Transport Accident Investigation Commission

Final report
Tuhinga whakamutunga

Rail inquiry RO-2022-101
Passenger train
Fire in auxiliary generator wagon
Palmerston North station
11 May 2022

November 2023

The Transport Accident Investigation Commission
Te Kōmihana Tirotiro Aituā Waka

No repeat accidents – ever!

"The principal purpose of the Commission shall be to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future, rather than to ascribe blame to any person."

Transport Accident Investigation Commission Act 1990, s4 Purpose

The Transport Accident Investigation Commission is an independent Crown entity and standing commission of inquiry. We investigate selected maritime, aviation and rail accidents and incidents that occur in New Zealand or involve New Zealand-registered aircraft or vessels.

Our investigations are for the purpose of avoiding similar accidents in the future. We determine and analyse contributing factors, explain circumstances and causes, identify safety issues, and make recommendations to improve safety. Our findings cannot be used to pursue criminal, civil, or regulatory action.

At the end of every inquiry, we share all relevant knowledge in a final report. We use our information and insight to influence others in the transport sector to improve safety, nationally and internationally.

Commissioners

Chief Commissioner	Jane Meares
Deputy Chief Commissioner	Stephen Davies Howard
Commissioner	Paula Rose, QSO
Commissioner	Richard Marchant (until 31 October 2022)
Commissioner	Bernadette Roka Arapere (from 1 December 2022)
Commissioner	David Clarke (from 1 December 2022)

Key Commission personnel

Chief Executive	Martin Sawyers
Chief Investigator of Accidents	Naveen Mathew Kozhuppakalam
Investigator-in-Charge for this inquiry	Louise Cook
Commission General Counsel	Cathryn Bridge

Notes about Commission reports
Kōrero tāpiri ki ngā pūrongo o te Kōmihana

Citations and referencing

The citations section of this report lists public documents. Documents unavailable to the public (that is, not discoverable under the Official Information Act 1982) are referenced in footnotes. Information derived from interviews during the Commission's inquiry into the occurrence is used without attribution.

Photographs, diagrams, pictures

The Commission owns the photographs, diagrams and pictures in this report unless otherwise specified.

Verbal probability expressions

For clarity, the Commission uses standardised terminology where possible.

One example of this standardisation is the terminology used to describe the degree of probability (or likelihood) that an event happened, or a condition existed in support of a hypothesis. The Commission has adopted this terminology from the Intergovernmental Panel on Climate Change and Australian Transport Safety Bureau models. The Commission chose these models because of their simplicity, usability, and international use. The Commission considers these models reflect its functions. These functions include making findings and issuing recommendations based on a wide range of evidence, whether or not that evidence would be admissible in a court of law.

Terminology	Likelihood	Equivalent terms
Virtually certain	> 99% probability of occurrence	Almost certain
Very likely	> 90% probability	Highly likely, very probable
Likely	> 66% probability	Probable
About as likely as not	33% to 66% probability	More or less likely
Unlikely	< 33% probability	Improbable
Very unlikely	< 10% probability	Highly unlikely
Exceptionally unlikely	< 1% probability	

Figure 1: Auxiliary generator wagon 130

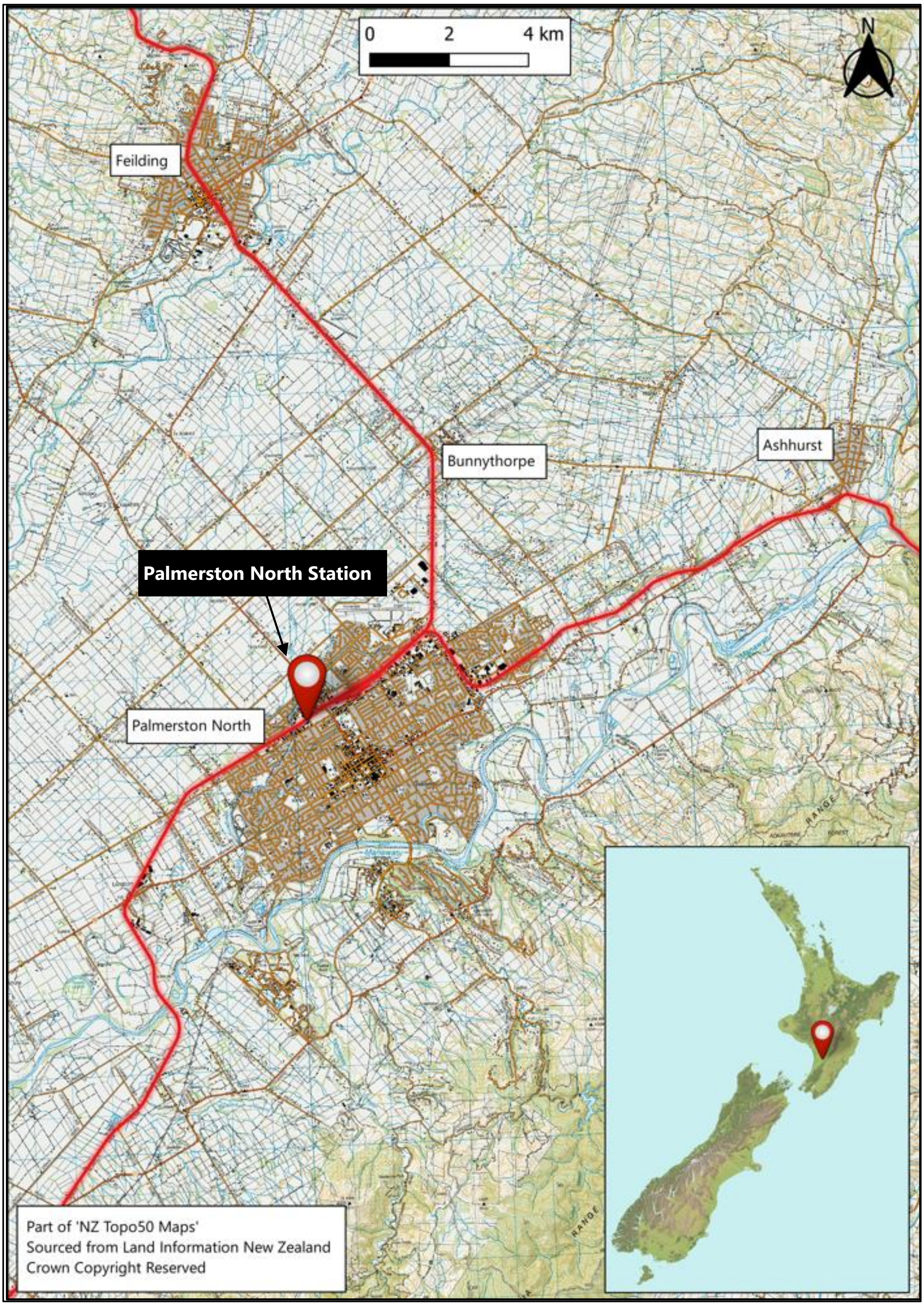

Figure 2: Location of incident
(Credit: Toitu Te Whenua Land Information New Zealand)

Contents
Rārangi take

Figures

1 Executive summary
Tuhinga whakarāpopoto

What happened

1.1 At about 0602, on 11 May 2022, the Capital Connection express passenger train was at the platform of Palmerston North station when the train manager discovered a fire on board the auxiliary generator wagon[1].

1.2 All passenger carriages were immediately evacuated before the doors were closed to prevent re-entry.

1.3 The train manager contacted Fire and Emergency New Zealand to report the fire and a fire appliance responded. On arrival firefighters observed a small fire in the auxiliary generator wagon, which they extinguished with a carbon dioxide portable fire extinguisher.

1.4 There were no injuries, and the fire damage was contained to the top box[2] and ceiling of the auxiliary generator wagon.

Why it happened

1.5 The fire was accidental and **likely** caused by the proximity of the exhaust tail pipe to the internal ceiling lining of the wagon.

1.6 The likelihood of a fire in the auxiliary generator wagon had increased due to a combination of the following factors:

- the top box was sealed closed and could not be opened for maintenance inspection
- the insulation within the top box was in poor condition with significant soot build-up
- the exhaust tail pipe had corroded to the extent that it no longer extended through and above the roof of the auxiliary generator wagon.

What we can learn

1.7 Rail vehicle maintenance must include inspection of all key parts and equipment to minimise the risk of a fire on board a passenger train.

1.8 Early fire detection systems on trains are vital to ensure any fire is detected at the earliest opportunity before spreading throughout the train.

---

[1] The purpose of an auxiliary generator wagon is to provide electrical power for ancillary services on passenger trains from a diesel-fuelled generator set. An auxiliary generator wagon can also be referred to as a generator/luggage van.

[2] The top box is the sealed box located above the generator set where soundproof material covers the exhaust silencer.

Who may benefit

1.9 All operators, maintenance staff and contractors responsible for auxiliary generator wagons may benefit from the findings from this report.

2 Factual information
Pārongo pono

Background

2.1 At the time of this incident, the Capital Connection express passenger train (the Capital Connection) was a long-distance passenger service that operated on weekdays between Palmerston North and Wellington. The service was operated by KiwiRail Holdings Limited (KiwiRail) on behalf of the Greater Wellington Regional Council and the Horizons (Manawatu/Whanganui) Regional Council.

2.2 Between 1971 and 1975, new wagons were imported from South Korea to be used as guards' wagons[3]. In 1998, Tranz Rail[4] modified six of these wagons and equipped each with an auxiliary generator to provide electrical power for ancillary services, such as air conditioning and saloon lighting, on passenger trains.

2.3 Five of these auxillary generator wagons (AG wagons) remained in operation at the time of this incident. Four were owned by KiwiRail, of which two were leased to other operators (Glenbrook Rail and Dunedin Rail). The fifth AG wagon was owned by Greater Wellington Regional Council and operated by Transdev Wellington[5].

Narrative

2.4 On Wednesday 11 May 2022, the Capital Connection from Palmerston North to Wellington had a consist[6] of one locomotive attached to seven carriages (six S-class carriages[7] and one serving carriage) and an AG wagon (AG130) at the rear (*see* Figure 3).

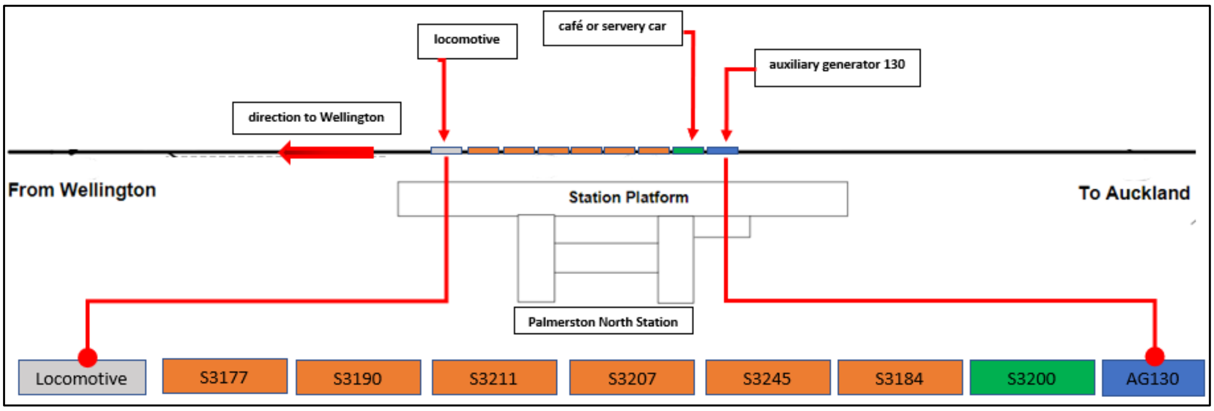

Figure 3: Capital Connection consist at Palmerston North station

2.5 The train was crewed by a locomotive engineer, a train manager and a train attendant.

---

[3] A wagon that is attached to the rear of a freight train and serves as an office for the train guard while they are in transit.
[4] Tranz Rail was the main rail operator in New Zealand from 1991 until it was purchased by Toll Holdings in 2003.
[5] Transdev Wellington is the operator of Wellington's Metlink rail network.
[6] A consist is the sequence of rail vehicles and locomotives that make up the whole train.
[7] An "S" (Scenic) class carriage is a corridor-type passenger carriage.

2.6 At about 0500, as part of their yard duties to ready the train for service, the train manager entered AG130 at the Palmerston North station to start the auxiliary generator set.

2.7 With the auxiliary generator set running, the train manager connected the power through to the rest of the train using the generator outgoing switch on the control panel.

2.8 After the train manager completed their yard duties, the diesel locomotive arrived and was coupled up to the train. This was followed by a standard brake test before the train was piloted[8] by the train manager to the main platform at Palmerston North station.

2.9 With the train berthed at the platform, the train manager released all external doors in preparation for passengers to board.

2.10 At about 0602, the train manager smelt something they described as a "burn off" (grass burning). The train manager walked to the back of the train to investigate the burning smell and realised it was coming from within AG130.

2.11 Upon entering AG130, the train manager noticed red embers in and around the exhaust silencer enclosure (the top box) of the auxiliary generator set.

2.12 The train manager stopped the auxiliary generator set by activating an emergency engine stop button located on the control panel, before isolating the batteries with the main control circuit breaker.

2.13 The train manager then contacted the locomotive engineer to report the fire and ask the locomotive engineer to alert train control.

2.14 At about 0604 the locomotive engineer notified the national train control centre[9] of the situation at Palmerston North station and then asked train control for the traction overhead power to be switched off.

2.15 The train manager contacted Fire and Emergency New Zealand to report the fire onboard the train.

2.16 The train manager and the train attendant evacuated all passengers and only after confirming that there were no passengers onboard, closed and locked the external doors to prevent re-entry.

2.17 At about 0612 the firefighters arrived and entered AG130 and extinguished a small fire in the top box area with a carbon dioxide portable fire extinguisher[10].

2.18 There were no injuries to passengers or the train crew. Fire damage was confined to the top box and the ceiling of AG130.

2.19 KiwiRail arranged buses to replace the train service and transport waiting passengers to Wellington.

2.20 The attending fire officer advised the train crew to have AG130 monitored for at least a 24-hour period. They also recommended that AG130 not be operated on the main line at speed during this period, because of the risk of the fire re-igniting.

---

[8] Provided line of sight vision for the Operator/Locomotive Engineer, ensuring the safety of a movement.

[9] The national train control centre is housed in Wellington Railway Station and is where train movements and track occupations are authorised by train controllers.

[10] A handheld active fire protection device usually filled with a dry chemical used to extinguish or control small fires, often in emergencies.

2.21 The locomotive engineer notified KiwiRail Operations regarding these fire risks. A shunt team was dispatched with a shunt locomotive to uncouple AG130 and take it to the nearby Palmerston North rail yard.

Key personnel information

2.22 The train manager joined KiwiRail as a train manager in 2015 and had been working onboard the Capital Connection since then.

2.23 The locomotive engineer had more than 15 years' experience driving trains.

2.24 The train attendant joined KiwiRail in 2021.

2.25 The KiwiRail train crew were trained in basic firefighting, this training included the use of portable fire extinguishers. However, as the AG130 was full of smoke and the portable fire extinguishers available were designed to fight small fires, the train crew exercised their judgment and did not attempt to put out the fire themselves.

Instructions to train crew in the event of a fire

2.26 KiwiRail had produced guidelines for the event of a vehicle on fire. Clause 3.2 of Section 4.1 (Motive Power Unit Inspection and Operating Instructions) of the KiwiRail Rail Operating Code[11] states:

> When a vehicle on a train is on fire, the Locomotive Engineer must use judgement as to the best course to adopt in the circumstances, taking into consideration the proximity of firefighting appliances, the load in the vehicle, and the possibility of damage to bridges, adjacent vehicles or property.

2.27 Clause 3.3 of the Code – Fire Precautions – states:

> The best protection against fire is cleanliness. This applies particularly to the engine and engine room, the underframe mounted equipment and bogies.

2.28 At clause 10.1 – Fire, in Section: 11 (Emergency Procedures) of KiwiRail's Operating Procedures, it states in part:

> Immediate action on discovery:
>
> - raise the alarm
> - call fire – dial 111
> - attempt to extinguish the fire – use appropriate extinguisher.

Vehicle information

Auxiliary generator wagon 130

2.29 AG130 was owned, operated, and maintained by KiwiRail.

2.30 The purpose of AG130 was to provide electrical power for ancillary services on the passenger section of the train from a 165 kVA[12] diesel-fuelled turbo auxiliary generator set. AG130 also provided storage for onboard services and a disabled access facility (a wheelchair ramp).

[11] *See* Appendix 1.
[12] Kilo Volt-Ampere(s).

Fire detection and response

2.31 There were no fire or smoke alarms in AG130.

2.32 AG130 contained a Lifeline 2000 automatic fire extinguisher system[13] (Lifeline 2000) attached to the auxiliary generator set, which was not activated during the incident.

2.33 The Lifeline 2000 was designed to be activated using an insulated, flexible double-link wire fitted within the auxiliary generator set enclosure. Heat generated by a fire would melt the insulation around the link wire and allow the two conductors to make contact, triggering the control unit to activate an explosive charge on a pressurised fire extinguisher bottle. The foam suppressant was ducted to discharge nozzles within the auxiliary generator set enclosure via plastic-coated aluminium tubing.

2.34 Inspection after the fire found that the insulation around the link wire had not melted and remained intact, unaffected by the incident, as would be expected given the location of the fire (*see* paragraph 3.14).

2.35 AG130 contained two portable 4.5 kilogram dry-powder fire extinguishers, one located in the luggage compartment, and another located at the other end of the wagon (*see* Figure 4). There was also one portable fire extinguisher in each passenger carriage of the Capital Connection.

2.36 None of the onboard fire extinguishers was used to extinguish the fire.

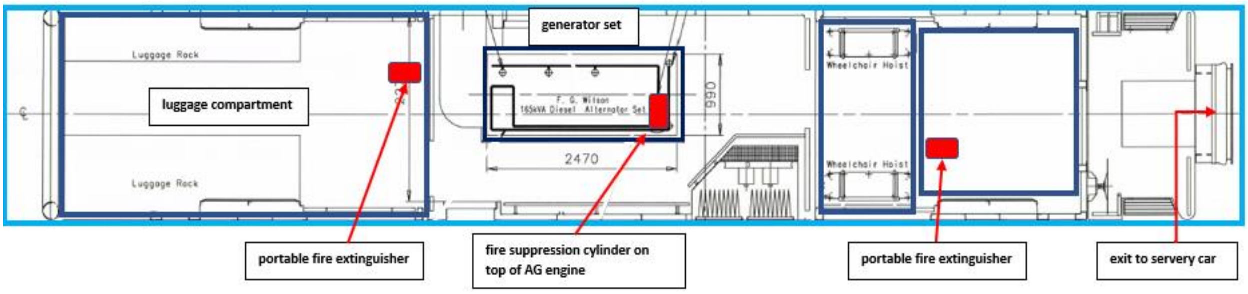

Figure 4: Location of fire extinguishing equipment on AG130

AG wagon exhaust system

2.37 The Commission inspected the exhaust systems of three AG wagons: AG130, AG176 and AG222. The AG130 and the AG176 were owned by KiwiRail, while the AG222 was occasionally leased by KiwiRail from Greater Wellington Regional Council. The AG130 exhaust system was the only one in which the exhaust tail pipe was missing, so that the auxiliary generator set's exhaust did not extend up through the top box and out through the roof (*see* Figure 5).

Figure 5: AG130 exhaust tail pipe inside, top and side views

[13] Lifeline fire suppression systems had been designed for use in rally cars and vehicles participating in motor sport events.

2.38 The inspection also revealed significant surface rusting and thinning of the AG130 's exhaust tail pipe (*see* Figure 6).

Figure 6: Exhaust tail pipe from AG130 after removal

2.39 When the top boxes of the three AG wagons were opened and inspected the soundproof material in AG130 showed signs of significant soot build-up between the layers (*see* Figure 7).

Figure 7: Top boxes of AG130 (left) and AG176 (right) showing condition of insulation
(Credit: Fire and Emergency New Zealand)

AG wagon inspection and maintenance programme

2.40 Before operating rail vehicles on the national rail network, an operator must provide a safety case to Waka Kotahi NZ Transport Agency (in consultation with WorkSafe NZ) to approve. The operator's rail vehicles must be compliant with the safety system described in that safety case before it can operate on the national rail network.

2.41 The inspection and maintenance of AG wagons was in accordance with KiwiRail's M2000 Mechanical Code[14] (the Code). The Code required the scheduled maintenance inspection of locomotive-hauled passenger rolling stock (which includes AG wagons) to be carried out by a service manager or team leader at the following intervals:

[14] Its purpose is to ensure that rail vehicles and associated equipment comply with the conditions of KiwiRail's Rail Licence and National Rail System Standards (NRSS).

- Power generator sets[15] – every 500 operating hours with an upper limit of 600 hours. Passenger B-check to be carried out with this service check.
- 1250km maintenance check with an upper limit at 1500km.
- The A maintenance check every 6000 km with an upper limit at 7000 km.
- The B maintenance check every 24000 km or 6 months whichever comes first, upper limit of 26000 km or 7 months whichever comes first.
- The C maintenance check every 12 months with an upper limit of 14 months.

2.42 The 500-hour check on auxiliary generator sets required the following work to be carried out:

- air filters clean or change
- engine oil change
- oil filters change
- fuel lift pump clean strainer and sediment bowl
- fuel filters change
- water filter change
- vee belts check tension and condition
- oil leaks rectify
- test run check idle speed, check intake fans operate OK.

2.43 On 19 April 2021, a 500-hour check was completed on the AG130 auxiliary generator set. The engine hour meter registered 43,967 operating hours.

2.44 On 1 September 2021 (eight months before the incident), a further 500-hour check was carried out. The engine hour meter registered 44,837 operating hours, making this check overdue by 370 hours. KiwiRail advised the Commission that the late scheduling of the check was because of staffing pressures.

2.45 During this check, it was noted that the oil pressure gauge was not working and there was an abnormal alternator output frequency of 50 Hz.

2.46 The most recent A, B and C checks on AG130 were undertaken within the specified timeframes and did not identify any major work to be carried out to either the wheels, braking system, electrical components, or the passenger car coupling system. There was no requirement to inspect the exhaust system or roof area during any of the checks.

Fire investigation

2.47 The fire was confined to the auxiliary generator set enclosure[16] of AG130, affecting the exhaust system and the ceiling of the wagon. There was smoke damage throughout AG130 (*see* Figure 8).

[15] The inspection and maintenance of the power generator set every 500 operating hours was independent of the inspection and maintenance checks of the wagon itself.

[16] The generator set enclosure includes the engine, generator, fuel system and cooling and exhaust systems.

Figure 8: The AG130 auxiliary generator set after the incident

A: auxiliary generator set, B: control panel, C: Top box

2.48 The diesel fuel for the auxiliary generator set was contained within a tank under the auxiliary generator set and had not been affected by the fire. Fuel pipes within the auxiliary generator set enclosure remained intact.

2.49 The independent fire investigator engaged by the Commission identified four potential causes of the fire:

1. Due to damage to the exhaust 'tail pipe' and it not extending above the exterior roof line of the carriage, a spark or sparks from the exhaust entered the space between the exterior roof and the interior ceiling lining igniting the combustible material, plywood, below the outer skin of the wagon
2. Due to damage to the exhaust 'tail pipe' and it not extending above the exterior roof line of the carriage, whilst parked the exhaust gases have built up in the space between the exterior roof and the interior ceiling lining raising the temperature of the lining and igniting the combustible plywood material, resulting in ignition
3. Due to the proximity of the exhaust 'tail pipe' to the combustible lining, pyrophoric action[17] has led to the ignition of the internal ceiling lining
4. Due to the location of the exhaust 'tail pipe', radiant heat from the exhaust pipe has ignited the interior ceiling lining.

2.50 The fire investigator determined that there were no electrical faults in the wiring and eliminated electricity as a possible cause of the fire.

2.51 The fire investigator concluded that the most probable cause of the fire was accidental and, because of the proximity of the exhaust tail pipe to the combustible lining, pyrophoric action had led to the ignition of the internal ceiling lining (potential cause 3 above).

Previous occurrences

2.52 Fires in AG wagons are not uncommon because of the presence of a wide range of fuel and ignition sources in the presence of running machinery.

[17] Pyrophoric action is the spontaneous ignition of something on exposure to the air.

2.53 The Commission has previously investigated several such fires,[18] resulting in the following recommendations:

- RO-2004-112: To modify the side shrouds of the DMU ADC cars to improve access to the auxiliary engines (recommendation 008/05, to Auckland Regional Transport Authority)
- RO-2004-116: To take steps to ensure that the cooling airflow is adequate and unrestricted within the generator enclosure around all parts of the diesel engine and the alternator housing, and that there is no build-up of diesel oil or dust particles. (recommendation 069/05, to Toll NZ Consolidated)
- RO-2006-101: To take steps to issue work instructions for maintaining safety-critical equipment and work on safety-critical components is signed off by someone other than the maintainer and all maintenance is recorded (recommendation 015/07, to Land Transport NZ).

[18] *See* inquiries: RO-2004-112; RO-2004-116 and RO-2006-101. These documents are available on the TAIC website https://www.taic.org.nz/

3 Analysis
Tātaritanga

Introduction

3.1 The following section analyses the circumstances surrounding the event to identify those factors that increased the likelihood of the event occurring or increased the severity of its outcome. It also examines any safety issues that have the potential to adversely affect future operations.

How the fire occurred

3.2 Commission investigators inspected the exhaust systems of three different AG wagons, including the AG130. Investigators found that the AG130 exhaust tail pipe no longer extended through the ceiling, and daylight was visible from inside the wagon (*see* Figure 9).

Figure 9: Daylight visible where exhaust tail pipe met ceiling of AG130

3.3 The degree of surface rusting and thinning of the exhaust tail pipe wall thickness indicated it is **very likely** that the damage was age related.

3.4 When the top box of AG130 was opened, investigators found the insulation material was in poor condition and contained a significant amount of soot. Although soot deposits in the top right of the top box may have been produced during the fire, it is **almost certain** that those in the centre and lower left of the top box were formed before the fire.

3.5 The independent fire investigator engaged by the Commission determined that the fire in AG130 was accidental (*see* Appendix 3: Fire Investigation Report), They also determined that the fire was **likely** caused by pyrophoric action (arising from the proximity of the exhaust tail pipe to the combustible lining) leading to the ignition of the internal ceiling lining.

3.6 In fire investigation terms, pyrophoric action refers to fires that have started in confined spaces, where long-term exposure to a source of heat causes carbon deposits such as charcoal and soot to form. A sudden influx of air, arising from degradation of the surrounding area, could cause these carbon deposits to ignite.[19]

3.7 It is **virtually certain** that the likelihood of a fire on board AG130 increased because of a combination of the following factors:

- the insulation within the top box was in poor condition, containing soot build-up
- the exhaust tail pipe had corroded and did not extend through and above the roof of AG130
- the top box was sealed closed and could not be opened for maintenance or inspection.

Inspection and maintenance

Safety issue: The programmed maintenance checks of the AG wagon were inadequate and did not include inspection of the exhaust system or of the roof. This increased the risk of fire from exhaust systems in poor condition.

3.8 KiwiRail's M2000 Mechanical Code stipulates the scheduled maintenance inspection intervals. The wagon schedule inspection systems are further detailed in the Wagon Inspection Manual M9202/01.

3.9 Because of staffing pressures, one of the 500-hour checks on AG130 was 370 hours overdue when it was carried out, but this had no bearing on the incident.

3.10 As part of the scheduled maintenance there was no requirement to inspect the top box or the roof of the wagon where the tail pipe should have extended through.

3.11 It is **virtually certain** that had the maintenance programme for AG130 included inspection of the auxiliary generator set exhaust system and the top box, the poor state of both the insulation and the tail pipe would have been identified.

Onboard fire detection system

Safety issue: All wagons should contain detection systems capable of alerting train crew and passengers to smoke or fire in any area within the wagon.

3.12 The auxiliary generator set within AG130 was fitted with a Lifeline 2000 automatic fire extinguisher system. However, that system did not include an audible alarm or other alert mechanism to warn the train crew or the passengers of a fire. Further, there were no other fire or smoke alarms within AG130.

3.13 The Lifeline 2000 fire extinguisher system was configured to detect and extinguish a fire in or on the auxiliary generator set. A fire within the wagon, but away from the auxiliary generator set, would not activate the system until the heat of the fire was such that the insulation around the link wire melted. The fire in the ceiling of AG130, around the exhaust tail pipe, had not yet reached the temperature required to melt the link wire insulation and activate the fire extinguisher system.

3.14 Given the fire was detected by the train manager smelling the smoke, it is **very likely** that a smoke detector would have warned the train crew of the fire at an earlier stage.

[19] Icove D.J. & Haynes G.A. (2017). Kirks Fire Investigation, 8th edition. Referenced by independent fire investigator's report (*see* Appendix 3).

3.15 The AG wagon is the last vehicle in the consist when travelling south to Wellington from Palmerston North. Had this train service departed with the fire undetected, it is **likely** that the fire would have remained undetected for some time. The Capital Connection travels through seven tunnels, two of which are over 1.2 kilometres long. A train on fire is an extremely dangerous situation, travelling through a tunnel would further exacerbate the seriousness of the situation as fire spreads more quickly in the confined space and evacuating passengers and crew away from the danger is more difficult.

3.16 In this incident, the fire was detected at a time when it was small enough for a Fire and Emergency New Zealand crew to attend and to extinguish it with a portable extinguisher. However, if the fire had continued and grown or occurred in an isolated location, the risk of more extensive damage to the train and danger to passengers and train crew would be far greater.

3.17 The loss of life and extent of property damage caused by a fire can be minimised by ensuring early detection, thus allowing appropriate action to be taken.

3.18 Although new passenger trains are designed and equipped with onboard fire detection systems, neither the "S" class carriages[20] nor AG wagon had any fire detection systems installed.

3.19 A **recommendation** has been made to KiwiRail to address this safety issue (*see* para 6.3).

[20] An "S" (Scenic) class carriage is a corridor-type passenger carriage.

4 Findings
Ngā kitenga

4.1 It is **virtually certain** that the likelihood of a fire on board AG130 increased because of a combination of the following factors:

- the insulation within the top box was in poor condition, containing soot build-up
- the exhaust tail pipe had corroded and did not extend through and above the roof of AG130
- the top box was sealed closed and could not be opened for maintenance inspection.

4.2 It is **virtually certain** that had the maintenance programme for AG130 included inspection of the auxiliary generator set exhaust system and the top box, the poor state of both the insulation and the tail pipe would have been identified.

4.3 It is **very likely** that a smoke detector would have warned the train crew of the fire at an earlier stage.

4.4 The train crew took appropriate action on discovering the fire, evacuating the passengers and minimising the danger to passengers and crew.

5 Safety issues and remedial action
Ngā take haumanu me ngā mahi whakatika

General

5.1 Safety issues are an output from the Commission's analysis. They typically describe a system problem that has the potential to adversely affect future operations on a wide scale.

5.2 Safety issues may be addressed by safety actions taken by a participant, otherwise the Commission may issue a recommendation to address the issue.

Maintenance checks

Safety issue: The programmed maintenance checks of the AG wagon were inadequate and did not include inspection of the exhaust system or of the roof. This increased the risk of fire from exhaust systems in poor condition.

5.3 In August 2022, KiwiRail informed the Commission that:

> The 12 monthly maintenance check for the Capital Connection fleet including AG vans was updated in August 2022 to include the following:
>
> ➢ Check motor generator exhaust extends above the roof
>
> ➢Check motor general exhaust rain flap is working
>
> ➢ Open muffler compartment every year ending with 0 or 5 e.g. (2025 or 2030)
>
> ➢ Inspect muffler, and exhaust pipe condition for damage, holes, corrosion, signs of exhaust leaks
>
> The 1250 km maintenance check for the fleet was updated in October 2022 to include:
>
> ➢ Check exhaust system and muffler box for signs of exhaust leakage, i.e. signs of soot.
>
> ➢ Check for fuel, water and oil leaks.

5.4 The Commission considers these safety actions have addressed the safety issue identified, and therefore no recommendation has been made.

Wagon fire detection alarms

Safety issue: All wagons should contain detection systems capable of alerting train crew and passengers to smoke or fire in any area within the wagon.

5.5 On 28 September 2023, KiwiRail informed the Commission:

> The two AG vans (AG130 and AG176) have been replaced in service in July 2023 by SRG class generator/passenger carriages that are equipped with trainlined fire detection systems. The Kiwirail AG vans are currently on a stabling check regime pending probable disposal and are used only in exceptional circumstances.
>
> KiwiRail suggests that a more suitable recommendation could be for owners and rail operators (licence holders) of this class of wagon to ensure that any AG vans returned to or used in regular or permanent service to be first equipped with suitable smoke and fire detection systems.

5.6 The Commission acknowledges KiwiRail no longer regularly operates either AG130 or AG176. However, while KiwiRail retain the AG wagons for use, albeit in exceptional circumstances, the safety issue remains. Therefore, the Commission has made a **recommendation** in Section 6 to address this issue.

6 Recommendations
Ngā tūtohutanga

General

6.1 The Commission issues recommendations to address safety issues found in its investigations. Recommendations may be addressed to organisations or people and can relate to safety issues found within an organisation or within the wider transport system that have the potential to contribute to future transport accidents and incidents.

6.2 In the interests of transport safety, it is important that recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.

New recommendation

6.3 On 25 October 2023, the Commission recommended that KiwiRail install smoke and fire detection systems in all auxiliary generator wagons in service to alert train crew and passengers to a fire at the earliest opportunity. (**039/23**)

6.4 On 13 November 2023, KiwiRail replied:

> This recommendation is accepted and implemented.
>
> KiwiRail no longer have any auxiliary generator wagons in service, since the two AG vans operating on Capital Connection have been replaced by SRG class carriages. All generator cars in use have fire mitigations in place that address the intent of this recommendation. If we do return any AG vans to service at any point in the future then we will make the necessary modifications to fire detection systems before doing so.

7 Key lessons
Ngā akoranga matua

7.1 Rail vehicle maintenance inspections must encompass all key parts and equipment to minimise the risk of a fire on board a passenger train.

7.2 Early fire detection systems on trains are vital to ensure any fire is detected at the earliest opportunity and contained.

8 Data summary
Whakarāpopoto raraunga

Vehicle particulars

Train type and number:	diesel locomotive hauled passenger express train 1203
Classification:	mainline
Year of Manufacture:	1971 to 1975
Operator:	KiwiRail

Date and time	11 May 2022, 0602
Location	Palmerston North station
Operating crew	locomotive engineer, train manager and train attendant
Injuries	no injuries
Damage	fire damage to the top box and the ceiling of the auxiliary generator wagon

9 Conduct of the inquiry
He tikanga rapunga

9.1 On 11 May 2022, the rail regulator notified the Commission of the occurrence. The Commission subsequently opened an inquiry under section 13(1) of the *Transport Accident Investigation Commission Act 1990* and appointed an investigator-in-charge.

9.2 Two Commission investigators arrived at Palmerston North rail yard, where AG130 was secured, late in the afternoon of 11 May 2022.

9.3 On 11 May 2022, the Commission engaged an independent fire investigator to assist in determining the cause of the fire.

9.4 The Commission interviewed witnesses on 12 May 2022.

9.5 Two Commission investigators visited KiwiRail Wellington freight depot on 13 May 2022 to examine two other AG wagons.

9.6 Three Commission investigators visited the KiwiRail Wellington freight depot on 24 May 2022 to re-examine AG130 and gather further evidence.

9.7 The Commission carried out further interviews on 30 May 2022.

9.8 On 22 August 2023 the Commission approved a draft report for circulation to four interested parties for their comment.

9.9 The Commission received four responses, of which two were submissions and two had no comment. Changes as a result of these have been included in the final report.

9.10 On 25 October 2023, the Commission approved the final report for publication.

Appendix 1 KiwiRail Rail Operating Code

3.0 FIRES

3.1 TRACKSIDE FIRES

If a Locomotive Engineer encounters a fire at the side of the line or on adjacent property, Train Control must be informed. If a track gang is encountered, the train must be stopped and the Ganger advised of the fire if the Locomotive Engineer has been unable to contact Train Control.

If fires endanger bridges, buildings, or other property and arrangements cannot be made for other members to reach the location within a reasonable time, the train crew must take the necessary steps to suppress the fire where possible.

DANGER: Beware of High Voltage Overhead Wires

3.2 VEHICLES ON FIRE

When a vehicle on a train is on fire, the Locomotive Engineer must use judgement as to the best course to adopt in the circumstances, taking into consideration the proximity of firefighting appliances, the load in the vehicle, and the possibility of damage to bridges, adjacent vehicles or property.

3.2.1 Extinguishing a Dynamic Brake Fire

The following procedure is to be used in the event of a dynamic grid fire on a DC, DFT and DX Class locomotive:

1. Suspend use of dynamic brake immediately a brake grid fire is discovered and use serial braking for the remainder of the grade.

   NOTE: The serial braking rules for the locality must still be observed.

2. Coast or drive the locomotive to an accessible location that has pressurized water available, is clear of tunnels, bridges and preferably overhead catenary wires.
3. Stop the locomotive and apply the locomotive and train brakes.
4. Shut down the diesel engine.
5. Open the battery knife switch.
6. Apply sufficient handbrakes on the train for the locality.

7. Spray water into the dynamic brake grids, until the grid insulation has cooled to the point where it will not spontaneously reignite.

> **IMPORTANT: Overhead Traction Wires**
> If stopped under or near overhead traction wires, before water is used, overhead power must be isolated, earthed and a permit to work issued.

8. The locomotive can now be restarted and operated normally for powering operation but no attempt should be made to use dynamic brake. The fault is to be written up in the 54D repair book for attention.

> **NOTE: DX Class Locomotives**
> No.5 Traction Motor will have failed, so locomotives must not be restarted and must be towed to destination.

3.3 FIRE PRECAUTIONS

The best protection against fire is cleanliness. This applies particularly to the engine and engine room, the underframe mounted equipment and bogies.

Diesel fuel alone is not readily flammable. A lit match will not ignite fuel oil in a clean container, but it will readily ignite diesel fuel spilt on paper or any other substance which can act as a wick.

To minimise the risk of fire, never leave waste rags, or paper in the engine room or use naked lights for inspection around the power unit. Report any arcing in electrical equipment and pay prompt attention to any overheating.

Cotton waste is prohibited on any locomotive, EMU and Railcar as it is a fire hazard. Cotton waste may also damage diesel engines, gearboxes, air compressors and electrical equipment.

Appendix 2 KiwiRail Operating Procedures

KiwiRail Operating Procedures | Section: 11 – Emergency Procedures

10.0 Fire

Level 3 Response Topic

10.1 Immediate Action on Discovery

- Raise the Alarm – shout "Fire Fire Fire"
- Call Fire - dial 111
- Attempt to extinguish the fire - use appropriate extinguisher.

10.2 If unable to Extinguish immediately

- Close all doors and windows and stop ventilation (to stop the fire)
- Evacuate all personnel and public to a safe area.

> **Danger:** Advise Train Control if the fire is on the railway corridor or adjoining land.

Appendix 3 Fire Investigation Report

Fire Investigation Report

AG130 Capital Connection
TAIC Inquiry No RO-2022-101

Colin Clemens
1 August 2022

This information relates to my engagement with the Transport Accident Investigation Commission and cannot be disclosed without the permission of the Commission.

WHAKARATONGA IWI – SERVING OUR PEOPLE   www.fireandemergency.nz

Description and use.

This fire occurred in an auxiliary generator wagon, AG130, which formed part of the Capital Connection service located at the Palmerston North Railway Station.

The wagon was built circa 1971 to 1975 as a Guards Wagon and was converted to its current use in 1998.

In its current configuration AG130 provides AC power to the passenger section of the train from a 165 kVA diesel fuelled turbo generator set (genset) located in the AG wagon. The wagon also provides storage for onboard services and a disabled access facility, a wheelchair 'ramp'.

Pre-incident events

During an interview, the Train Manager advised that their normal procedure was to board and unlock AG130, start the genset to power the other carriages and then set about their usual duties

Discovery of Fire

Whilst carrying out their normal duties the Train Manager smelt smoke about one carriage length (approximately 17 metres) from AG130 which smelt 'like a burn off'. After entering AG130 they saw red embers in/around the exhaust box. They proceeded to isolate the genset and batteries then contacted the Locomotive Engineer to contact Train Control. The Train Manager called 111 to alert Fire and Emergency.

Fire Response

At 6:05 a.m. on 11 May 2022 Fire and Emergency New Zealand received a 111 call to a fire in a generator van at Palmerston North Railway Station, Fire and Emergency incident F3480283.

One fire appliance responded from Milson Fire Station. On arrival firefighters observed a small fire which was extinguished with a Carbon Dioxide portable fire extinguisher, after which a small amount of ceiling lining was removed to check for any further evidence of fire.

Interviews

Formal interviews were conducted by TAIC staff, I was in attendance and able to seek clarification of information where necessary. Information from these interviews informs this report.

Scene Examination

The fire was contained to the genset compartment of the AG130 wagon. The fire did not affect the genset other than the exhaust system and the ceiling/roof of the carriage with smoke damage to the rest of the compartment.

Fire damage was contained to the exhaust silencer enclosure and the ceiling of the carriage. There was heat damage to the steel framing surrounding where the exhaust passed through the ceiling and roof as visible in Photo 1 and Photo 2.

Firefighters removed part of the ceiling to ensure that the fire had not extended to other parts of the ceiling, debris can be seen on the deck around the genset.

The fire extinguisher system installed on the genset with the extinguisher cylinder on top of the control panel did not activate as the activation sensors were on the genset, not the rest of the carriage.

Photo 1.
View of genset from internal entry to compartment.
A = Genset. B=Genset control panel.
C = Exhaust silencer enclosure.
IMG_2078.jpg.

Photo 2
Opposite end of the genset shown in Photo 1.
Red arrow indicates the tubing for releasing the fire extinguisher medium.
IMG_2081.jpg.

When viewed from the opposite end of the compartment the fire damage was visible at the end of the exhaust silencer enclosure, with only smoke damage visible further along towards the door.

Visible in Photo 2 is the tubing and one of the nozzles for discharging the extinguishing media. It is visible that the discharge tubing is remote from the fire area.

The extinguishing system detection was via a 'hot wire' system.

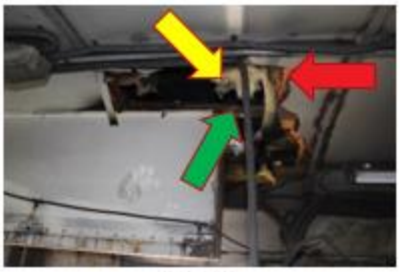

Photo 3.
Red arrow indicates plywood type material. Yellow arrow indicates insulation material. Green arrow indicates steel frame of roof structure.
IMG_2080.jpg.

A closer inspection of the damage to the ceiling of AG130 revealed that there was 'non-combustible' insulation material, apparently a fibre glass sheet material, similar in appearance to that used in household insulation, installed in the cavity between the ceiling and the outer roof covering of AG130.

It was also noted that the ceiling lining appeared to be a veneer and plywood combination.

It was not possible to identify how close this ceiling material and insulation were installed to the exhaust pipe where it penetrated through the outer roof prior to the fire.

Photo 4.
Cabling in vicinity of the fire area.
IMG_2082.jpg.

The cabling that ran to/from the genset control panel and the genset appeared to have been unaffected by the fire, apart from sooting visible to the exterior of the cables.

Photo 5.
Arrow indicates daylight visible.
Note condition of electrical cables.
IMG_2103.jpg

During the initial examination daylight was observed through the space where the fire had occurred. This indicated that the exhaust pipe was potentially missing above the outer roof level.

Photo 6.
Yellow circle indicates location where exhaust had previously passed through outer roof lining.
IMG_2110.jpg

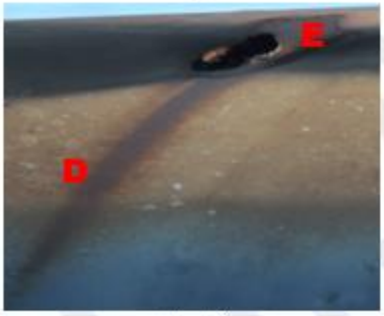

Photo 7.
Close up view of external exhaust and roof.
D = 'Rust' stain.
E = 'Heat' damage.
Part IMG_2112.jpg

A closer examination of the roof of AG130, using a camera and telephoto lens, revealed that the exhaust pipe did not extend beyond the outer roof. Further, the photo shows an area where there appears potentially 'rusty water' has stained the roof below the exhaust pipe. Additionally, above the exhaust pipe there was an area of the roof which appeared to have been heated which had affected the surface.

Following the relocation of AG130 to the Wellington Rail Yards, under impound, further inspection and dismantling of the fire affected area of AG130 was undertaken. Concurrent with the examination the opportunity was taken to investigate the exhaust setup of two additional similar AG wagons, AG176 and AG222.

Photo 8.
AG176.
Part of IMG_2124.jpg

It was noted that AG176 was fitted with a "T" style end to the exhaust pipe which extended through the roof with no openings around it.

Photo 9.
Close up of AG176 external exhaust
Part of IMG_2126.jpg.

Photo 10.
AG222.

IMG_2148.jpg.

Photo 11.
Close up of AG222 external exhaust
Part of IMG_2151.jpg.

It was apparent that there is no standard external exhaust configuration for the three AG wagons examined

Prior to opening and examination of the exhaust silencer enclosure of AG130 it was possible to observe the exhaust silencer enclosure of AG 176.

Photo 12.
External access cover of exhaust silencer enclosure removed from AG176.
IMG_2114.jpg

Once the external access cover to the exhaust silencer enclosure was removed some sooting was visible on the insulation.

Photo 13.
Part of the insulation removed from the exhaust silencer enclosure removed from AG176.
IMG_2117.jpg

With the removal of the insulation it was apparent that there had been sooting to the ceiling of the enclosure and to the insulation material. This sooting may indicate either a leak in the exhaust system or exhaust products re-entering the enclosure.

The general state of the silencer was noted with surface rusting which was also visible on the tail pipe.

The exhaust silencer enclosure of AG130 was then examined.

Photo 14.
Exhaust silencer enclosure AG130.
Part of IMG_2939.jpg

With the removal of the access cover to the exhaust silencer enclosure of AG130

DRAFT

the state of the insulation was apparent. The enclosure structure showed signs of rusting, potentially indicating prolonged water ingress.

The insulation material also showed signs of sooting throughout. The sooting in the upper right side may be as a result of the fire, however the sooting to the middle and left lower areas is less likely to be due to the fire and may be due to exhaust gas leakage over time.

Photo 15.
Exhaust silencer enclosure less insulation material AG130.
IMG_2951.jpg

Following the removal of insulation material, the exhaust end of the silencer became visible and the extent of damage to the external portion of the 'tail pipe' became visible.

Daylight was visible around the top of the 'tail pipe' as visible in Photo 15.

The 'tail pipe' was subsequently removed from the exhaust silencer.

Photo 16.
Exhaust 'tail pipe' from AG130.
IMG_2182.jpg

Photo 17.
Exhaust 'tail pipe' from AG130.
IMG_2184.jpg

Once removed from the roof of AG130 the condition of the exhaust 'tail pipe' became visible. The above photos show the condition inside the 'tail pipe' and the external condition.

Photo 18 *Exhaust 'tail pipe' from AG130.* IMG_2188.jpg	Photo 19. *Exhaust 'tail pipe' from AG130.* IMG_2189.jpg	Photo 20. *Exhaust 'tail pipe' from AG130.* IMG_2190.jpg	Photo 21. *Exhaust 'tail pipe' from AG130.* IMG_2191.jpg

The irregular pattern of damage to the 'tail pipe' would appear to be potentially age related. There were no visible cut marks which would likely be linear. Additionally, the degree of surface rusting and thinning of the wall thickness most likely indicates that this is the effect of corrosion and is a time related event.

Photo 22
Floor of AG130 adjacent to the genset. White circle indicates rust area.
IMG_2970.jpg

It was noted that the floor of AG130 adjacent to the genset control panel had rusted through.

The condition of the floor may indicate the condition of the exhaust flue prior to this incident.

Point of Origin

The cause of this fire was accidental, with 4 potential causes.

1. Due to damage to the exhaust 'tail pipe' and it not extending above the exterior roof line of the carriage, a spark, or sparks, from the exhaust entered the space between the exterior roof and the interior ceiling lining igniting the combustible material, plywood, below the outer skin of the wagon.
2. Due to damage to the exhaust 'tail pipe' and it not extending above the exterior roof line of the carriage, whilst parked the exhaust gasses have built up in the space between the exterior roof and the interior ceiling lining raising the temperature of the lining and igniting the combustible ply wood material, resulting in ignition.
3. Due to the proximity of the exhaust 'tail pipe' the combustible lining, pyrophoric action[1] has led to the ignition of the internal ceiling lining of AG130.
4. Due to the location of the exhaust 'tail pipe', radiant heat from the exhaust pipe has ignited the interior ceiling lining.

I consider that the most likely cause of this fire is 3 above, Due to the proximity of the exhaust 'tail pipe' the combustible lining, pyrophoric action has led to the ignition of the internal ceiling lining of AG130.

Elimination of other Possible Causes

Electrical.

The electrical cables in the vicinity of the fire did not display any visible signs of any electrical faults. The insulation and other coverings were intact, the only damage attributable to the fire was surface sooting as is visible in Photo 4. An attempted test run of the genset as part of this investigation was achieved successfully indicating that there were no electrical faults in the wiring in the vicinity of the fire.

Colin Clemens
Senior Specialist Fire Investigator

References:

Icove, D.J., Haynes G.A. (2018). Kirks Fire Investigation, 8th Edition, Pearson, 259-260.

DRAFT

[1] Kirks Fire Investigation, 8th Edition, Icove D.J., Haynes G.A

Kirks Fire Investigation, 8th Edition, Pages 259 – 260.

4.5.3 LONG-TERM HEATING (LOW-TEMPERATURE IGNITION)

Wood, especially in massive form, requires a considerable amount of heat to cause its ignition. For flaming combustion, there must be enough heat flux to pyrolyze volatiles from the wood and ignite those vapors. Temperatures around proper flues and chimneys in good repair are not expected to reach the 250°C (482°F) minimum ignition temperatures for fresh wood. However, it has been reported that exposure to much lower temperatures (below 105°C or 221°F) causes degradation of wood to charcoal (Schwartz 1996; Cuzzillo and Pagni 1999b). This charcoal, also erroneously called pyrophoric carbon, is sometimes found in wood around heat sources like furnaces and chimneys. Although the term **pyrophoric** is technically misapplied here because it refers to materials that ignite spontaneously in air at moderate temperatures 54°C (130°F) or below, it is widely used in fire investigation in discussing wood that appears to ignite at temperatures far below its usual ignition temperatures.

pyrophoric material ▪ Any substance that spontaneously ignites upon exposure to atmospheric oxygen (NFPA 2017b, pt. 3.3.151).

It is apparent to experienced fire investigators that fires have begun in confined spaces in wooden structural components where exposure to a source of some heat for long periods of time has caused far more charcoal to form than would be expected from the duration of the reported (or observed) fire.

Our review of fire cases that present the strongest argument for the formation of self-heating charcoal shows that the circumstances are often as Bowes predicted: a heat source near wood that is protected by a barrier of metal or tile or in a very confined area like a pipe or flue snugly fitted through a wooden beam for a long period of time, followed by structural collapse or other change that allows a sudden inrush of fresh air, can precipitate a flaming fire (Bowes 1984). Production of this charcoal is clearly a long-term phenomenon, often requiring many months, and more typically years, to reach combustible form and critical mass. Martin and Margot reported that temperatures as low as 105°C (221°F) were capable of degrading wood but that the lower the temperature, the longer the time required (Martin and Margot 1994).

The mechanism for this process is complex and has been the subject of some debate, especially concerning the applicability of a predictive thermodynamic technique called Frank-Kamenetskii after its creator (Drysdale 2011, 12–14). There are several important features of these processes that have to be recognized:

- The conversion of fresh wood to a charred or cooked state can occur at low temperatures [well below 250°C (482°F) and possibly as low as 77°C (170°F)] over a long period of time.
- Fresh wood when heated produces gases and vapors that will support flaming combustion but requires that significant heat be applied to effect this pyrolysis and then ignition, whereas charcoal has many fewer volatile components and supports only very limited flaming combustion but will readily support glowing combustion.
- Fresh whole wood (i.e., sawed lumber) will not self-heat unless very hot, but charcoal will.
- Fresh wood has a much higher permeability to air along its growth axis than across it.
- Smoldering combustion can result from runaway self-heating.
- A mass of fuel undergoing smoldering combustion can transition to open flame if ventilation causes a high enough heat release rate (either external, as from a draft of wind, or enhanced buoyant flow around or through the mass).

When all these factors are taken into consideration within the context of the previously described scenarios, we can see that there is a supportable hypothesis for these fires. First, heat is applied to a mass of wood that has, by its mass or covering, limited exposure to air (Cuzzillo and Pagni 1999a). The wood degrades to a cooked form with the gradual release of the volatile fuel vapors insufficient to support flames (with the characteristic flat, shrunken surfaces with sharp-edged segments). The charred, cooked wood has a high permeability to air enhanced by the multiple cracks into the wood produced by the cooking, a low thermal inertia, and an ability to self-heat, all very different from fresh wood. Continued application of heat to such a material can induce runaway self-heating, especially if air is admitted as the result of shrinkage or separation from sealing materials. This runaway self-heating is the critical step in the process.

At this point, there is ignition (self-sustained smoldering combustion), but it may not be recognized from outside the cavity or concealed space where it is taking place. If enough air is admitted and the enhanced ventilation causes a high enough heat release rate, the smoldering combustion can transition to flaming combustion (with the rapid involvement of adjacent intact wood structural members). The flaming stage is often detected as the "fire."

The conditions have to be nearly perfect—temperatures typically between about 100°C and 200°C (212°F and 392°F) with limited ventilation so that heat is not readily dispersed and oxygen is generally excluded, and there is an adequate mass of wood. There are extensive data on the relationship between fuel mass, environmental temperature, and time to develop runaway self-heating. These conditions are sometimes found in accidental fires investigated, but the investigator must be careful of blaming "pyrophoric carbon" for any fire in the vicinity of a flue or hot water pipe merely because no other cause can be identified. As Bowes pointed out:

- The temperatures of heating surfaces have to be at high temperatures [although nowhere as high (200°C; 400°F) as his calculations indicated];
- The wood has to have substantial mass (plywood floors are more likely to simply char through than to ignite);
- The temperature of the hot surface has to be high enough to maintain heat flux on the wood to overcome losses due to conduction or convection;
- The time has to be long enough (weeks, months, or years, depending on the intensity of the applied heat); and
- There has to be exclusion (or limited circulation) of air in the vicinity until just prior to detection of the fire (Bowes 1984).

One case involving all five of these elements was the result of a water heater that sat on a wooden platform protected by a steel sheet and an asbestos barrier. Some weeks after a new water heater was installed, the platform began to burn and the fire was detected. Figure 4-3 illustrates a similar case.

It should be remembered that smoldering combustion (in charcoal) requires very low oxygen concentrations and that fresh air, with its richer oxygen supply, is required to sustain open flames. Because of the time required for the production of charcoal, low-temperature ignition of wood can generally be eliminated as a cause of fires in very new buildings. Interestingly, Babrauskas, Gray, and Janssens reported that wood in contact with a surface with a temperature in excess of 77°C (170°F), even if periodic, should be considered a potential ignition scenario (Babrauskas, Gray, and Janssens 2007). Both Underwriters Laboratories (UL) and the Building Code of the City of New York (Section C26-1400.6) cite 170°F as the upper safe temperature for wood surfaces.

As with most other accidental ignition sources, careful investigation and evaluation must be carried out before concluding that low-temperature ignition or an overheated chimney is a cause. In addition to there being much more char than expected, if the wood timber is cross sectioned, the char should also gradually change from complete char, to partially pyrolyzed, to undamaged as one moves away from the purported heat source. Unfortunately, the processes involved and their interaction are complex, and currently there are no data showing an exact relationship between temperature of exposure and time to ignition.

4.5.4 TRASH BURNERS AND INCINERATORS

Fires started by trash burners will rarely require much investigation because of the obvious nature of the origin and the fact that the pattern will trace directly to the burner it

Kōwhaiwhai - Māori scroll designs

TAIC commissioned its four kōwhaiwhai, Māori scroll designs, from artist Sandy Rodgers (Ngāti Raukawa, Tūwharetoa, MacDougal). Sandy began from thinking of the Commission as a vehicle or vessel for seeking knowledge to understand transport accident tragedies and how to avoid them. A 'waka whai mārama' (i te ara haumaru) is 'a vessel/vehicle in pursuit of understanding'. Waka is a metaphor for the Commission. Mārama (from 'te ao mārama' – the world of light) is for the separation of Rangitāne (Sky Father) and Papatūānuku (Earth Mother) by their son Tāne Māhuta (god of man, forests and everything dwelling within), which brought light and thus awareness to the world. 'Te ara' is 'the path' and 'haumaru' is 'safe' or 'risk free'.

Corporate: Te Ara Haumaru - the safe and risk free path

The eye motif looks to the future, watching the path for obstructions. The encased double koru is the mother and child, symbolising protection, safety and guidance. The triple koru represents the three kete of knowledge that Tāne Māhuta collected from the highest of the heavens to pass their wisdom to humanity. The continual wave is the perpetual line of influence. The succession of humps represents the individual inquiries.

Sandy acknowledges Tāne Māhuta in the creation of this Kōwhaiwhai.

Aviation: Ngā hau e whā - the four winds

To Sandy, 'Ngā hau e whā' (the four winds), commonly used in Te Reo Māori to refer to people coming together from across Aotearoa, was also redolent of the aviation environment. The design represents the sky, cloud, and wind. There is a manu (bird) form representing the aircraft that move through Aotearoa's 'long white cloud'. The letter 'A' is present, standing for a 'Aviation'.

Sandy acknowledges Ranginui (Sky father) and Tāwhirimātea (God of wind) in the creation of this Kōwhaiwhai.

Maritime: Ara wai - waterways

The sections of waves flowing across the design represent the many different 'ara wai' (waterways) that ships sail across. The 'V' shape is a ship's prow and its wake. The letter 'M' is present, standing for 'Maritime.

Sandy acknowledges Tangaroa (God of the sea) in the creation of this Kōwhaiwhai.

Rail: rerewhenua - flowing across the land

The design represents the fluid movement of trains across Aotearoa. 'Rere' is to flow or fly. 'Whenua' is the land. The koru forms represent the earth, land and flora that trains pass over and through. The letter 'R' is present, standing for 'Rail'.

Sandy acknowledges Papatūānuku (Earth Mother) and Tāne Mahuta (God of man and forests and everything that dwells within) in the creation of this Kōwhaiwhai.

Transport Accident Investigation Commission

Recent Rail Occurrence reports published by the Transport Accident Investigation Commission (most recent at top of list)

RO-2022-103	KiwiRail W6 shunt and Metro (Go Bus) Route 60 bus, near miss at Selwyn Street level crossing, Christchurch, 8 August 2022
RO-2021-105	Unintended movement resulting in locomotive and wagon entering Picton Harbour, Picton, 1 September 2021
RO-2021-106	Derailment of Train 220, South of Hunterville, 13 December 2021
RO-2021-103	Te Huia passenger service, train parting, North Island main trunk line, Paerata, 19 July 2021
RO-2021-102	Freight Train 391, collision with light truck, Saunders Road, Marton, 13 May 2021
RO-2021-101	Serious injury during shunting operations on board the Aratere, Interislander ferry terminal, Wellington, 9 April 2021
RO-2020-101	Level crossing collision, Mulcocks Road, Flaxton, 10 February 2020
RO-2020-104	Safe working irregularity, East Coast Main Trunk Line, Hamilton – Eureka, 21 September 2020
RO-2020-103	Collision between bus and locomotive, Clevely Line level crossing, Bunnythorpe, 16 September 2020
RO-2019-108	Level crossing collision, Piako Road, Morrinsville, 7 December 2019
RO-2020-102	Express freight Train 932, strikes hi-rail vehicle, Limeworks Road, 24 April 2020
RO-2019-105	Express freight Train 268, derailment, Wellington, 2 July 2019
RO-2019-107	Passenger service SPAD and near collision, Wellington, 6 November 2019
RO-2019-106	Passenger train 804, Irregular disembarkation of passengers, Rolleston, Canterbury, 3 September 2019
RO-2019-104	Unsafe entry into worksite, Taimate, 5 June 2019

Price $17.00

ISSN 2815-889X (Print)
ISSN 2815-8903 (Online)