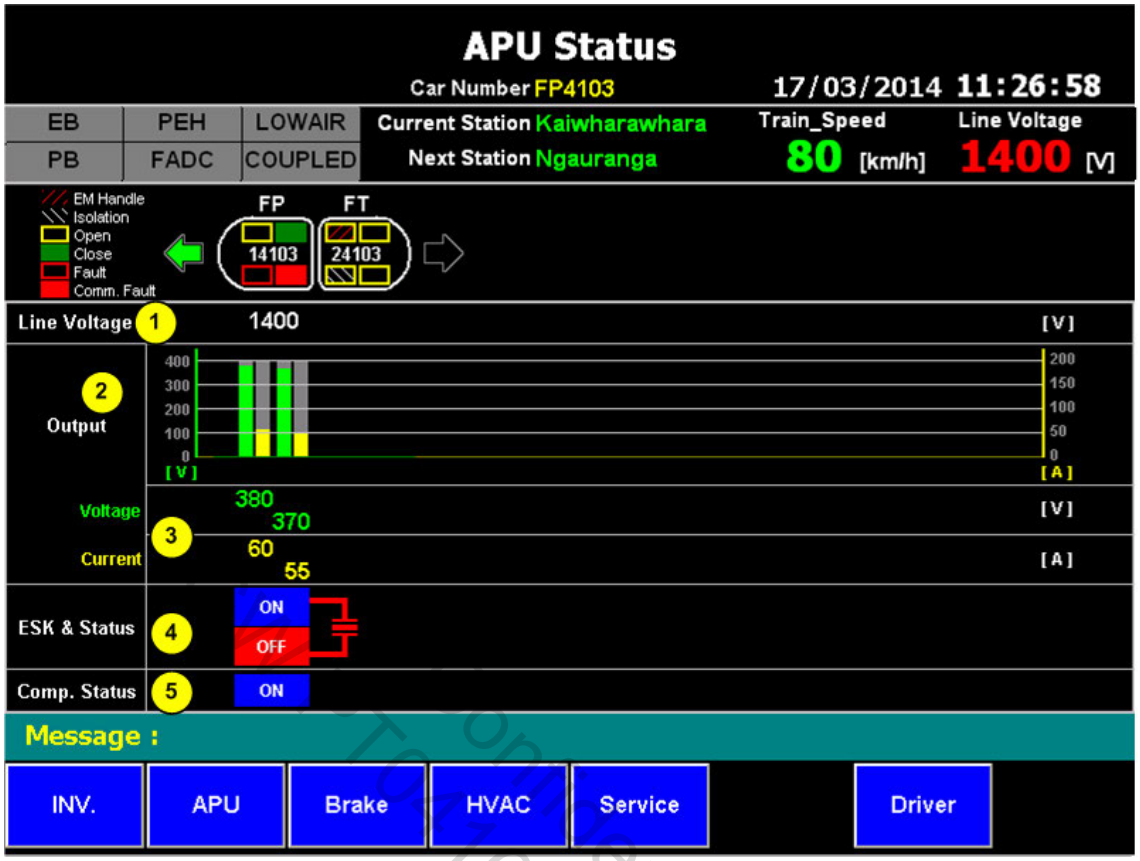


Figure B-35 APU Status Screen

The operating data of the Auxiliary Power Supply Unit (APU) and Compressor Motor (CM) are shown in the APU Status Screen. Detailed items are displayed as follows:

1. Line Input Voltage (from APU)
2. APU output voltage, current: This items is displayed by graph.
3. APU output voltage, current: This items is displayed by text.
4. Cross Feed Contactor (CFC) operating status and APU major failure status.

APU OK, AC output voltage (380V) display

APU Major Failure

APU Off


Cross Feed Contactor is operated


Cross Feed Contactor is not operated

5. Compressor motor status

Compressor motor is on

Compressor motor is off

10.4.8 Brake Status Screen

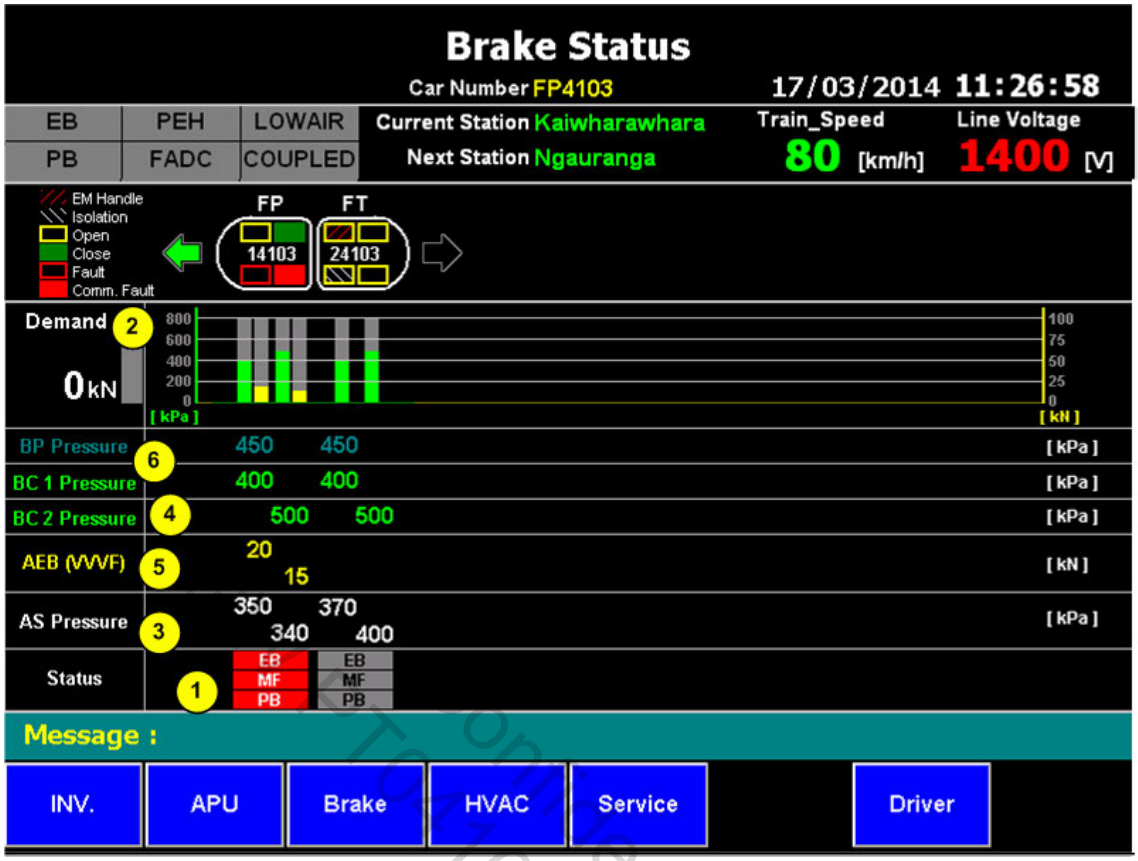


Figure B-36 Brake Status Screen

Operating data for the train brakes are displayed in the Brakes Status Screen. Detailed items are displayed as follows:

1. Brake status: Emergency brake or Major Failure is displayed in red:

   EB Emergency Brake is applied

   EB Emergency Brake is released

   MF Major Failure is detected

   MF Major Failure is not detected

   PB Parking Brake is applied

   PB Parking Brake is released

2. Brake demand (0-120 [kN])
3. Passenger load (0 ~600 [kPa])
4. BC pressure (0 ~765 [kPa])
5. Achieved electrical brake from VVVF (0~120 [kN])
6. Brake Pipe Pressure (0 ~765 [kPa])

10.4.9 HVAC Status Screen

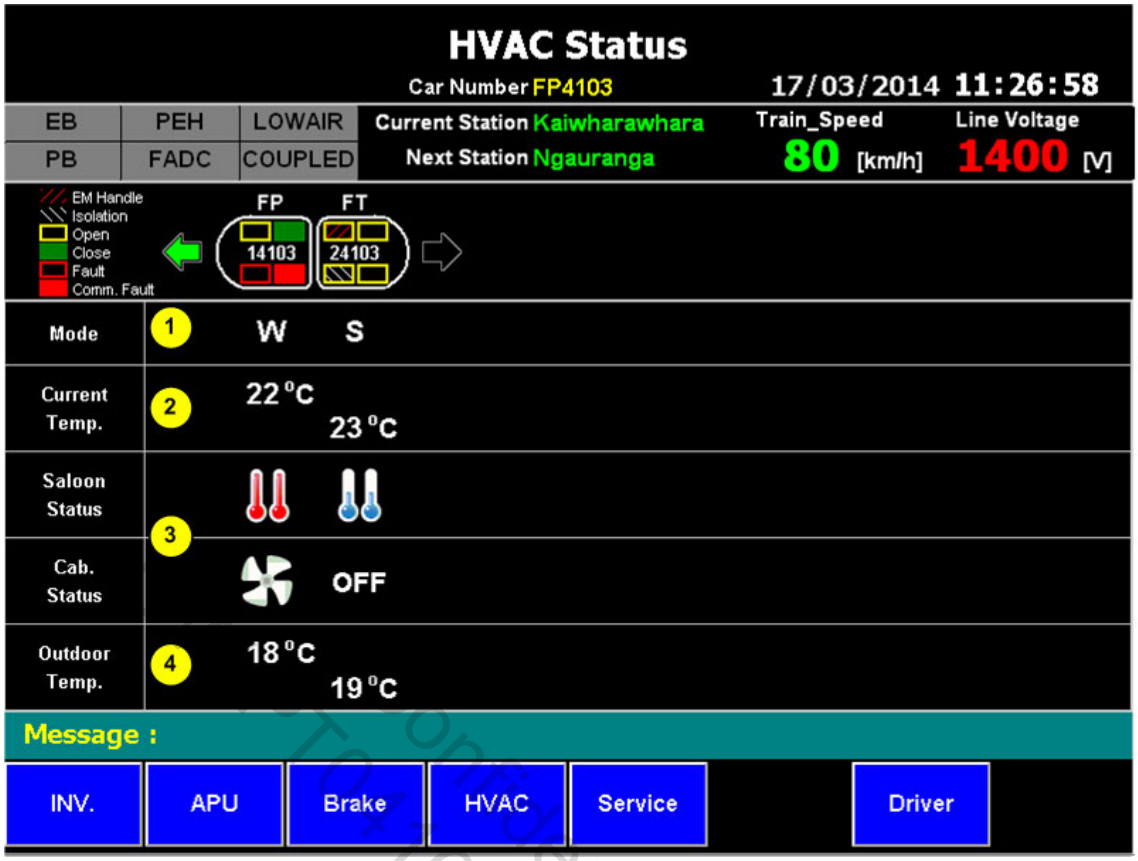


Figure B-37 HVAC Status Screen

The HVAC operating status is displayed in this screen.

1. HVAC Mode (Summer/Winter)
2. Current room temperature
3. Operating mode:

 Half Cool Mode

 Full Cool Mode

 Half Heat Mode

 Full Heat Mode

 Fan Mode

4. Outdoor average temperature

10.4.10 Service Status Screen

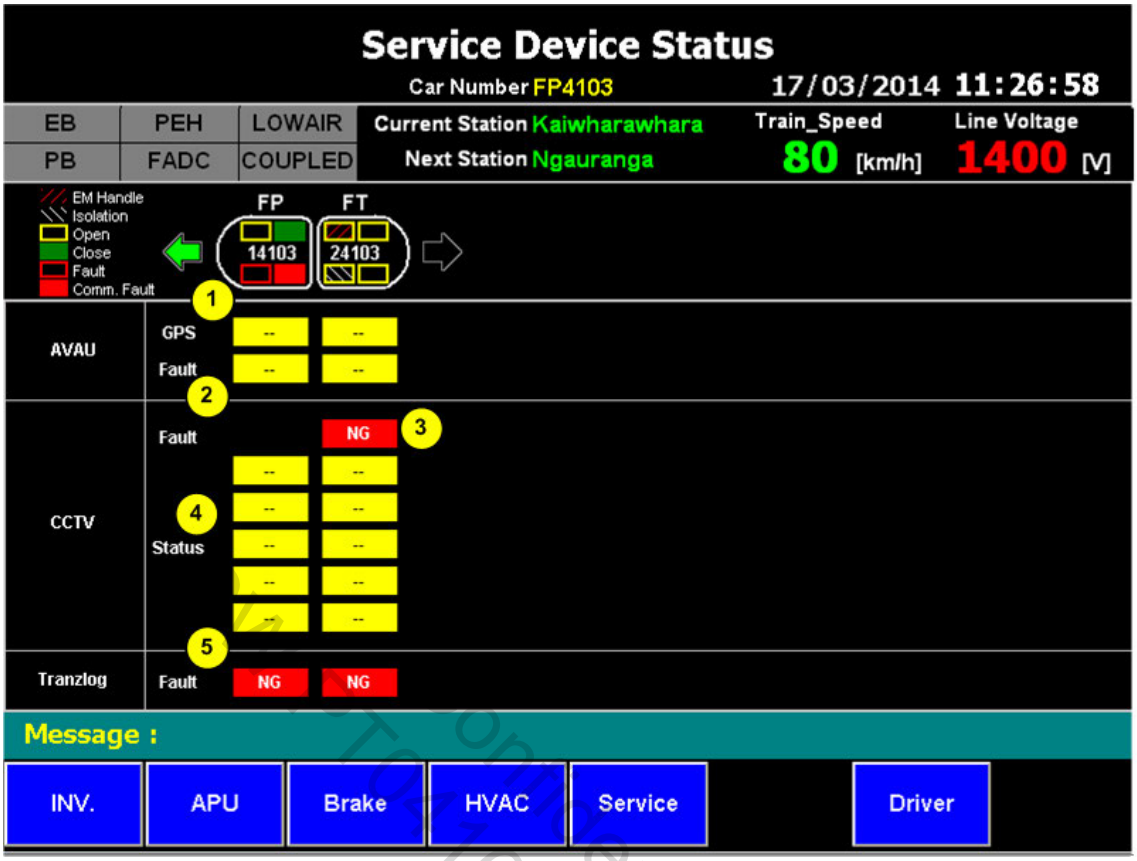


Figure B-38 Service Status Screen

Operation status of service devices (AVAU/CCTV/Tranzlog) is displayed on this screen.

1. GPS status : OK/NG

   OK GPS is OK

   NG GPS is NG (Not Good)

   -- Communication Error

2. AVAU status : MAIN/OK/NG

   MAIN Main AVAU (Master Operation)

   OK AVAU is OK

   NG AVAU is NG (Not Good)

   -- Communication Error

3. CCTV status : OK/NG

CCTV is OK

CCTV is NG (Not Good)

4. Camera status

Camera 1 is OK

Camera 1 is NG (Not Good)

Communication Error

5. Tranzlog status : OK/NG

Event Recorder is OK

Event Recorder is NG (Not Good)

10.4.11 Driver's System Set Screen

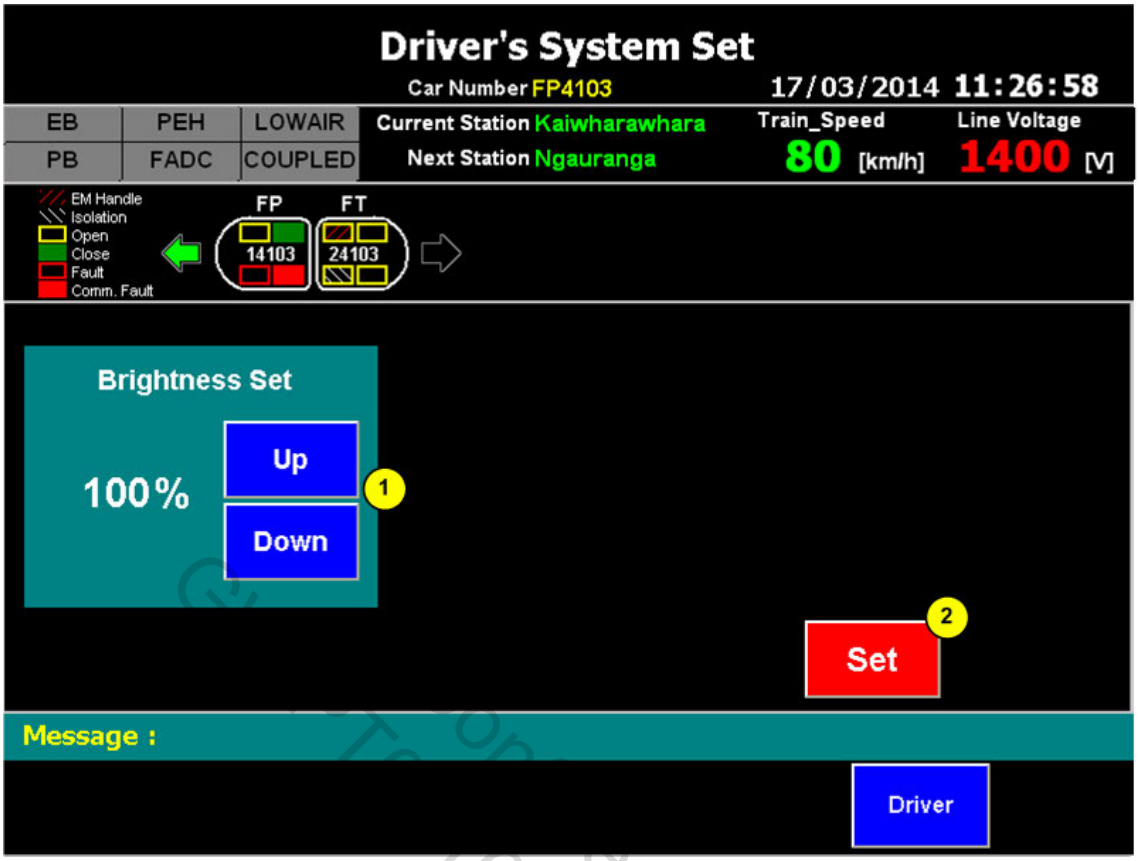


Figure B-39 Driver's System Set Screen

Driver can adjust the brightness through this screen.

1. Adjust Button
2. Set Button

10.4.12 Help Screen

The following information is shown in the Help Screen:

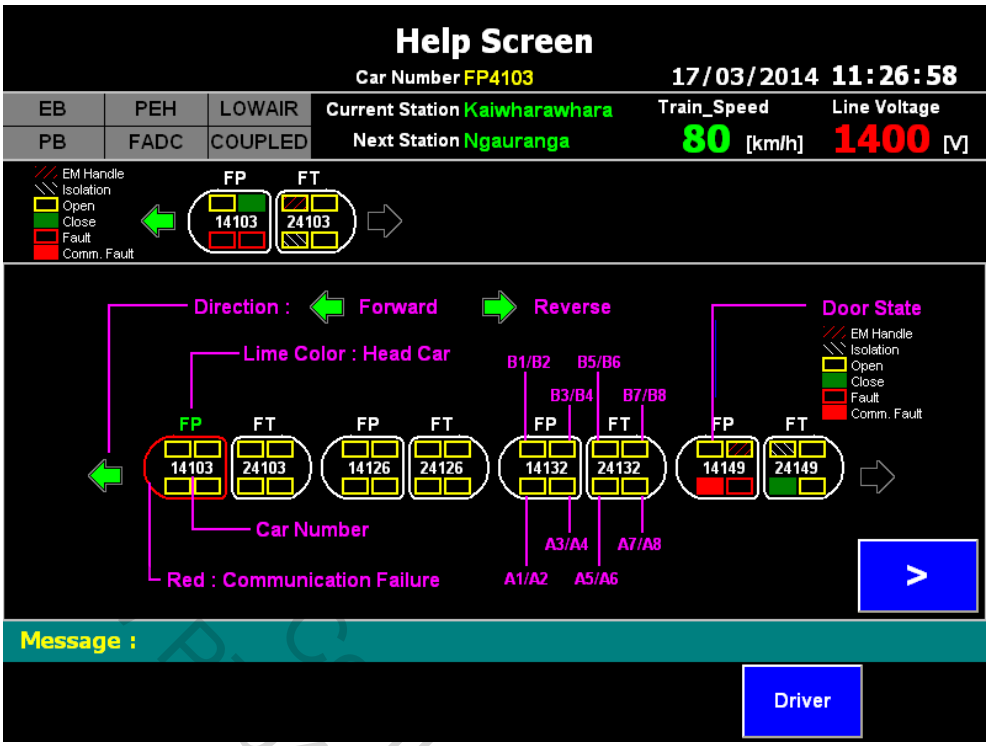


Figure B-40 Help Screen 1

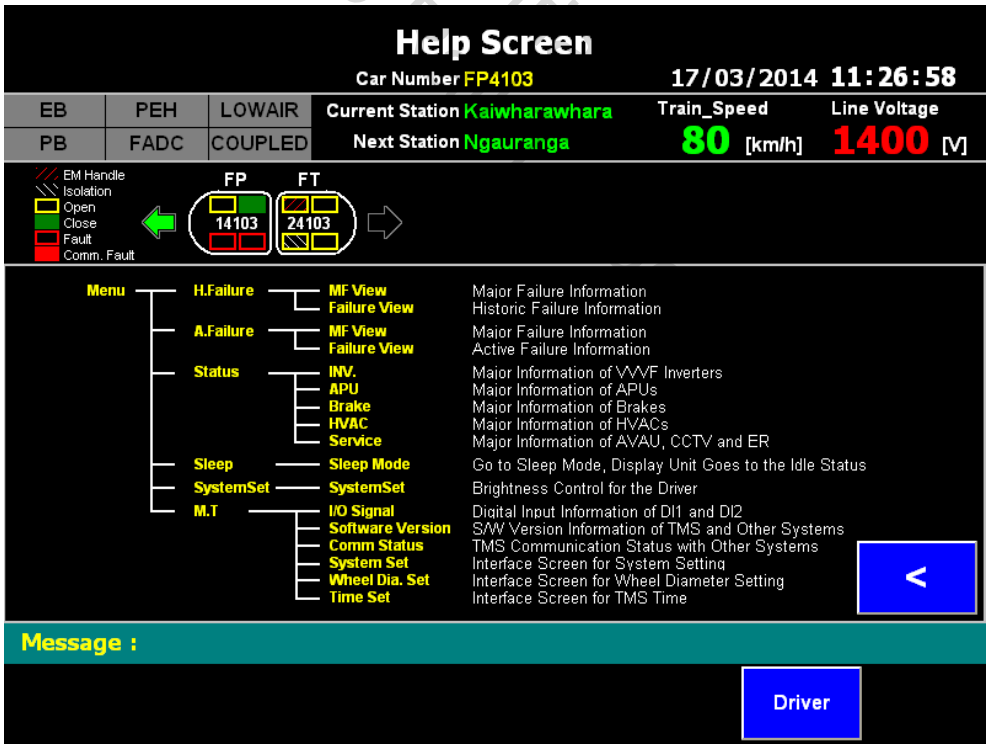


Figure B-41 Help Screen 2

11 Operating Procedures of Bodyside Door System

11.1 Door Control Station

Figure B-42 Door Control Station

11.1.1 Crew Door Control Panel

11.1.1.1 Train Manager's Key (TMK)

The TMK is used by the Train Manager to set the operating state of the Door Control Station via the Train Manager's Control Switch (TMCS). The TMCS has three possible operating positions:

1. "Run"
2. "Control"
3. "Isolate"

The TMK can only be removed while in the "Run" or "Isolate" positions. The Door Control Station will remain in the last state selected when the TMK is removed, i.e. if the TMK is removed when in the "Run" position, the Door Control Station will remain in "Run" state.

11.1.1.1.1 "Run"

This is the normal operating state and the normal TMK insert position. The Crew Door Control panel is not activated while in this state.

11.1.1.1.2 "Control"

To activate any Door Control Station the Train Manager must insert and rotate the TMK to the "Control" position. The Crew Door Control Panel is then active and Local Door control is possible at the active Door Control Station. Once the Train Manager's task at the Door Control Station is complete, the Train Manager must rotate the TMK to the required position ("Run" or "Isolate") and remove the TMK. It is not possible to remove the TMK from the "Control" position.

The Door Control Station will not activate if TMK is rotated to "Control" when speed is greater than 5kph.

The Door Control Station will also not activate if TMK is rotated from "Isolation" position to "Control" position before calibration/reset of Door Control Unit completes which takes approximately 5 seconds. If the Door Control Station is not activated because the TMK has been rotated from "Isolation" to "Control" position before the calibration/reset completes, the TMK needs to be rotated back to "Run" position then return to "Control" position to activate the Door Control Station properly.

The Door Control Station will not activate if the Locomotive Engineer operates the "DOOR ISOLATION" push button. If the Locomotive Engineer operates "DOOR ISOLATION", "RIGHT OF WAY" ("ROW") will illuminate BLUE at all Door Control Stations until "DOOR ISOLATION" is disabled ("DOOR ISOLATION" is described further in Section 11.3.1).

11.1.1.1.3 "Isolate"

To isolate any Local Door, the Train Manager must ensure that the door is **closed and locked** and then insert and rotate the TMK to the "Isolate" position. The Door Control Station is inactivated while in the "Isolate" state. An isolated door will maintain its isolated status when the TMK is removed at the "Isolate" position. To reset the isolated status of the Door Control Station, the TMK must be inserted and rotated from the "Isolate" position to the "Run" or "Control" position. Isolating a door will disconnect the adjacent door from the Door Closed Safety Loop.

11.1.1.2 "RELEASE" Push Button and Lamp

When the TMK is inserted and rotated to "Control" position, "RELEASE" and "OPEN" will be enabled at the active Door Control Station only. "RELEASE" will illuminate RED. "OPEN" will illuminate GREEN.

When the "RELEASE" pushbutton is pressed, the Local Door will open and all "OPEN" push buttons on the same side of the train to the active Door Control Station will be enabled and illuminate GREEN. An audible alarm will sound at each enabled door.

"RELEASE" will remain enabled and illuminate RED until "ROW" button is operated.

11.1.1.3 "ALL CLOSE" Push Button and Lamp

When the "ALL CLOSE" pushbutton is pressed, all open doors will be closed and locked. "OPEN" buttons will be disabled and illumination extinguished. The Local Door will remain open. 2 seconds before the beginning of door closing, an audible alarm will sound at each door until closing of the door is complete.

"ALL CLOSE" will illuminate YELLOW at all Door Control Stations when all doors have closed and locked (except for the Local Door, which will remain open).

11.1.1.4 "RIGHT OF WAY" (ROW) Push Button and Lamp

It is not possible for the Train Manager to operate "ROW" until all doors have closed and locked, including the Local Door.

When the "ROW" pushbutton is pressed, "ROW" will illuminate BLUE for 3 seconds to indicate that control of the train has been passed from the Train Manager to the Locomotive Engineer. "RELEASE" and "OPEN" at the Local Door will be disabled & illumination extinguished. The Locomotive Engineer will receive an audible alarm and the cab "ROW" will illuminate GREEN for 3 seconds.

After operation of "ROW", the Train Manager can only regain control of the train by rotating the TMK to "Run" position and then back to "Control" position.

If the Locomotive Engineer operates the "DOOR ISOLATION" push button, "ROW" will illuminate BLUE at all Door Control Stations until "DOOR ISOLATION" is disabled ("DOOR ISOLATION" is described further in Section 11.3.1).

11.1.2 Passenger Door Control Panel

The Passenger Door Control Panel pushbuttons provide Local Door control for the Train Manager at the enabled Door Control Station, and door control for passengers at all other doors on the same side of the train.

11.1.2.1 "OPEN" Push Button and Lamp

When the TMK is rotated to the "Control" position, "RELEASE" and "OPEN" will be enabled at the active Door Control Station. "RELEASE" will illuminate RED. "OPEN" will illuminate GREEN.

Pressing the "OPEN" pushbutton will open the Local Door and enable "CLOSE" at the Local Door only, meaning the Train Manager can open/close the Local Door without enabling "OPEN" buttons at any other doors. When pressed, the "OPEN" button will illuminate green and red. It will then be disabled and illumination will extinguish. "CLOSE" will be enabled and illuminate RED.

Once "RELEASE" has been operated by the Train Manager, "OPEN" buttons will be enabled at all doors located on the same side of the train. Enabled "OPEN" buttons will illuminate GREEN. An audible alarm will sound from enabled "OPEN" buttons.

Operation of any "OPEN" button will open the adjacent doors. When pressed, "OPEN" will illuminate GREEN and RED. It will then be disabled and illumination will extinguish. "CLOSE" will then be enabled and illuminate RED.

11.1.2.2 "CLOSE" Push Button and Lamp

Once the "OPEN" button has been pushed at any enabled door system, "CLOSE" will be enabled. "CLOSE" will illuminate RED when enabled.

Operation of the "CLOSE" button will close and lock the adjacent doors. "CLOSE" will illuminate GREEN and RED during push button operation. 2 seconds before the beginning of door closing, an audible alarm will sound until closing of the door is complete.

"CLOSE" button will be disabled and illumination will extinguish after operation of the "CLOSE" button. "OPEN" will then be enabled and illuminate GREEN until "ALL CLOSE" is operated by the Train Manager.

11.1.2.3 "OUT OF ORDER" Lamp

The "OUT OF ORDER" lamp will illuminate RED when the door is isolated.

11.1.2.4 Wheelchair Ramp

If the wheelchair ramp is required to be used and the Train Manager uses the TMK and releases doors at another Door Control Panel then prior to deploying the ramp Train Manager will need to at the wheelchair ramp Door Control Panel insert TMK and "CLOSE" then "OPEN" to create a Local Door.

However if Train Manager is not near by then the other options available are:

1. When audible alarm sounds at door then push the passenger "OPEN" button.
2. When audible alarm sounds and doors start to close obstacle protection will reopen the doors.

11.2 External Door Controls & Indicators

11.2.1 External "OPEN" Push Button and Lamp

Once "RELEASE" has been operated by the Train Manager, external "OPEN" buttons will be enabled at all doors located on the same side of the vehicle. External "OPEN" buttons will illuminate GREEN when enabled. An audible alarm will sound from enabled "OPEN" buttons.

Operation of external "OPEN" will open the adjacent doors. The external "OPEN" button will illuminate GREEN and RED when pushed. It will then be disabled and illumination will extinguish.

11.2.2 External "OUT OF ORDER" Lamp

The external "OUT OF ORDER" lamp will illuminate RED when the door is isolated.

11.3 Cab Controls and Indicators

11.3.1 "DOOR ISOLATION" Push Button and Lamp

The "DOOR ISOLATION" pushbutton is located on Operation panel #1.

Operation of "DOOR ISOLATION" by the Locomotive Engineer will prevent the Train Manager from being able to operate the Door Control Station. "DOOR ISOLATION" will illuminate RED when operated.

Operation of "DOOR ISOLATION" will cause the "ROW" Lamp to illuminate BLUE at all Door Control Stations until "DOOR ISOLATION" is disabled.

11.3.2 "DOOR CLOSED" Lamp

The "DOOR CLOSED" lamp is located on Operation panel #3.

The "DOOR CLOSED" lamp will illuminate WHITE in the active cab when all door systems are closed and locked.

11.3.3 "RIGHT OF WAY" ("ROW") Lamp

The "ROW" lamp is located on Operation panel #3.

An audible alarm will sound and "ROW" lamp will illuminate GREEN in the active cab for 3 seconds after Train Manager operates "ROW" at the active Door Control Station.

11.3.4 "CAR ISOLATION" 2-Position Switch

The "CAR ISOLATION" switch has 2 positions – normal and isolate – and is located on Operation Panel #8 in the cab of the of TC only.

Verify all doors are closed and locked prior to activating "CAR ISOLATION".

Operation of "CAR ISOLATION" by the Train Crew will isolate the two car unit. When "CAR ISOLATION" is operated:

- All doors will close and lock.
- All external "OUT OF ORDER" lamps will illuminate RED.
- Main interior lighting will switch off.
- Emergency lighting and passenger Emergency Help Points will remain active.

"CAR ISOLATION" can be used in a multi-unit train consist when only some of the units should be in active service.

11.3.5 "STABLING" Push Button

The "STABLING" pushbutton is located on Operation panel #6.

Operation of the "STABLING" pushbutton by the Locomotive Engineer will cause all doors to automatically close and lock.

11.4 Crew Access Device

Operation of a Crew Access Device by a Train Crew Key (TCK) allows Crew members to open the adjacent door manually.

The adjacent door will automatically close 20 seconds after operation of the Crew Access Device. If "OPEN" is operated at the adjacent Door Control Station before the 20 second automatic closing of the door, the door will automatically close 90 seconds after operation of "OPEN".

The Crew Access Device does not require any Door Control Station to be active.

The Crew Access Device will only operate when power is supplied to the DCU.

11.5 Automatic Obstacle Detection

11.5.1 Obstacle Detection during Opening

If an obstacle is not cleared after three attempts to open a door, the door will fully close and lock.

11.5.1.1 Train Manager Indication

When an obstacle is detected at a door, a warning buzzer will be activated until the obstacle is removed.

11.5.1.2 Locomotive Engineer Indicator

Locomotive Engineer will receive a door fault indication on the TMS. The Locomotive Engineer can inform the Train Manager which door system requires investigation.

11.5.2 Obstacle Detection during Closing

If an obstacle is not cleared after three attempts to close a door, the door will fully open.

11.5.2.1 Train Manager Indication

The "ALL CLOSE" lamp will illuminate YELLOW at all Door Control Stations when all doors have closed & locked and all “OPEN” push buttons are deactivated. (except the Local door)

The internal "DOIL" mounted above the obstructed door will illuminate WHITE until the adjacent door is closed & locked and “OPEN” push button is deactivated.

The external "DOIL" mounted above the obstructed door will illuminate WHITE until the adjacent door is closed & locked and “OPEN” push button is deactivated.

11.5.2.2 Locomotive Engineer Indicator

The "DOOR CLOSED" lamp will illuminate WHITE when all door systems are closed and locked.

Locomotive Engineer will receive a door fault indication on the TMS.

11.6 Typical Door Operation Sequence

11.6.1 Door Opening

1. Train stops at correct position along platform.
2. Train Manager inserts TMK and rotates to the "Control" position. (ALL CLOSE light should illuminate to indicate all doors are closed and locked.)
3. Train Manager presses the "RELEASE" pushbutton. The Local Door will open and "OPEN" push buttons will be enabled at all doors located on the same side of the vehicle. If the Train Manager requires the Local Door only to be opened, the Train Manager should operate the "OPEN" pushbutton.
4. With doors enabled, Train Manager can rotate TMK back to "Run" and remove the TMK to assist with passenger work.

11.6.2 Door Closing

1. Train Manager inserts TMK and rotates to "Control" position.
2. Train Manager operates "ALL CLOSE". All doors will close except the Local Door.
3. Train Manager steps out onto the platform to check along the train (second door check).
4. Train Manager operates "CLOSE" push button. Local Door will close.

5. When Local Door has closed, Train Manager operates "ROW" signalling to the Locomotive Engineer that all doors are closed and locked.

12 Operating Procedures of the Auxiliary Power Supply Unit

Before a train can be placed in service, it must be inspected to ensure that all equipment functions correctly and safely. The following procedure is used to prepare the Auxiliary Power Unit (APU) for operation.

The APU will only start when all of the following conditions are met:

a. No major or minor failure is present

b. Line voltage is over 1000 V

c. APU RUN signal is present

d. Control power is applied to the auxiliary power supply inverter control unit

To operate the APU, the train crew must perform the following steps:

	Train Crew Activity	Remark
Step 1	Supply the control voltage to the vehicle and check vehicle condition is normal.	
Step 2	Push the "Pantograph Raise" pushbutton to begin operation of the vehicle. At that time, the line voltage and APU RUN signal are supplied to APU.	
Step 3	If voltage is low TMS warning will be displayed.	APU output voltage : 415V±5%
Step 4	If line voltage does not meet APU output voltage range, APU condition must be checked.	

13 Coupling and Uncoupling Procedures

WARNING

COUPLERS ARE TO BE USED ONLY WHEN IN PERFECT MECHANICAL CONDITION AND ONLY FOR THE PURPOSE OF COUPLING, FOLLOWING OPERATING RULES AND WITH REGARD FOR HAZARDS DESCRIBED BELOW. ANY DEFECTS MUST BE RECTIFIED BEFORE THE COUPLERS ARE USED IN SERVICE.

ENSURE THAT YOU HAVE READ AND FULLY UNDERSTAND ALL INFORMATION PROVIDED, ESPECIALLY INFORMATION CONTAINED IN THIS MANUAL, BEFORE OPERATING OR WORKING ON THE COUPLERS.

ONLY TRAINED AND AUTHORISED PERSONNEL ARE PERMITTED TO OPERATE THE COUPLERS.

WHEN PERFORMING A COUPLING MANOEUVRE, THE VEHICLE YOU ARE COUPLING TO MUST BE STATIONARY AND APPROPRIATELY SECURED AGAINST UNINTENTIONAL MOVEMENT, I.E. PARK BRAKE APPLIED.

FAULTY OPERATION CAN ENDANGER HUMAN LIFE AND / OR CAUSE DAMAGE TO PROPERTY AND / OR THE ENVIRONMENT.

ELECTRIC POWER MUST BE SWITCHED OFF BEFORE WORKING ON THE COUPLERS.

ACCIDENTAL RELEASE OF THE LOCKING MECHANISM MAY RESULT IN THE COUPLING LINK EXTENDING FROM THE FRONT FACE OF THE COUPLER AT HIGH SPEED AND WITH GREAT FORCE.

13.1 Description of Coupler

SD10 auto-couplers are self-centring and make mechanical, pneumatic and electrical connections automatically when units are brought together. No manual intervention is required under normal operating conditions.

When units are brought together a locking device first engages to make a secure mechanical connection. This also brings pneumatic MR and BP connections into alignment under pressure, forming an air-tight seal. Once air supply is established, covers over the electrical coupler heads are retracted and the electrical heads come together to make an electrical connection between the units.

Uncoupling is done remotely from the Driver's cab, reversing the coupling sequence. Units do not automatically move apart when uncoupled.

13.2 Coupling Procedure for automatic coupler

WARNING

NO PERSON MAY STAND BETWEEN UNITS DURING THE COUPLING PROCESS.

CAUTION

AUTOMATIC COUPLERS OF THE TC END ARE ONLY ALLOWED TO COUPLE WITH AUTOMATIC COUPLERS OF THE MC END. OTHERWISE DAMAGE MAY OCCUR ON THE ELECTRIC COUPLERS.

WARNING

TRAIN MAY NOT BE OPERATED WITHOUT CONFIRMATION OF A SUCCESSFUL COUPLE.

Use the following steps to couple Matangi units:

1) Check suitability of location. If possible avoid coupling on 'S' curves or turnouts. Minimum curve radius for coupling is 150m.
2) Bring one unit to a halt 0.5-0.75m from the opposing unit. Maximum distance is 1m.
3) If it is necessary to couple on canted or curved track with a curve radius below 185m (moderate curve), visually check alignment of couplers before proceeding.

NOTE

Automatic couplers are self-centring and cannot be manually adjusted.

NOTE

Gathering range is greater in one direction i.e. when gathering horns overlap (see Figure B-43).

4) Driver must be seated when coupling. It is not necessary to maintain visual contact with the couplers.

5) To couple:

   a) Ensure stationary unit has park brake applied.

   b) Release park brake on moving unit.

   c) Apply minimum power to achieve 0.5-1.0km/h, i.e. slow walking pace.

   d) Put power / brake controller into coast before contact and allow units to collide.

6) Coupling will occur automatically.

7) Lower tread-plates, gangway and attach hand-rails.

A successful couple is indicated in the following way:

- Uncouple light on OP#6 (panel above driver's head) will illuminate to indicate a mechanical couple has been made.

NOTE

This is the primary indication of a successful couple.

- Brake Pipe Gauge will drop to zero to indicate a pneumatic couple and brakes will be applied on both units.
- TMS "coupled" icon will illuminate red to indicate a successful electrical couple. Additional vehicles will be shown in the consist once detected.

NOTE

TMS is a secondary system for notification only. TMS indication by itself is not sufficient to verify a successful mechanical/pneumatic couple.

- Once a successful couple has been made the cab from which the couple was performed will become a dead/intermediate cab.

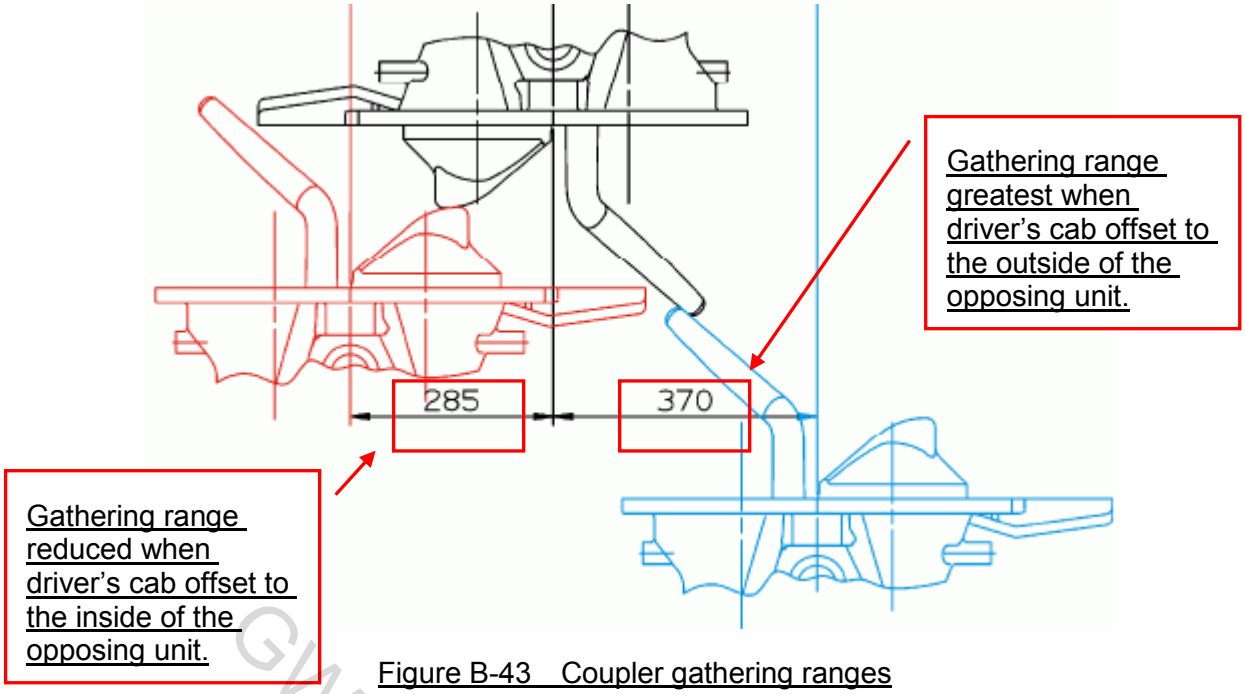


Figure B-43 Coupler gathering ranges

13.2.1 Unsuccessful couple

An unsuccessful couple will be indicated in the following way:

- Brake gauge will stabilise to 150kPa and air will leak from BP and/or MR.
- "Uncouple" button on OP#6 will not illuminate.
- TMS "coupled" button will not be illuminated red.
- Visual inspection will indicate electrical heads are not connected.

To re-attempt coupling use the following steps:

1) Press and hold the "Uncouple" button on OP#6 to reset the coupler.
2) Reposition the unit by setting back 0.5-0.75m. Maximum distance 1m.
3) Follow the coupling steps listed above to a maximum coupling speed of 2km/h (slow/moderate walking pace).
4) Coupling may be attempted a maximum of 3 times.

13.3 Uncoupling procedure for automatic coupler

Use the following steps to uncouple Matangi units:

1) Stop and apply park brake
2) Ensure that hand-rails are in 'closed' position and gangway flaps are up.
3) Turn Master Controller Key to 'ON' position in the intermediate cab.
4) Check that the Uncouple button on OP#6 is illuminated to show units are coupled.
5) Push and hold the Uncouple button on OP#6 for two seconds.
6) Electrical, pneumatic and mechanical connections will be uncoupled automatically.
7) After uncoupling, drive unit out a short distance from the lead cab to provide clear

indication it has been uncoupled.

8) Couplers are now ready to re-couple.

A successful uncouple is indicated in the following way:

- Brake pipe will charge.
- Tail lights will illuminate on the opposite unit.
- Uncouple light on OP#6 will be extinguished.
- Coupled icon on TMS will be extinguished and TMS will show fewer carriages in the consist.

13.3.1 Manual Uncoupling in Case of Fault

WARNING

BEFORE UNCOUPLING, THE COUPLERS THE ELECTRICAL HEADS MUST BE MANUALLY SEPARATED.

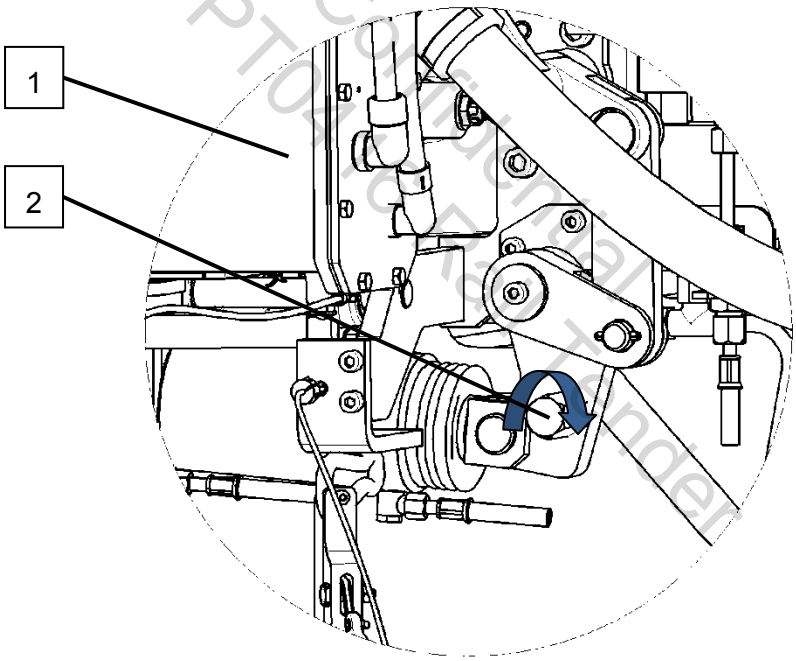
ELECTRIC POWER MUST BE SWITCHED OFF (UNITS STABLED) BEFORE MANUALLY UNCOUPLING THE ELECTRICAL HEADS.

If automatic uncoupling is not successful, uncoupling can be performed manually. If there is a pneumatic fault then the electrical heads must be retracted first, otherwise they will fail to retract before the mechanical couple is broken and damage may result.

If there is a pneumatic failure on either unit, use the following steps to manually uncouple the electrical heads:

1) Ensure that park brake is applied, hand-rails are in 'closed' position and gangway flaps are up.
2) Stable both units to electrically isolate the electrical heads.
3) Close the red pneumatic circuit isolation cock at the coupler head (see Figure B-44).
4) Retract the electrical head of each unit by rotating the hexagon pin (see) clockwise with an adjustable wrench or 24mm socket or ring spanner.
5) Manually uncouple the couplers using the pull-cable as described in Section 13.3.2.
6) Open the red pneumatic circuit isolation cock at the coupler head.

Figure B-44 Pneumatic circuit isolation cock (closed position)



1 Electric Coupling (for orientation purposes only)
2 Hexagon Pin

Figure B-45 Locating Position for Wrench

13.3.2 Manual Uncoupling in Case of Fault – Pneumatic system available

If the pneumatic system is available or the electrical heads have already been retracted manually, use the following steps to manually uncouple the units:

1) Ensure that park brake is applied, hand-rails are in 'closed' position and gangway flaps are up.
2) Check clearance behind you.
3) Remove the red-handled release cable from its hook beneath the electrical head
4) Pull cable firmly to the full extent of travel.

NOTE

If the pneumatic system is available, the electrical heads will retract before the heads are fully uncoupled. Continue to pull until the cable reaches a hard stop.

5) Electrical, pneumatic mechanical and connections will be uncoupled.
6) Return release cable to its hook.

Figure B-46 Manual uncoupling pull-cable

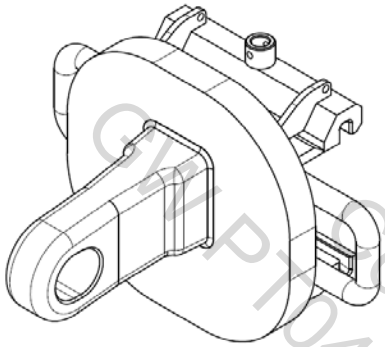
13.4 Adapter Coupler

13.4.1 Description of Adapter Coupler

SD10 adapter couplers enable vehicles with incompatible drawgear to couple to auto-coupler equipped Matangi units. They are used for rescue purposes and shunting. Each adapter has three components, two of which are used at once. The two parts are stored separately and fitted together one at a time on the rescue vehicle. The adapter is never lifted or carried as a complete assembly.

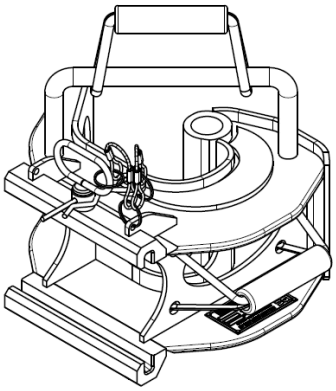
Part #1 (Hook and Pin adapter)

Fits onto locomotive (if equipped with hook & pin coupler).



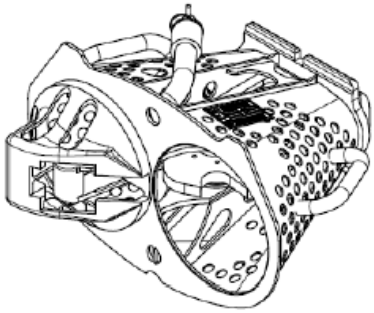
Part #2 (Knuckle adapter)

Fits onto locomotive (if equipped with knuckle coupler) or Ganz / Matangi unit without auto-coupler.



Part #3 (SD10 adapter)

Always used because it couples to the auto-coupler of the Matangi unit. Fits onto parts #1 or #2.



13.4.2 Rescue adapter installation (knuckle coupler)

- Ensure that knuckle coupler is in closed position
- Using the top carry-handle (strap), lower Part #2 into the closed coupler.

NOTE:

Do not use side carry-handle or metal top shelf when installing. Use top fabric handle only.

- Slide Part #3 sideways into Part #2. Ensure Part #3 is centred and insert pin to prevent sideways movement. Secure pin with R-Clip. Note that the top of Part #3 is indicated by a notch.
- Bring vehicles to within 0.5-0.75m to check vertical alignment. Ensure that each cone will contact within the hole of the opposing face.
- If the adapter coupler needs to be raised vertically, remove Part #3 to reduce the weight of the adapter. Lift Part #2 and insert a wooden spacer beneath the top shelf. Then re-install Part #3.
- Check horizontal alignment and move coupler of rescue vehicle into place manually if required. Note that Matangi auto-couplers are self-centring and cannot be adjusted manually.

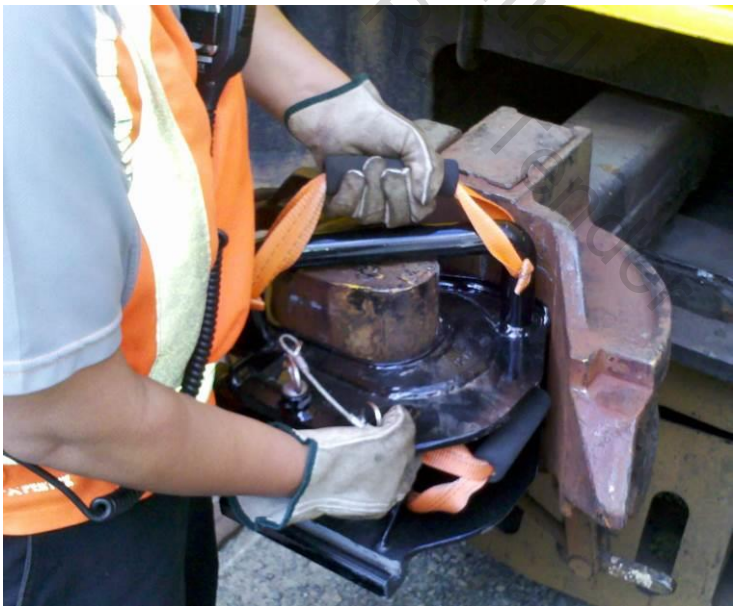


Figure B-47 Fitting rescue adapter to knuckle coupler

Figure B-48　Rescue adapter assembled on Ganz

13.4.3 Installation (hook & pin)

- Lift Part #1 into position on the rescue vehicle. Hold Part #1 firmly in place and insert pin to secure it. The top of the adapter is indicated by a hole.
- Slide Part #3 sideways into Part #1. Ensure Part #3 is centred and insert pin to prevent sideways movement. Secure pin with R-Clip. The top of Part #3 is indicated by a notch.
- Bring vehicles to within 0.5-0.75m to check vertical and horizontal alignment. Ensure that each cone will make contact within the hole of the opposing face.
- If the adapter coupler needs to be raised vertically, remove Part #3 to reduce the weight of the adapter. Lift Part #2 and insert a wooden spacer beneath the top shelf. Then re-install Part #3.
- Move coupler into place manually if required.
- Check horizontal alignment and move coupler of rescue vehicle into place manually if required. Note that Matangi auto-couplers are self-centring and cannot be adjusted manually.
-

Figure B-49 Fitting rescue adapter to hook & pin locomotive

Figure B-50 Rescue adapter assembled on locomotive

13.4.4 Preparing Matangi for coupling

- Turn the red electrical box isolation cock of the unit to be rescued to the Isolate position. This is located on the side of the auto-coupler beneath the cab mask.
- Turn the white MR and BP isolation cocks to the Isolate position. These are located on either side of the auto-coupler, beneath the cab mask
- Before coupling, check that both the auto-coupler and the adapter are in the 'cocked' position, with tongues retracted
- If the auto-coupler tongue is extended then the auto-coupler needs to be re-cocked. Pull the release cable firmly to the full extent of travel
- The adapter tongue can be re-positioned manually if required.

13.4.5 Coupling with adapter coupler

- Couple at 1-2km.h. If the couple is successful, a green indicator will be visible through the round window on top of the SD10 adapter head and should be lined up with the pointer. This is the primary indication of a successful mechanical couple
- Connect the BP hose first. This is located on the top of the adapter. Attach the BP hose to the rescue vehicle using the kidney connector.
- Attach the BP hose to the top of the adapter by pulling back the collar of the fitting while inserting the hose. Then slide the collar forward to secure the connection.
- Repeat for MR hose. If there are MR hoses in the shunting locomotive.
- Once both hoses are connected, open the MR and BP cocks on the rescue vehicle, Then open the MR and BP isolation cocks on the Matangi unit

NOTE:

Leave the red electrical head isolation cock in the Isolate position. If air is supplied to the electrical head when the unit is coupled, the electrical heads will come forwards and may cause damage

Figure B-51　Rescue adapter successfully coupled

13.5 Gangplank Connection

The gangplank allows crew to travel between two units. The moving plate is connected to the fixed plate by a hinge and folds up when not in use.

When two units are coupled, the moving plate of the gangplank is deployed to the front of the opposite cab and overlapped with the opposing plate as shown in Figure B-52.

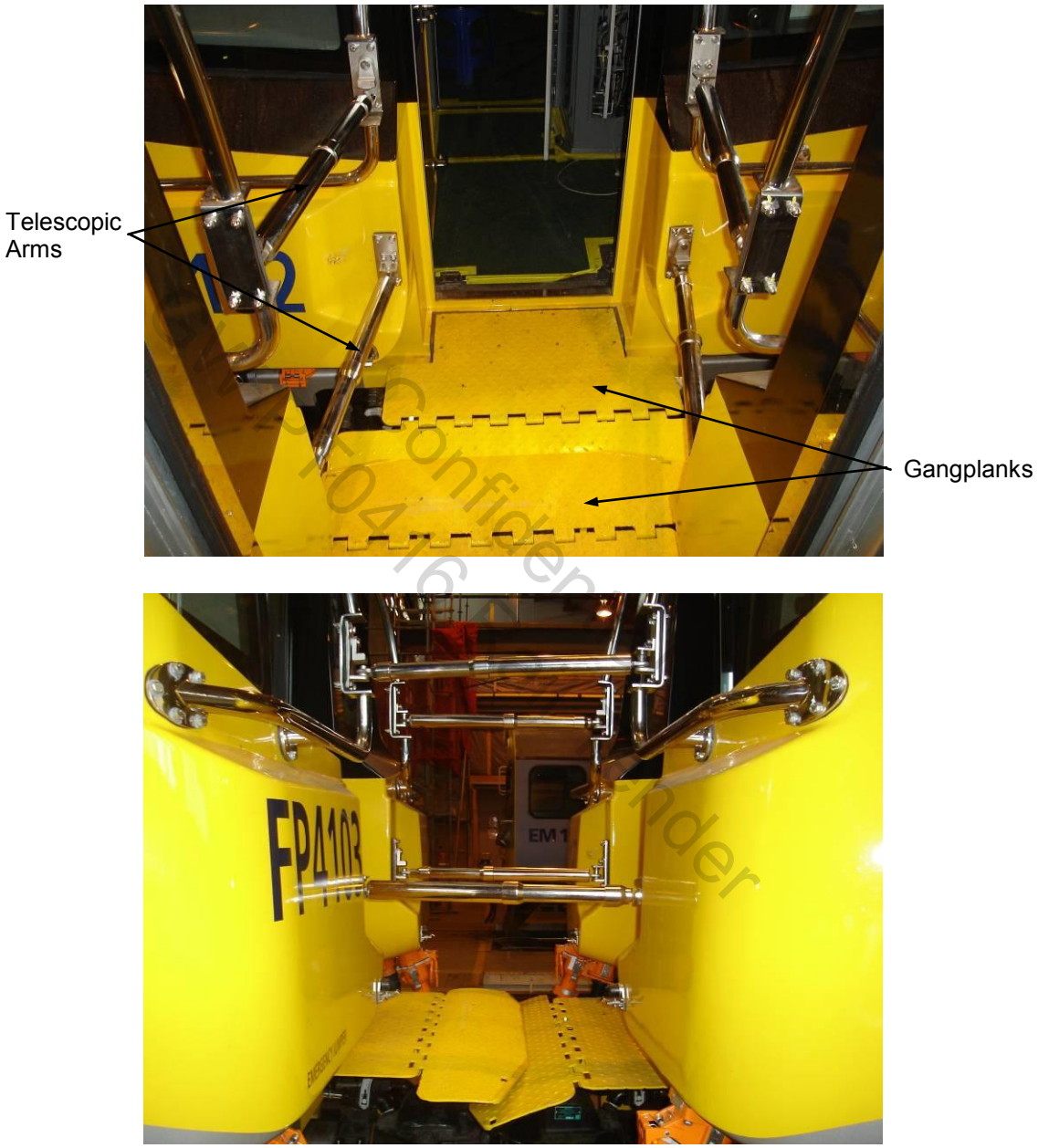


Figure B-52 Gangplank Connections

NOTE

Extreme care must be exercised when moving between units coupled together – especially through turnouts.

14 Wheelchair Ramp Operation

Two floor-mounted double-leaf wheelchair ramps are provided to allow wheelchair passage from the car floor to the station platform and vice versa. The wheelchair ramp is designed to be folded and stowed into the frame of the floor and is secured by a locking device. The wheelchair ramp can be easily deployed and stowed by one crew member.

The wheelchair ramp, when required to load/off-load wheelchair seated passengers, is manually placed in the door threshold with the door open when the train is stopped. It must be manually returned to its storage place prior to departure.

Refer to 11.1.2.4 keeping doors open when operating wheelchair ramp.

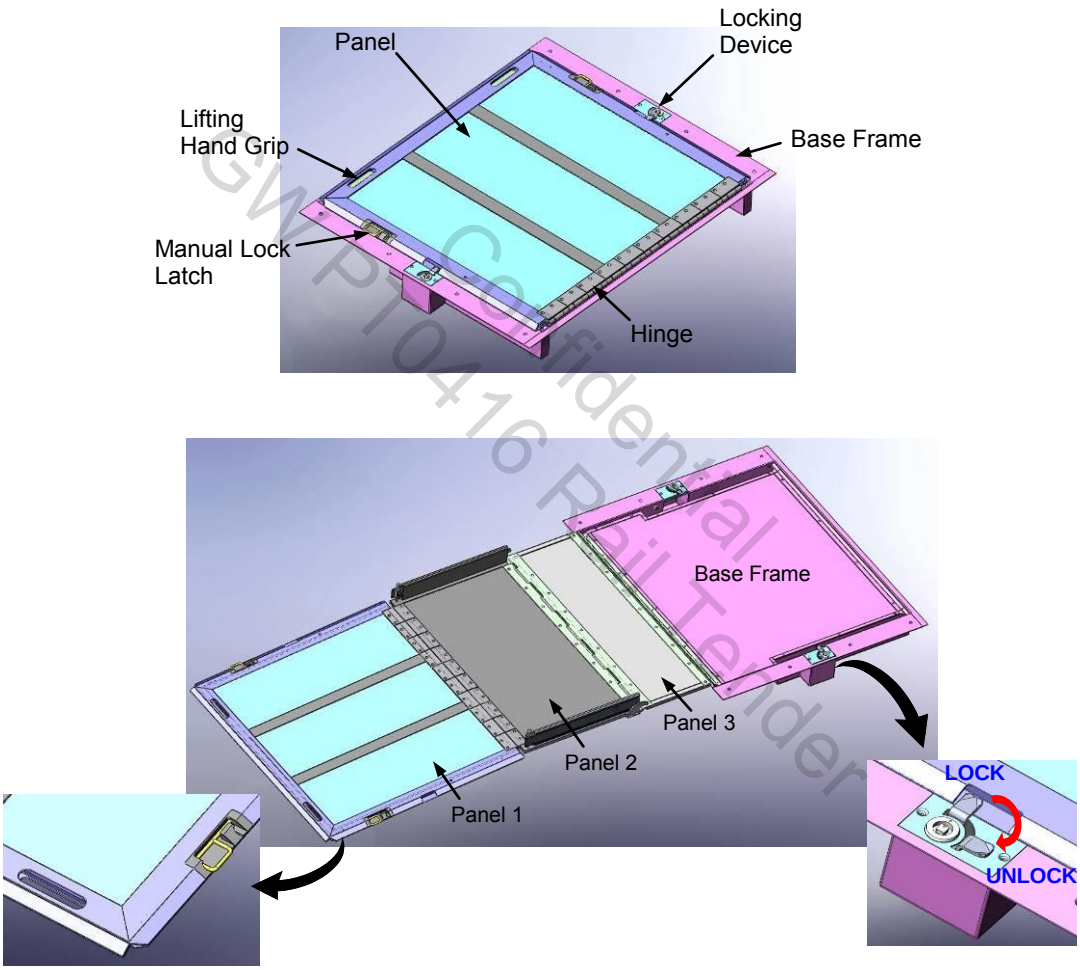


Figure B-53 Wheelchair Ramp

Deploy Sequence

Step 1

Ensure that interested parties are ready to participate and the way is clear.

Communicate your intentions to passengers and wheelchair users.

Ask passengers to clear the wheelchair space if necessary.

Step 2.

Stand inside the unit alongside the lock to be released.

Release the lock

Repeat for the other side

Step 3.

Incline forward at the hips and /or place one foot inside the unit.

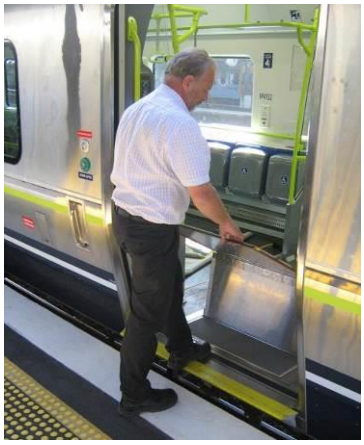
Reach down and grasp the ramp via the hand-holds.

Step 4.

Lift the ramp up out of the base frame.

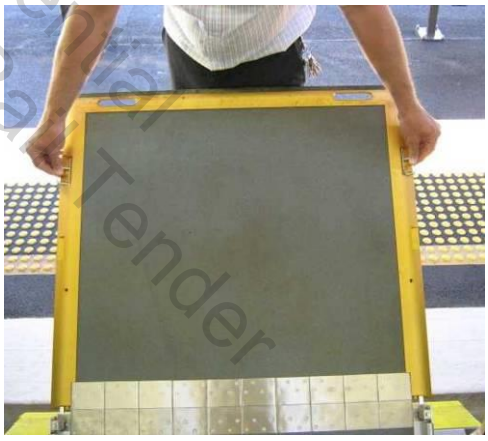
Step 5.

Step back from the unit onto the platform bringing the ramp with you



Step 6.

Lock the side locks.



Step 7.

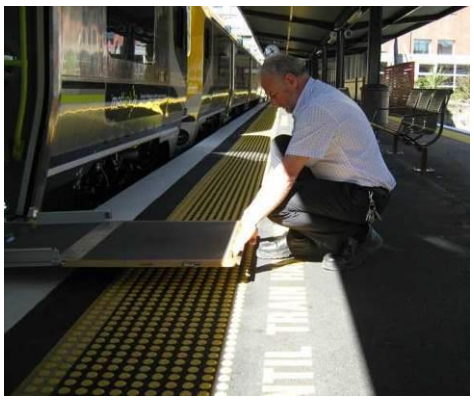
Ensure there is no one behind you.

Step backwards bringing the ramp with you until the third section (short) of the ramp is out flat.

Allow third section of ramp to fall into place. **NOTE:** the smallest ramp section will fall onto the step with a slight bang, this is normal.

Step 8.

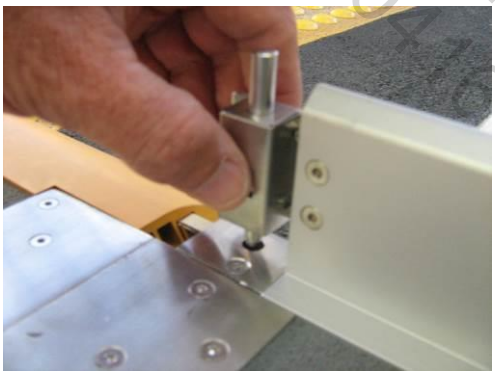
Bend your knees, incline forward at the hips and lower ramp to within 100mm of the platform and release.



Step 9.

Take one step forward onto the ramp and deploy the side rails.

Lock into place by pushing the pin down. (see below)



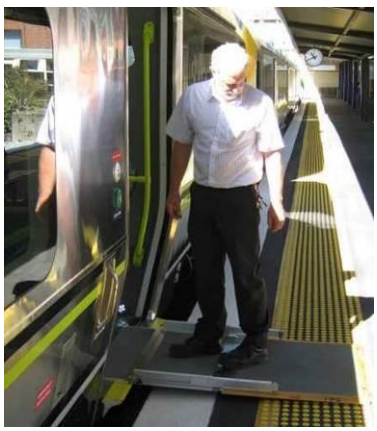
Release button to deploy side rail

Push pin down to lock side rail in place

Step 10.

Check for stability.

NOTE: Do not bounce on the ramp.



Folding sequence

Step 1.

Take one step forward onto the ramp and release locking pins on both sides and slide away side rails.

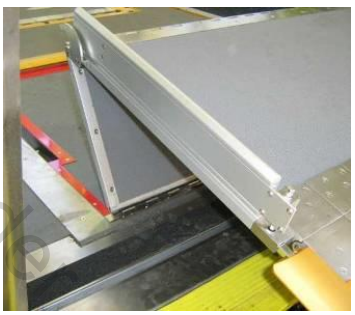
Step 2.

Move to one side of the ramp. Assume a bent knee, semi-squat position. Place hand nearest the unit on the side rail and other hand on the ramp section – shoulder-width apart.

Straighten knees slightly, lift ramp, breaking the hinges of the middle section and pass the ramp through the hands in towards the unit so that the third (short) section is now positioned just past the vertical. (see below).

Lift ramp breaking the hinges.

Pass ramp through hands.



Third section past vertical.

Step 3.

Move to front edge of ramp.

Assume a bent knee semi squat position.

Grasp ramp – one hand at front side edge to lift ramp just off the platform and one hand in the hand hold.

Once off the platform move the other hand to the hand hold and lift up to a comfortable level.

Step 4.

Keeping end of ramp close to the body reach forward with one hand to release the lock.

Change hands and release other lock.

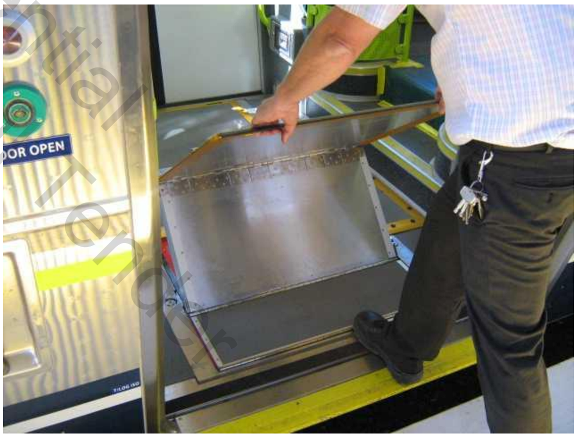
Step 5.

Keeping the end of the ramp high and close to the body walk forward towards the unit the third small section will drop into the base frame.

A small flick forward with the arms will “break” the hinge of the newly unlocked section.

Step 6.

Continue to walk the “broken” ramp forward.



Step 7.

Take one step into the unit

Incline forward slightly at the hips and bend the front knee. Lower ramp until last hinge is touching the floor

The single ramp leaf can be released from mid calf level.

Step 8.

Step into the unit.

Stand closest to the side to be locked.

Insert the key and lock the ramp down.

Repeat the same for the other side.

15 Wheelchair Restraints

In each TC, 2 wheelchair spaces are identified within a graphic marked at floor level showing the wheelchair footprint. The wheelchair restraint system is an in-floor recessed latch channel, described as an "L-track configuration". The associated tie-downs are stowed in a cupboard located under the adjacent priority seating. Two wheelchair restraint storage areas are located underneath the longitudinal seats on TCs. Four wheelchair restraints are stored in each box.

Figure B-54 Wheelchair Space and Restraints

The train crew must assist people in wheelchairs to secure their wheelchair safely.

For each wheelchair, obtain four restraint straps and then position the wheelchair between the floor tracks. Snap each retractor located on the end of the strap into the floor track, pull each strap and attach the hook at the opposite end to a secure portion of the wheelchair frame or structure. Once all four restraints are attached, ask the passenger to apply the wheelchair's brakes.

To remove the wheelchair restraints, slowly pull the strap out from the retractor and unhook each restraint from the wheelchair, press the strap wind button at the retractor, press the release button on the retractor to release it from the floor track, then stow the wheelchair restraint straps back in the cupboard located under the adjacent priority seat.

Figure B-55 Wheelchair Restraints

16 Bicycle Restraints

A bicycle storage area is located under the fold-up seats. This arrangement can accommodate up to 3 bikes at a time. 3 straps are provided to enable users to secure the bikes in position. The strap holds bicycle frame or structure to retain in position and length of each strap is manually adjustable. Bicycle restraints can be hidden behind fold-up seats when not in use.

Figure B-56 Bicycle Storage Space and Restraints

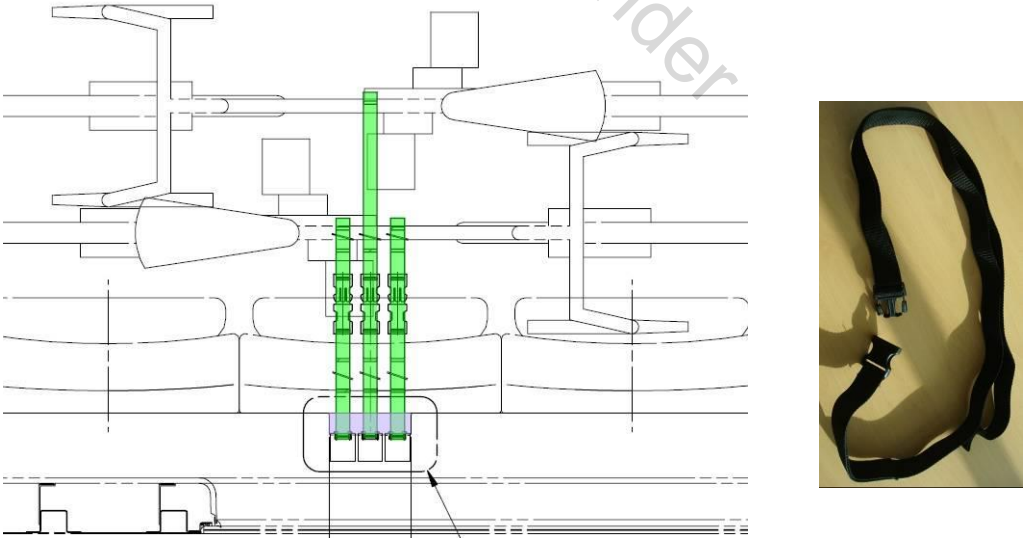


Figure B-57 Bicycle Accommodation with Restraints

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