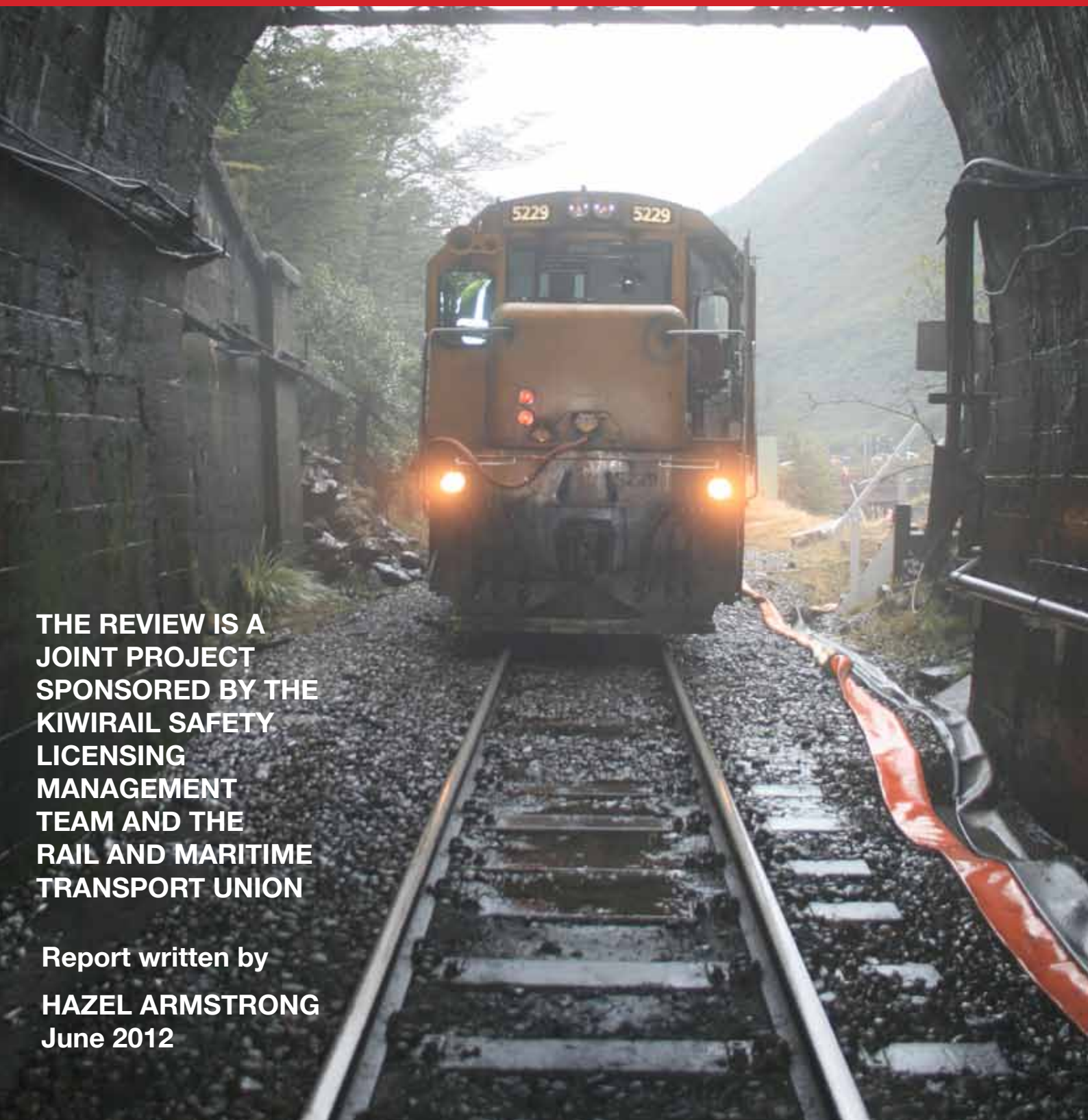
REVIEW OF SAFE WORKING PROCEDURES FOR TRAIN OPERATIONS IN THE

OTIRA TUNNEL



THE REVIEW IS A JOINT PROJECT SPONSORED BY THE KIWIRAIL SAFETY LICENSING MANAGEMENT TEAM AND THE RAIL AND MARITIME TRANSPORT UNION

Report written by

HAZEL ARMSTRONG
June 2012

The TranzAlpine

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COVER PHOTOGRAPH:
Looking out the eastern portal of the Otira Tunnel, stationary engine on work train.

PHOTOGRAPH: DBW

REVIEW OF SAFE WORKING PROCEDURES FOR TRAIN OPERATIONS IN THE OTIRA TUNNEL

Final report to the Steering Committee: 30 June 2012

Written by Hazel Armstrong, chair of the Working Group

The review is a joint project sponsored by the KiwiRail Safety Licensing Management Team and the Rail and Maritime Transport Union.

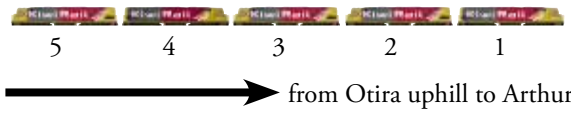
BACKGROUND: The workers' experience

THE Otira Rail Tunnel, completed in 1923, is 8.5 km long and is situated on the Midland Line linking the West Coast of the South Island with the Canterbury region on the East Coast. The single track, straight rail tunnel has a 1 in 33 gradient rising 244 metres from the Otira portal to the Arthur's Pass portal. It is unlit, with no formed walkways on either side of the track. There is a drain on the southern side of the tunnel. A northerly air flow predominates, providing an air flow up the tunnel 75% of the time.[1]

The Otira Rail Tunnel carries coal from the West to East Coast (the uphill journey). There are up to 7-8 return trips per day. Each train consists of 30, 72 tonne (gross) uncovered coal wagons. There are also two return freight trains and a passenger train, the TranzAlpine.

On the uphill journey five diesel powered DX locomotives are required to haul the 30 coal wagon trains and the two freight trains. Three of the five DX locomotives (the bankers) are based at Otira to assist trains on their uphill journey. Two locomotives are usually sufficient for the TranzAlpine, but the bankers are used if the TranzAlpine is particularly long. On the uphill journey the banker locomotive engineers (LEs) are travelling in the lead locomotive (number 1) which is clear of fumes.

LOCOMOTIVE CONFIGURATION (front is 1)



At Arthur's Pass the five diesel locomotives are split between locomotives three and four. Four becomes the lead train locomotive for the trip to the East to Christchurch from Arthur's Pass; three becomes the lead banker locomotive for the downhill run back to Otira as illustrated:

Locomotive number three has become fumey with combustion gases and diesel particulates by the time it reaches Arthur's Pass. The banker LE enters the cab at Arthur's Pass and ventilates it.

The banker locomotives make 4-5 downhill runs from Arthur's Pass to Otira in each shift. The banker LE generally returns alone on the downhill journey, and throughout his shift makes up to eight trips through the tunnel.

The train LE continues his east bound journey in locomotive number four which on entry is fumey, but ventilation brings the fumes down to an acceptable level.

The train LEs would experience two trips through the tunnel per shift. The train LE generally travels alone on the downhill trip.

In total there are up to 25-27 movements through the tunnel in 24 hours.

The uphill journey from Otira to Arthur's Pass takes 25 minutes of which approximately 15 minutes is in the tunnel. The down hill journey takes 20 minutes. Following each train movement the tunnel is purged of exhaust gases, 20 minutes for uphill movements and 15 minutes for downhill movements.

1 Otira Tunnel Department Of Labour 1996

A typical example of the plant used by the track workers in the tunnel.

Each train has an LE who is based in Christchurch or Greymouth. There are 50 LEs based in Christchurch and 20 based in Greymouth. There are, in addition, four LEs who have specialist training and are mostly based at Otira.

Maintenance

Track and structures workers enter the tunnel to undertake a range of jobs: inspecting, welding rail, cleaning and replacing ballast, re-railing, putting up sheeting, replacing sleepers, etc. Generally the track workers work in gangs, however the welder and track inspector work alone. Signals and communications staff enter the tunnel to maintain the assets such as phones, cables, etc that are installed in the tunnel. Most maintenance is carried out during six 36 hour coal route shutdowns throughout the year. It is estimated that 12-15 track workers regularly work in the Otira Tunnel over any given year. Most are KiwiRail employees; however some contractors also work in the tunnel.

Track workers use standard plant within the tunnel which is not tunnel specific. Some of the plant used in the tunnel have no filters, catalytic converters, or scrubbers to filter the fumes. Some are petrol powered, including rail saws, prolines, etc, and some are diesel, such as trucks, diggers and tampers[2]. Track staff have been advised not to refuel in the tunnel. Sometimes track workers work alongside a work train, which is diesel powered. Examples include laying ballast and tamping. The ventilation fans are used whenever work is done in the tunnel.

Track workers who work in the Otira Tunnel have reported: headaches, skin rash, stinging eyes, fatigue, dry and irritated throats, dry coughs and nausea. The employees link these symptoms to fumes.

The track staff work from the Arthur's Pass end of the tunnel. There are no showers at the Arthur's Pass end. Staff should be encouraged to use the showers at Otira which are available at the station and the Infrastructure and Engineering (I&E) amenity block. This would reduce exposure to skin from the residue of the fumes. It is undesirable to take home clothing which is laden with residue.

As an example of possible causality of some of these symptoms: oxides of nitrogen are known to be present in the fumes. The primary route of exposure to oxides of nitrogen is by inhalation, but exposure by other routes can cause health effects. Oxides of nitrogen are irritating to the eyes, skin, mucous membranes, and respiratory tract. On contact with moisture, nitrogen dioxide forms a mixture of nitric and nitrous acids.[3] Acute diesel particulate exposure may cause irritation to the eyes, nose, throat and lungs and some neurological effects such as lightheadedness.

The western portal at Otira

2 KiwiRail Working in tunnels and gas safety instructions – best practice guidelines author K Morgan 29 August 2011.

3 Per Carol McSweeney, Air Matters, occupational hygienist.

Mike Morgan showing where he resets the governor, usually in the dark.

Management of hazards

The Department of Labour has issued Workplace Exposure Standards and Biological Exposure Indices[4]. In its preface it says:

> *"Exposure to hazardous or toxic substances continues to be one of the most significant causes of occupational ill health and injury."*

It sets out the responsibilities of the employer to:

- Systematically identify hazards;
- Systematically manage those hazards by eliminating them, isolating them or minimizing them, in that order of preference;
- Provide suitable protective clothing and equipment to staff;
- Provide safety information to staff;
- Provide training and supervision so that work is done safely;
- **Monitor the environment and health of employees to ensure their work is not having a detrimental effect on them[5];**
- Provide opportunities for employees to participate in the workplace's health and safety systems[6];
- Record and investigate workplace accidents; and
- Report serious harm accidents suffered by employees to the Department of Labour.

Summary of hazards

The Otira Tunnel is an environment with its own unique hazards; controls have been put in place, but any control has the potential to fail, thereby exposing workers (or passengers) to hazards in an extremely hostile environment.

The working group identified this list of hazards:

- Combustion gases, fumes, diesel particulates, coal dust and respirable silica.
- Hot and cold temperatures.
- Noise.
- Potential for failure of communication while working in the tunnel.
- Slip and trip hazards from rough and untidy underfoot conditions in the tunnel.
- Fire in the locomotives and vehicles (particularly the DX class locomotives).
- Broken rail which can cause de-railments.
- Working alone.

It also identified serious issues with:

- Reporting of hazards and incidents in the tunnel under both the Health and Safety in Employment Act and under NRSS5.

It identified the need to:

- review procedures (as required by the Terms of Reference);
- undertake environmental monitoring: noise, gas, fumes, dust, particulates, heat (pursuant to the Health and Safety in Employment Act [HSE]);
- review the medical standards under NRSS3 and requirements for health monitoring under the HSE Act;
- review the current personal protective equipment issued to staff (e.g. masks, monitors, clothing) to ensure they are fit for purpose; and
- review evacuation and emergency procedures, training and re-enactments (as required by the Terms of Reference).

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4 Workplace Exposure Standards issued by the Department of Labour effective July 2011 6th Edition

5 Emphasis added by author as KiwiRail has not undertaken monitoring of environmental hazards and health of employees, as required by the 1996 DOL recommendations to TranzRail. The highlight is to reinforce the legal requirement to monitor hazards and health.

6 Involving employees in the development of safety procedures is highlighted by this requirement under the HSE Act. KiwiRail complies with the HSE Act by including employees in the development of safe working procedures such as L6.1.

Some of the working group with two visitors on a onsite visit to Otira Tunnel Libby Carr, Brian Armstrong, Mike Williams, Mike Morgan, Chris Stoop, Jed O'Donoghue, Sean Moran and Karen Fletcher.

The unique characteristics of the tunnel: hazards identified

Sand (respirable silica):

Due to moisture and coal dust on the rail head, beach sand is dispensed by the LE, or automatically by the traction management system in the locomotive, in order to get sufficient traction to get through the tunnel.[7] Up to 80 tonnes of sand are deposited into the tunnel each year. The respirable silica component of the sand has been identified as a respiratory hazard.

Sampling showed that during tamping respirable silica was present. However, due to the short duration of the sampling and the unusual situation on the shift when sampling took place[8] these results possibly under-represent the levels over a normal shift in the tunnel during tamping. In normal tamping operations sand is stirred up by the regulator and tamping equipment.

Sampling of the banker LE during normal operations has shown that respirable silica is well below the workplace exposure standard.

Combustion gases and diesel particulates (fumes):

The fume hazards that are present in the tunnel are: carbon monoxide, carbon dioxide, oxides of nitrogen (combustion gasses), diesel particulates, respirable dust, inhalable dust, volatile organic compounds, including hydro-carbons and complex organics[9].

The tunnel can be defined as a 'confined space'[10] or a restricted space depending on where the employee is working within it. The exposures are likely to be greater in the interior of the tunnel than at either its exit or entry. When the fans or doors have failed, the fumes, gas, dust and diesel particulates cannot be freely dispersed into the atmosphere.

The Department Of Labour Workplace Exposure Standards (WES) publication says:

> *"Defining an exposure level that will achieve freedom from adverse health effects is the major consideration for assigning these WES. However, compliance with the designated WES level does not guarantee that all workers are protected from discomfort or ill health. The range of individual susceptibility to hazardous and toxic substances is wide, and it is possible that some workers will experience discomfort or develop occupational illness from exposure to substances at levels below the WES."*[11]

As of 12 June 2012, the International Agency for Research on Cancer (IARC) classified diesel engine exhaust (diesel particulates) as carcinogenic to humans (group 1), based on sufficient evidence that exposure is associated with an increased risk of lung cancer. Chronic exposure to diesel particulate is also asociated with bladder cancer.[12]

Dr Chris Walls stated in his letter to the Working Party dated 3rd July as follows:

Workplace Exposures

There are a number of hazardous exposures during the Otira Tunnel transit. Dr Walls has concentrated on the exposures likely to cause significant acute ill health or that might cause health issues after chronic (long term) exposure.

7 Report on the stall and subsequent skid back of no 804 (TranzAlpine) in Otira Tunnel 28 March 2004

8 Air Matters Report: The tamping operation had to be aborted due to other risks being identified. Fishplates in the ballast were flicking against the tunnel walls.

9 Air Matters, Sampling strategy and proposal for occupational hygiene testing in the Otira Tunnel: 30.3.12

10 Kiwi Rail Working in tunnels and gas safety instructions authored by Keith Permain and dated 29 August 2011 document number KRNI SA 0006.

11 Page 10 Workplace Exposure Standards Department Of Labour

12 IARC (WHO) press release no 213 Diesel Engine Exhaust carcinogenic.

These exposures are:

Exposure	Acute health effects	Long term health effects	Carcinogenicity
Carbon dioxide	In sufficient concentration causes drowsiness and stupor, these effects would lag well behind acute effects of other contaminants	Not clearly defined but excess levels are likely to have a general deleterious effect the risks of ischaemic heart disease and the like	Group 4
Carbon monoxide	In sufficient concentration causes unconsciousness and death. Sub lethal doses cause brain injury	Not clearly defined. Non lethal excess exposure causes a brain injury. The medical outcome of small frequent excesses of moderate intensity is not defined	Not classified
Diesel particulate	Acute irritant effects on mucous membranes (eyes, nose, lung)	The medical outcome of small frequent excesses of moderate intensity is not defined.	A Group. One carcinogen for bladder cancer and lung cancer
Oxides of nitrogen	Acute irritant effects on mucous membranes (eyes, nose, lung)	The medical outcome of small frequent excesses of moderate intensity is not defined	Not classified
Oxides of sulphur	Acute irritant effects on mucous membranes (eyes, nose, lung)	The medical outcome of small frequent excesses of moderate intensity is not defined	Sulphur dioxide is classified as Group Three – Group Three is not classifiable as to its carcinogenicity to humans.

Of the various exposures the most concerning in the short term is that to carbon monoxide and in the long term to diesel particulate. In the short term exposures to carbon monoxide of sufficient concentration can cause collapse, in extreme exposures death and in a concentration sufficient to cause collapse a long lasting brain injury.

High exposures to the oxides of nitrogen and sulphur cause irritation to the mucous membranes (weepy reddened eyes, coughing etc) and if intense enough a respiratory condition called Reactive Airways Dysfunction Syndrome (RADS), a type of occupational asthma.

The effects of recurrent, relative short peak exposures to carbon monoxide and the oxides of Nitrogen and Sulphur are not understood. However one can only assume some deleterious effect on respiration and small but cumulative insults leading perhaps to additional cardiac and respiratory problems.

In response to the 1995 incident KiwiRail took some steps (but not all those recommended by

Incident 1

On 23rd February 1995 an LE suffered an acute effect from fumes. He had to check for de-railed wagons while the train was stopped in the tunnel. The engines of the two diesel locomotives were running during this process. The Department of Labour (DOL) investigated the incident and undertook monitoring of carbon monoxide. The DOL identified health effects from the exhaust fumes including eye irritation, sore nose and throat, coughing, wheezing and a tight chest, fatigue, stomach pains and diarrhoea. The DOL also mentioned the possibility of build up, over a shift, of carbon monoxide levels in the blood. The DOL noted that the train was stationary for approximately 30 minutes. The LE walked for 280 metres on two occasions. The heat in the tunnel was reported as "intense". The respirators were ineffective with the filters becoming saturated rapidly. The LE attended A & E at Christchurch Hospital. The DOL identified the following essential factors: the enclosed nature of the tunnel; the tunnel ventilation; the fact that the engines were brought up to full power; the need for LEs to leave the cab and work in the tunnel; the fact that the engines were running at low idle while the train was checked; and the heat build-up from the exhaust fumes[13].

The DOL made six recommendations. There is one which needs to be emphasised: that a written log of break downs in the tunnel is maintained. This log should include the names of the LEs working in the tunnel, the length of time spent working in the tunnel and other relevant details. Whilst IRIS reports some of this information, it does not record the length of time spent working in the tunnel, nor the levels of exposures.

13 Fume exposure incident in Otira Tunnel 23 February 1995 DOL Rod Dickson Health and Safety Inspector (hygiene).

Incident 2

On 8th September 2011, train 846 departed from Otira. Train control advised the LE that the doors had closed but the fans were not working. The train stopped in the tunnel three times. On the occasion of the last stall, 50 metres from the eastern portal, the fumes resulted in almost zero visibility. Setting back was considered but as they were 6km from the western portal, it was considered to be hazardous. Train control attempted to reset the fans but this caused the doors to open and aggravate the situation. The LE experienced roll over of the fumes when the door was opened.

The fans and door were installed in 1997.

the DOL). In 1997 two fans and a door were installed at the western portal (the Otira end) to draw down the fumes emanating from the diesel locomotives. They serve to cool the locomotives and to clear fumes from the tunnel after the train has exited[14]. The hazards are being effectively controlled by the ventilation system, which is fans and a door, and the purging cycle of the tunnel. However, additional steps have been identified to further control the hazard. These steps are identified in the recommendations to this report.

There have been issues related to fan and door reliability.[15] The working group notes the data it collated and considers that fan and door failures still occur frequently. When this occurs the main defence against the fumes has failed, and emergency procedures must be followed.

If the fans or door fails, the rear locomotives are likely to overheat and shut down. A shut down occurs when the locomotive reaches a critical temperature. Hot exhaust gases from the leading locomotives are drawn into the intakes of the rear locomotives causing overheating.[16] The train may stop in the tunnel for a number of other reasons such as trains partings, burst hose, etc.[17]

The working party believes that there is still an on-going problem with defective locomotives being dispatched for use on coal trains. This was identified in 2005[18]. Under-reporting of locomotives with recurring reliability problems compounds the problem. There are certain locomotives that can be consistently unreliable, and it is up to LEs to persist in reporting faults in the 54D repair book. When there is consistent unreliability, and if a fault results in a train stalling, then an HM2[19] should be completed as well. IRIS reporting would follow as a matter of course. Locom-otives which are unreliable should not be used on the Midland Line until they have proven reliability.

Each stall, when there has been a fan or door failure (ie a ventilation failure) exposes the driver to fumes. The banker and locomotive LEs experience "roll over", a description of the fumes rolling over the cab and rolling through the tunnel. If this occurs in the tunnel, the confined space experience is acute as the cab and driver is immersed in a thick fog of fumes.

Generally, in the event of a ventilation failure, the banker LE sets the train back clear of the western portal. During set back the train is travelling back through the fumes. However, in some situations depending on where the train stalls, current procedures allow for the banker LE to exit the cab and attempt to rectify the fault. This process takes about 20 minutes.

Testing during ventilation failures on 31 May 2012 showed exposures for all combustion gases and diesel particulates above the WES and the STEL when the driver was outside the cab. The testing shows that when outside the cab an exposure of less than15 minutes would be sufficient to bring the biological exposure indices to 3.5%.

In the cab the combustion gases and diesel particulates continued to show levels above the STEL, in particular oxides of nitrogen and diesel particulates. Carbon monoxide remained above the 60 minute STEL. Thus, during set back, the levels of combustion products continue to be high.

The results of the testing show the mask is appropriate for the levels of carbon monoxide and oxides of nitrogen for a short duration. The length of time that a driver may be exposed to fumes, the humidity and the work rate will reduce the working life of the filter. The level of diesel partic-

14 Ontrack Rail Operating Procedures section L6.1 – 6.00 Otira Tunnel door operations: 6.2.1 automatic operation: once an uphill train is completely inside the tunnel the door will close and the first fan line (locomotive cooling) will start after a time delay. When the train is clear of the axle counter heads at Arthurs Pass the second fan line will start and will run for 20 minutes before the door re-opens and turns off both fans. When a down train is clear of the UTD indicator the door will close and both fans will start. After 15 minutes the fans will turn off and the door will open.

15 See page 15 for list of incidents.

16 Otira Tunnel mock door tests 8-9 November 1995 Rod Dickson DOL

17 Operating procedures Otira Tunnel- hand delivered by Brent Gillett 29.2.12. The procedures identify procedures for fire on the 3rd, 4th 5th locomotive; burst hose; broken buffer.

18 30 wagon trains: Notes of key issues 6th April 2005.

19 HM2 is a hazard report form

ulates will affect the filter and make breathing more difficult (ie increases breathing resistance).

A banker LE did experience breakthrough after 10 minutes work when outside the cab in the tunnel. A C60 would provide longer protection against CO. The current mask and filter may not adequately protect the banker LE in the outside environment during a ventilation failure. Therefore we recommend that if the train is able to be set back, this is the preferred option. In other words, alighting from the cab should only occur in cut and run scenarios.

The testing shows that oxygen (O_2) drops below the WES of 19.5%, both outside and inside the cab during set back. As the O_2 levels are 18.5% outside the cab and just below 19.5% during set back, we recommend this warrants further testing before a decision is made on augmented air supply.

The risks associated with the impact of nitrogen oxide (NO) and carbon dioxide (CO) on exposed skin was identified in 2005 but this does not appear to have been followed up.[20]

The track staff work from the Arthur's Pass end of the tunnel, where there are no showers. However, track staff should be encouraged to use the showers at Otira which are available at the station and the Infrastructure and Engineering (I & E) amenity block.

Elimination of the hazards - fumes and gas and diesel particulates

Prior to 1997, locomotives were a combination of electric and diesel powered. In 1997, they were replaced solely with diesel powered locomotives. The option of re-electrification is occasionally assessed.[21] Electrification would eliminate the fume, gas and diesel particulate problem.

Recommendations:

★ *That the benefits of electrification are assessed from a health and safety perspective.*

Isolation of the hazards - fumes and particulates

Options for isolation were discussed which may include remote control.

Sealing the locomotives was discussed by the working group, however, it is acknowledged that this may be difficult to achieve with the current fleet. The steering group said that sealing the cabs could be considered again with a fleet upgrade.

★ *That when KiwiRail upgrades the fleet, that consideration is given to ensuring that the locomotive cabs are sealed and air conditioned.*

★ *That the air quality is checked to ensure that the cab air is clean prior to re-entry at Arthur's Pass.*

Minimisation

The HSE Act requires an employer to take all practicable steps to control a hazard that is regarded as significant. If the hazard cannot practically be eliminated or isolated, then minimisation must occur. KiwiRail has been minimising the significant hazards (fumes and particulates) by installing fans and a door, but this control (when it is operating effectively) only serves to minimise the hazard by reducing the levels of fumes, gas and particulates in the tunnel, it does not eliminate the hazard or isolate the worker from the hazard.

Toll Rail undertook a risk assessment in April 2005 of the operation of 30 wagon coal trains (up from 24 wagons). The risk assessment identified fumes as a hazard whilst operating inside the tunnel. The solution was to provide gas monitors in tunnel refuges to provide additional purging status information. Due to operational difficulties with the monitors, this intervention was not implemented.

The risk of failure of the Otira Tunnel fan system was also identified in 2005. Performance of the fans was to be monitored. This recommendation was not appropriately implemented, monitoring of fan failure has not been consistently observed.[22]

Where a significant hazard is minimised, then under section 10 (2) of the HSE Act, the employer shall, along with providing suitable clothing and equipment, monitor the employees exposure to the hazard; and take all practicable steps to obtain consent to monitor their health in relation to the hazard.

KiwiRail has not complied with the monitoring requirements under the HSE Act, nor under its

20 30 wagon trains: Midland /Stillwater- Westport: notes of key issues raised during LE briefings Greymouth/Otira/Christchurch 6th April 2005.

21 Otira Tunnel briefing paper author Walter Rushbrook. 2008

22 Toll Rail Risk Assessment issue 6 April 2005.

own risk assessment.

Fumes in tunnel during stall test.

There have been few investigations undertaken of incidents following a LE, banker LE or maintenance staff being exposed to gases or fumes.

Medical monitoring

The NRSS3 Health Assessment of Rail Safety Workers (effective date 18/10/10) covers certification for rail workers who work on the network.

> *"Their purpose is to predict the occurrence of sudden incapacity or medical illnesses that may affect the safe operation of the network. They do not and were not designed to address occupational safety and health issues or personal health issues that might be affected by rail work. These would be dealt with by other mechanisms and would usually be developed on a case by case basis depending on the question and issue."*[23]

The working party has been advised that some track staff have been identified as category 1 high level safety critical workers, as of 2012. The health requirements for category 1 are that there is no risk of sudden incapacity; and that there should be an overall assessment of physical and psychological health.

As stated earlier, NRSS3 does not require KiwiRail to institute a regular medical testing regime for either the short or long term effects from the fumes and diesel particulates, which are regarded as occupational health and safety questions. However, NRSS3 allows the authorised health professional to recommend more frequent assessments depending on the needs of the individual worker, and triggered health assessments can be conducted in response to incidents. These assessments are likely to address a particular health issue and include scheduled review assessments.[24] Dr Walls the KiwiRail Chief Medical Officer has said: *"As with all workplace exposures any subsequent monitoring programme would be a mixture of environmental, personal and biological monitoring that gives the best predictor of safety/health maintenance or as a warning that safe levels are being exceeded."*

The remoteness of the region also makes it difficult for Otira based staff to visit a doctor/nurse at the end of their shift for any biological monitoring or health check after exposure to fumes. For this reason environmental monitoring is preferred.

There are good legal reasons to establish a specific medical monitoring regime for Otira Tunnel workers. As Dr Walls points out, compliance with NRSS3 is not compliance with the HSE Act. However, KiwiRail must comply with the HSE Act. A medical monitoring regime could be done by way of a special and triggered assessment regime under NRSS3, or as a stand-alone requirement to enable KiwiRail to show compliance with the HSE Act.

Dr Walls monitoring/screening suggestions are:

Exposure	Monitoring/screening
Carbon dioxide	Not applicable.
Carbon monoxide	Carboxyhaemaglobin as soon as is possible post significant exposure – capable of causing collapse.
Diesel particulate	Lung cancer – no screening practical at this time, encourage health measures. Bladder cancer – annual mid stream urine examined for red blood cells.
Oxides of nitrogen	Regular medical monitoring not practicable. Spirometry following large exposure capable of causing more than trivial respiratory symptoms.
Oxides of sulphur	Regular medical monitoring not practicable. Spirometry following large exposure capable of causing more than trivial respiratory symptoms.

Triggered evaluation should occur with excess exposure to oxides of nitrogen and would focus on respiratory function (questionnaire and lung function) and reported to the RMO. The action point is when exposure reaches 2/3 of the STEL.[25]

Environmental monitoring

There is no evidence that there has been any environmental monitoring undertaken since 1996 (which was undertaken on behalf of the DOL), other than monitoring of aldehyde exposure which was undertaken in 2009[26]. The aldehyde exposure was monitored because track workers reported

23 NRSS3 (National Rail System Standard 3) Health Assessment of Rail Safety workers, 18-11.10.

24 Dr Chris Walls email to Hazel Armstrong 29.3.12 and email 2.4.12.

25 Dr Chris Walls and reporting to Working Group, 21-6-12

26 Aldehyde exposure assessment during maintenance operations in the Otira Tunnel for Ontrack 18th August 2009.

experiencing nausea and headaches while working in the tunnel. The track workers were clearing coal dust and sand build ups on the side of the track using two wagon mounted diesel excavators. They were also laying fibre optic cable using a wagon mounted excavator. The monitoring was for formaldehyde, acetaldehyde and acrolein exposures and showed no significant exposure for these substances.

After the fans were installed, there were incidents of fan failure with drivers detecting fumes as a consequence. Trials were undertaken using fixed monitors to measure gas and fume levels but this monitoring failed[27] and no further attempts were made until this working group arranged for Air Matters to monitor. For the period 1996 to 2012 neither KiwiRail nor employees have had the benefit of appropriate and comprehensive environmental monitoring. As far as the working group can ascertain there has been no monitoring for diesel particulates at all. Train control has never had reliable visibility of gas levels in the tunnel.

Carol McSweeney, occupational hygienist from Air Matters, suggested that there is technology available to put in place fixed monitors in tunnels which would give real time readings of air quality. When this occurs then both the employer and employee will have a better idea whether the employees are being exposed to significant hazards which have the potential to cause serious harm. Train control needs to be able to monitor gas levels.

Personal monitoring:

The LEs and track staff carry gas monitors with audible and visual alarm capable of measuring exposure to nitrogen dioxide (NO_2), percentage of oxygen, carbon monoxide (CO) to levels well beyond the work exposure standards[28]. However these monitors only trigger an alarm, and are not considered suitable for gas exposure monitoring[29].

The monitor alerts the employees when the gas level reaches the workplace exposure level; the short term exposure level. The monitors do not monitor nitrogen oxide, diesel particulates, carbon dioxide, respirable dust or volatile organic compounds. The monitors are an emergency management tool; they do not control the hazard. When the alarm goes off, it signals to the employee that they should put on their mask and/or evacuate.

The gas monitors do not record the length of time the employees is exposed to the hazard, or who the person is. They cannot measure the employees exposure to the hazard over a period of time; e.g. over an eight hour shift, or a short term exposure over a 15 minute period.

Thus there is no analysis of the types and frequency or duration of exposures over any given day, let alone over longer periods of time.[30] The working party had reports from LE staff that they considered the monitors to be out of date and of poor quality, and that they often fail. The track workers have a later model of gas monitor.

It became apparent to the working party that Infrastructure & Engineering (I & E) does have personal monitors that can log the data of real time exposures, but this had not been activated.[31] However, the equipment used by LEs and banker drivers does not have this functionality[32].

The working group arranged for monitoring to occur in both normal running situations and when there is a train stalling. A description of the monitoring undertaken is set out in the report from Air Matters.

Personal Protective Equipment (PPE):

The staff carry a full face gas mask with a P3 canister, capable of protection for a maximum of 20 minutes exposure to CO. It filters diesel particulates and removes oxides of nitrogen.[33].

During the 2012 KiwiRail Ordinary Safety Assessment undertaken by the NZ Transport Authority in June 2012, the interim report noted[34]: *"During the review of the Otira Tunnel, spare gas masks were checked and discrepancies were found with testing dates. Some masks were given two years before re-test, others just one year. Even taking the most optimistic position, Mask #56 was last tested 29/10/09."*

The action required was that KiwiRail should ensure that the management of equipment which is expected to be available in locomotive cabs, and as spares for the Otira Tunnel, receives further attention to ensure all required equipment is available and within prescribed test dates, and that equipment checks are effective, and accurately recorded.

Recommendations

★ *That KiwiRail purchases suitable equipment to enable it to download data, store the data and assess exposures for employees, both for regular shift work and following incidents.*

27 Risk assessment of 45 wagon coal trains. Portal Monitors are not designed to operate at the pressures generated within the tunnel.

28 The monitors are real time, and do not keep a record of exposure levels. The first alarm is activated when the time weighted average has been reached. The second alarm is activated when the short term exposure limit (STEL) is reached. When the gas levels rise to ceiling limits, gas masks are to be put on and the tunnel evacuated. Working in tunnels and gas safety instructions author Keith Permain 29 August 2011.

29 Drager Miniwarn technical and instructions for use handbooks

30 The DOL recommended to NZ Rail Ltd in 1996 that the exposure of the LEs to carbon monoxide be monitored to establish exposures over a variety of operating and meteorological conditions; and that a written log of break downs in the tunnel be maintained. This log should include the names of the engineers working in the tunnel, the length of time spend working in the tunnel and other relevant details.

31 Neil Campbell verified to the working group that I & E monitors can log the data of exposures to NO2 and CO.

32 Some LE monitors do have data logging capability, but not all, and KR has lost the ability to get the data off these monitors anyway. (Communication to the working group from Brent Gillett)

33 Manufacturers specifications: limitations in intended use Drager Respiratory filters instructions for use.

34 2012 KiwiRail Ordinary Safety Assessment – Interim Report 6/06/2012Page 16 of 23

- ★ *That employees monitor oxygen levels, CO, and oxides of nitrogen on every entry to the tunnel.*
- ★ *That personal and environmental monitoring along with centralised reporting occurs for track workers under different work scenarios in the Otira Tunnel e.g. use of plant, use of regulator, tamping, re-railing, laying ballast etc and for LEs and on board staff of the TranzAlpine.*
- ★ *Once the levels are established for different work scenarios, and appropriate controls implemented, then a regime of monitoring would be put in place.*
- ★ *That affected employees, the RMTU, the Otira Focus Group and senior management will be provided with the results of the environmental and personal monitoring.*
- ★ *That KiwiRail keeps records of exposures to employees and the results of health monitoring for each individual employee.*
- ★ *That PPE is fit for purpose, is available and is checked for effectiveness, to protect against the hazards encountered in the tunnel.[36] More data is needed to assess appropriate PPE for oxygen. Three further sets of data arising from a stall test are considered a minimum. A CO60 filter is more appropriate in the interim until testing is complete.*
- ★ *That procedures comply with Department of Labour Workplace Exposure Standards (WES) guidance, in particular ensuring breaks occur between exposures which reach the Short Term Exposure Level (STEL).*
- ★ *That training in the use of PPE is practically focussed.*
- ★ *That the reliability of fans and doors is both an operational and health and safety issue and failures should be reported in compliance with both NRSS5[37] and the HSE Act.*
- ★ *That gas awareness training by Mines Rescue be undertaken by banker LEs, train managers, and persons in charge of work groups in the tunnel.*
- ★ *That contractors carry evidence/proof that they are certified to meet KiwiRail's training requirements and also which certifies their knowledge of KiwiRail's procedures.*
- ★ *That a code specific for ventilation system failure be created for entering into IRIS; and a code be created for Otira Tunnel.*
- ★ *That KiwiRail install indicators outside the tunnel at both ends which indicates whether the fans and doors are functional.*
- ★ *That workers and contractors are encouraged to shower after a shift.*
- ★ *That it is mandatory to shower after an incident in the tunnel and change their clothes prior to returning home in order to wash off fume, dusts and diesel particulates.*
- ★ *That showers are installed at Arthur's Pass.*
- ★ *That KiwiRail review its purchasing policies and consider retrofitting plant to reduce emissions.*
- ★ *Where the results of monitoring show that the hazard (or hazards) is not being controlled, then all practicable steps must be taken to either eliminate, isolate or minimise the hazard.*
- ★ *KiwiRail has an emergency response plan which needs to be reviewed and updated. That a triggered action response (TAR) be established. All of which needs to be regularly reviewed; and*
- ★ *That the tamper cab is up-wind of the engine (ie cabs are on the east end of machinery).*

Heat:

An overheated locomotive is extremely hot to touch.[38] LEs have said they get burns on their arms when they have to reset the locomotives after a train stalling. Without a modulating governor, the banker LE must reach in behind the governor (which is awkward) to reset it. His arm comes into contact with the hot engine, hence the risk of burns. In the long term, this hazard could be eliminated by fitting DX locomotives with modulating governors.

The workers also say the heat in the tunnel is overwhelming when the fans are not working, leading to sweating. The temperature when outside the cab during the stall test reached a maximum of 45 Celcius which resulted in an elevated core temperature of the driver.

35 Banker LEs have more exposure to hazards in the tunnel, LEs can also experience elevated levels.

36 One banker driver has advised that he experienced penetration of the gas filter by the fumes. The review of PPE must include a review of the filter capacity and type of filter. Drager has advised that the filter lasts up to 20 minutes in the presence of carbon monoxide, therefore the procedure needs to change to reflect this limitation on use. A C060 filter may be more appropriate.

37 NRSS5 (National Rail System Standard 5) Occurrence Management, 20-11-11.

38 In 2004 testing of the top of an engine showed a temperature of 65 degrees (per communication Theo Klok).

Peter Rickerby standing beside the tamper.

One track worker reported that the heat and sweat causes his safety glasses to fog up. The track workers say they experience hot working conditions when they are working in the tunnel without the fans on, and when the fans are on, they get cold! Temperatures were measured during sheeting on 18/5/12. With the fan on, the temperature was 6.6^{0}C. The PPE that has been supplied to track workers includes: beanies, thermal underwear, overalls, jackets, gloves, and hearing and eye protection.

Track employees take care to drink water to prevent dehydration.

Recommendations:

★ *That clothing provided is able to prevent burns from touching hot locomotives during the resetting process. In the long term, consideration should be given to fitting modulating governors to coal route locomotives.*

★ *Temperature will vary with the time of the year. It is recommended that temperature is seasonally and task-specifically assessed with appropriate steps taken to ensure staff are adequately clothed for the conditions they are operating in.*

Noise:

Noise levels in the tunnel have not been measured historically. Air Matters measured the noise levels for track workers when they were doing sheeting and tamping. The average levels found from testing a person doing sheeting was 107db with a peak of 143 db. For tamping the level over two and a half hours was 93 db with a peak of 136 db. The workplace exposure standard is 85 db over an eight hour shift.

There are high levels of noise when trains are working alongside track workers and when track workers are using machinery. It is reported that it is particularly noisy when track workers have to work alongside a work train in the tunnel, and when the brake block squeals against the wheel as the LE uses the brake to control the train.

It is also particularly noisy when the train stalls and the LE has to exit the cab to rectify a fault, such as a burst hose, in one of the trailing locomotives.

The levels were measured at 102 db while the driver was out of the cab. The banker LEs average noise level over a normal eight hour shift is 80.5 db.

Current procedures are that the hearing protection is worn in the cab when drivers are operating above notch 4. Above notch 4 is needed on the uphill journey through the tunnel.[39]

The Department of Labour recommends five yearly measurements of noise when processes remain the same.

Recommendations:

★ *Where the noise levels are not known, environmental noise measurement must occur. When the noise levels are known and the process remains the same, then the frequency of environmental measurement of noise must occur every five years.*[40]

★ *That hearing is tested at least every two years for all workers working in the tunnel, including contractors, according to Department of Labour Guidelines.*[41]

★ *That PPE is assessed as being fit for purpose.*

★ *That KiwiRail provide training to ensure that hearing protection is worn effectively.*

Slips, trips and falls:

Water drips down from the roof and runs down the walls. The water drains into a concrete channel on the Southern side of the tunnel, and comes out of the tunnel at the Western Portal - at the Otira end. Due to the steep grade of the tunnel, the water in the channel runs swiftly. [42]

The channel has a mix of concrete covers and mesh, and the mesh has corroded in parts and cannot reliably hold a person's weight. As there are no formed walkways on either side of the tunnel and it is unlit, underfoot conditions are hazardous[43].

The sand and coal dust combines with the water to create mud spots which cause rail failures. This combination also causes an acidic medium causing accelerated corrosion of the rail and fastenings.[44] A re-railing programme has now been completed, with rails left on the upside of the tunnel

39 ROC S3 1.1.5 p8 Hearing protection must be worn when: Working close-by (outside the cab) of an operating locomotive, generator, forklift or any other noisy environment. When riding locomotives and / or wagons. Wheel squeal is a noise hazard that must be protected against. In a locomotive cab when engine noise etc. is excessive, this includes: When the locomotive is operating under full power or in high notch (notch 4-8);When in a tunnel or cutting where sound reverberates off walls;When operating on an incline under power.

40 Department of Labour Approved Code of Practice for the Management of Noise in the Workplace, Revised 2002. This recommends 5 yearly environmental testing when everything remains the same.

41 Noise Induced Hearing Loss of Occupational Origin- A Guide for Medical Practitioners- 1994. After the base line hearing test, audiograms should be repeated no further apart than 2 yearly.

42 Otira Tunnel briefing paper October 2008 author Walter Rushbrook.

43 Appendix C rail corridor hazard summary- from Tunnel Evacuation Exercise Oct 2010 identifies: slip or fall on ballast or uneven conditions; possible loose or missing culvert cover; fall from side of ballast and or track formation; uneven ground, mud, poor visibility.

44 Otira tunnel briefing paper October 2008 author Walter Rushbrook.

waiting to be removed. This has resulted in an obstructed "walk" way.

Underfoot conditions in the tunnel are rough following ballast cleaning work.

Recommendations:

- ★ *That lighting of the walk way be installed which can be activated upon demand during an emergency and during work.*
- ★ *The drain covers, both concrete and mesh, must form an alternate safe walking surface.*
- ★ *That coal wagons are covered to reduce coal dust.*
- ★ *That mud spots be given a higher priority for repair.*
- ★ *That the formed walkway is reinstated and maintained clear of obstructions.*
- ★ *That rail not needed for re-railing should not be left in the tunnel obstructing the walk way.*
- ★ *That mud spots be given a higher priority for repairs and that a 4th banker is trialled to establish whether it would reduce the amount of sand used in the tunnel for traction (because sand is a cause of mud spots).*

Evacuation and emergency response:

The Terms of Reference required the Working Group to review emergency evacuation re-enactments and procedures.

There are inadequacies in the emergency procedures for the passenger group. There is concern about the safety of passengers if an evacuation in the tunnel is required in an emergency. Passengers are not briefed about the hazards of the tunnel and emergency procedures except in the most general terms. The working group generally considered that the procedures around passenger evacuation need to be reviewed.

The procedure says that passengers could walk down the centre of the railway track, but this is undesirable if the train is uphill of the evacuating passengers. It would be better if there was an uncluttered walk way which could be illuminated that passengers could use. If passengers were to be evacuated from the tunnel, then they would be confronted by undecked bridges on the Bealey and Rolleston Rivers. Most likely, if at all possible, passengers should remain on the train. Although the evacuation exercise was successful in controlled conditions it nonetheless highlights some issues. Evacuation exercises should continue to be realistic and lessons learnt should be implemented.

Tunnel workers including LEs, passenger train managers and track workers should be inducted into operations of the fans and door. Training should be practical, with employees gaining knowledge of procedures and the environment in the tunnel.

There are no signs showing the metreage on the north side of the tunnel. Signs and metreage are dirty and are not regularly cleaned which results in them becoming obscured. There are no self-contained refuges. As stated above, the underfoot conditions are poor and the tunnel is unlit. However, there are phones at intervals in the tunnel, which are regularly checked.

The tunnel door indicator at the Otira end is not visible for trains travelling in both directions, thus the banker LE does not know whether the door is open or closed behind an uphill train.[45]

There is concern about the risk of a runaway train during an emergency. The standard for air brakes which are automatically applied is that they can hold a train for about 10 minutes. After 10 minutes they could release[46], i.e. not hold the train.

If the driver cuts and runs due to an emergency, hand brakes and chocks are needed to hold the 30 coal wagons. During a cut and run procedure, the banker driver is expected to manually apply the hand brakes and insert the chocks on the locomotives and the five lead wagons. The process of applying brakes, inserting chocks, in an unlit tunnel with rough underfoot conditions, and wearing a mask, is highly undesirable.

Recommendations:

- ★ *That emergency procedures which advise passengers to walk in the middle of the track be reviewed, especially the advice to walk out of the tunnel in the middle of the track behind the train as there is a risk of a run-away train if brakes fail during an emergency.*

45 Otira Tunnel Focus group 4.10.11- LE sub group

46 Refer to 45 wagon coal train trial and M2000

47 Repeater Down Tunnel Door (Indicator) Door (RDTD)

Jed O'Donoghue, Hazel Armstrong and Karen Fletcher.

- ★ *That the bridges across the Rolleston (western) and Bealey (eastern) Rivers be fully decked to enable rescue vehicles access and egress.*
- ★ *That an additional indicator is placed on the south side of the tunnel opposite RDTD[47], so that drivers going in either direction can tell whether the door is open or closed. This would enable the banker LE to know whether the door has closed behind him; and whether the door is open when setting back.*
- ★ *That signs showing the metreage or distance and direction to the nearest tunnel portal be placed on the walkway on the north side of the tunnel.*
- ★ *That any signs and indicators need regular cleaning, which should be scheduled accordingly.*
- ★ *That a formed, uncluttered walkway be provided, which can be lit upon demand during an emergency evacuation[48].*
- ★ *That spring applied brakes or a similar system are investigated to prevent workers having to manually apply park brakes when in the tunnel.*

That the Otira Tunnel Focus Group:

(a) review the emergency equipment that is provided to all staff (including track workers, TranzAlpine staff, banker and locomotive drivers);

(b) identify any procedures that require amendment, including the briefing that passengers receive about the hazards of the tunnel and emergency procedures;

(c) update the emergency response plan and establish a triggered action response.

(d) Review the emergency training[49] to assess whether it provides employees with a practical understanding of the environment, their own capabilities, and how emergency procedures should be implemented;

(e) That any training resources are reviewed and where necessary updated;

Working alone:

The steep grade and heavy axle loading mean that wear and tear of the track is high. The Otira Tunnel is part of the Cass ganger territory. He works alone and at times enters the tunnel alone. The banker LE and train LEs travel through the tunnel alone on the downhill journey.

The working group identified one of the greatest risks of working alone is when there is a fan and/or door failure. This requires the driver to exit the cab to re-set the locomotive if the train stalls. At this point the banker LE will be outside the cab and alone in the tunnel, walking through dense fumes, with difficult underfoot conditions. If the person fell and was injured or overcome by fumes, train control would not know exactly where the person is in the tunnel; the LE uses an odometer reading to calculate how far the train has travelled into the tunnel.

A system is needed to accurately locate a train and/or person in the tunnel in case of emergency. There is concern that the odometer readings may be inaccurate, this is apparently due to speedo failures in the tunnel.

Continuous communication is essential for LEs who must exit the cab in the tunnel, for any reason, especially when this is due to a fan and/or door failure. Rail Operating Procedures Section L 6.1 Otira Tunnel (30-6-08) at 7.1 states that channel 4 VHF radio communication is permitted in an emergency situation. In these circumstances, train control should not permit or carry out any transmissions on the Rolleston to Otira radio system. The VHF radio coverage is continuous in the tunnel with train control on channel 4. This includes transmission from the locomotive to train control and from VHF portable to train control, between a person using a portable and LE on either locomotive or portable radio. Channel 4 can be used for two persons in the tunnel e.g. between the banker LE on the ground and the LE in the cab.

The locomotive UHF portable radio will not work in the tunnel. The working party believes an investigation is needed into whether the UHF system that has been installed in the tunnel can be commissioned to provide full radio coverage within the tunnel for emergency situations.

There is concern that there is interference on channel 4 from the Telecom shed at Arthur's Pass. This is relevant to track workers who need to communicate with someone in Arthur's Pass during an emergency.

48 KiwiRail Job Plan/forms March 2012 Hazard: working on uneven surfaces: control: ensure adequate vision and lighting.

49 Train managers would benefit from attending critical incident management training.

Recommendations:

- ★ *That any staff working alone in the tunnel should access Channel 4 pursuant to the procedures. This includes situations where a driver must exit the cab due to a stalling or train stopping for any reason*[50].
- ★ *That train control should be able to ascertain where a train is located in the tunnel.*
- ★ *That a mouth or throat activated communication device be implemented to improve communication, especially as the driver is wearing hearing protection and a face mask when he is in the tunnel during an emergency.*
- ★ *That interference in Channel 4 communications at Arthur's Pass is resolved by Telecom.*
- ★ *That KiwiRail investigate whether the UHF system that has been installed in the tunnel can be commissioned to provide full radio coverage within the tunnel for emergency situations.*

Incident 3

On 8 July 2009 there was a fire on the TranzAlpine (DX locomotive 5189) at Cass. The train set back to Cass and Barrie Drummond extinguished the blaze with a fire hose. Had the fire occurred in the tunnel there could have been a catastrophic loss of life. Fire has been identified as a significant hazard by the working group. The working group reviewed the 'enterprise wide significant risk and hazard register: mainline driving operations', and found that fire in the tunnel was not specifically mentioned. If fire took hold of a DX class locomotive in the tunnel, the train could be trapped in the tunnel. DX class locomotives do not always have fire detection and shutdown systems.

Fire:

The 'Enterprise wide significant risk and hazard register' did not identify fire in tunnels as a significant hazard, whereas the working group does consider fire in DX locomotives within the tunnel to be a significant hazard.[51] A fuel leak could potentially be a catastrophic event. Some of the DXs do not have fire detection/suppression equipment and shutdown systems.

Recommendations:

- ★ *That the work programme for putting fire detection systems and shutdown systems into DXs be accelerated.*
- ★ *That all DXs used in the tunnel must be fitted with fire detection and shutdown systems, this includes DX banker locos and DXs when they are used on a passenger service.*
- ★ *That DFB class locomotives are used for passenger services through the tunnel as they are the least prone to fire.*

Broken rail:

Broken rail has the potential to cause a de-railment. The line is not track circuited therefore there is no indication of where the broken rail is; or in fact if there is a broken rail. There are an alarming number of broken rails occurring in the tunnel at present.

Recommendation:

- ★ *That continuous track circuiting is considered in the Otira Tunnel to detect broken rails.*

Psychological Impact of working in the tunnel

The working group surveyed workers and asked them what their greatest fears were about working in the tunnel:

- Getting trapped in the tunnel, especially in the event of a fire;
- Experiencing an earthquake;
- A tunnel cave in;
- A major derailment or breakdown;
- Being overcome by fumes or heat; and
- The long-term health effects of fumes, gases and diesel particulates.

50 KiwiRail Job Plan/Forms March 2012: hazard: working alone: control ensure adequate means of communication is available and/or use 155 tracking system

51 See Final Fire RA Otira Tunnel Review 11/4/12

Critical Incident Response

KiwiRail's Critical Incidents Policy, dated 1 May 2012, says: *"employees may be under stress following an accident or incident."* The working party considers that a train stalling, which has occurred because of fan or door failure and results in a roll-over of fumes, that requires a banker LE to exit the cab to undertake work in the tunnel, is a critical incident. If the LE is forced to cut and run or set back, this should also be regarded as a critical incident.

The procedure as it is now written is less likely to require a banker LE to exit the cab to reset the engines when the fans have failed. The banker LE is now likely to set back if this is possible. However, setting back is not always practicable, and still gives rise to exposure to high levels of fumes.

Incidents:

The working group wanted to establish the scale of the problem: i.e. the frequency of the reported incidents and the causes of the incidents. For example, in what circumstance would a LE be exposed to fumes (e.g. when the fan failed and the train stalled in the tunnel) and for how long was the LE exposed to fumes, and what would be the concentration of those fumes?

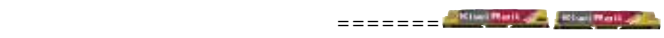
This enquiry posed an enormous challenge to the working group. The working group could not find a single data set which held this information. Information about hazards could be sourced in stand-alone data sets including: 155 (the fault reporting data base); IRIS (the occurrence/incident reporting data base, which also hold information about reported hazards); HM2s (which are paper based hazard reports); H 91s (near hit and injury forms); employee diaries; minutes of health and safety meetings and focus groups, train logs, and KiwiRail close call/incident report forms. It is possible that some of these forms are not even in use anymore. There was no single place within KiwiRail, nor a single person to whom one could turn to obtain a comprehensive understanding of the reporting system let alone a data set of incidents/hazards occurring in the Otira Tunnel across both freight and infrastructure.

The working group has collated a list of incidents experienced by staff over the last five years.

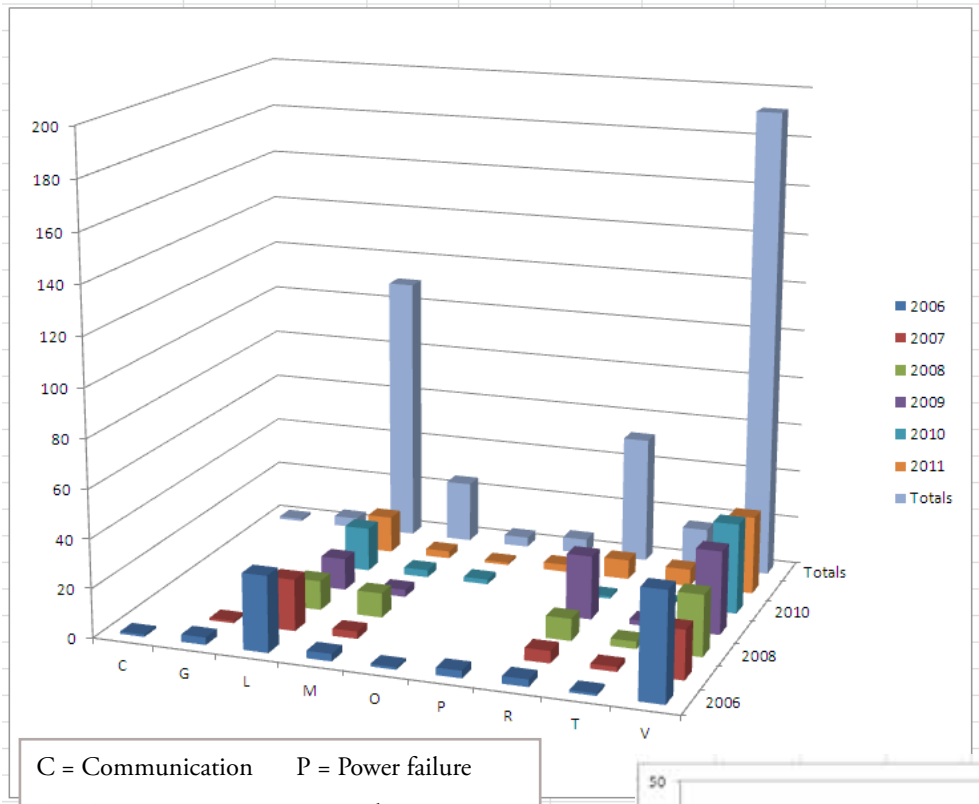
- A communication failure is recorded when train control cannot communicate with the signalling system. This failure would prevent train control from knowing the status of the fans, doors and signals. If train control does not know the status of these vital features, then they cannot inform the LE.
- A radio failure is recorded because it prevents the employee communicating with train control. This means the employee cannot advise of hazards encountered, or be advised of hazards identified by train control e.g. a broken rail or ventilation failure.
- A gas monitor failure records the failure of those monitors that had been installed in the tunnel.
- A locomotive fault is any recorded stalling which is caused by a locomotive fault, however, some ventilation failures which result in a train stalling may have been wrongly recorded as a locomotive fault.
- Train partings are recorded when the train separates, e.g. because of a broken buffer or knuckle; or separation because of a mud spot in the track.
- Other is a reported incident in the tunnel which was not defined.
- A power failure means that the fans didn't work, resulting in a train stalling.
- Broken rail records a broken rail which can result in de-railment, therefore trains must stop.
- Ventilation system failure is when the alarm goes off in train control, or it is recorded by a LE or banker LE that the fans or door have failed to operate. A consequence of this is the train stalling.

Each of these failures has the potential for an adverse health and safety impact. A train stalling exposes staff to fumes and gases, heat and noise.

The working group observes that locomotive faults and ventilation failures are the prominent issues to address. These failures may be related. Locomotive faults have reduced over time, but ventilation failures remain persistently high.

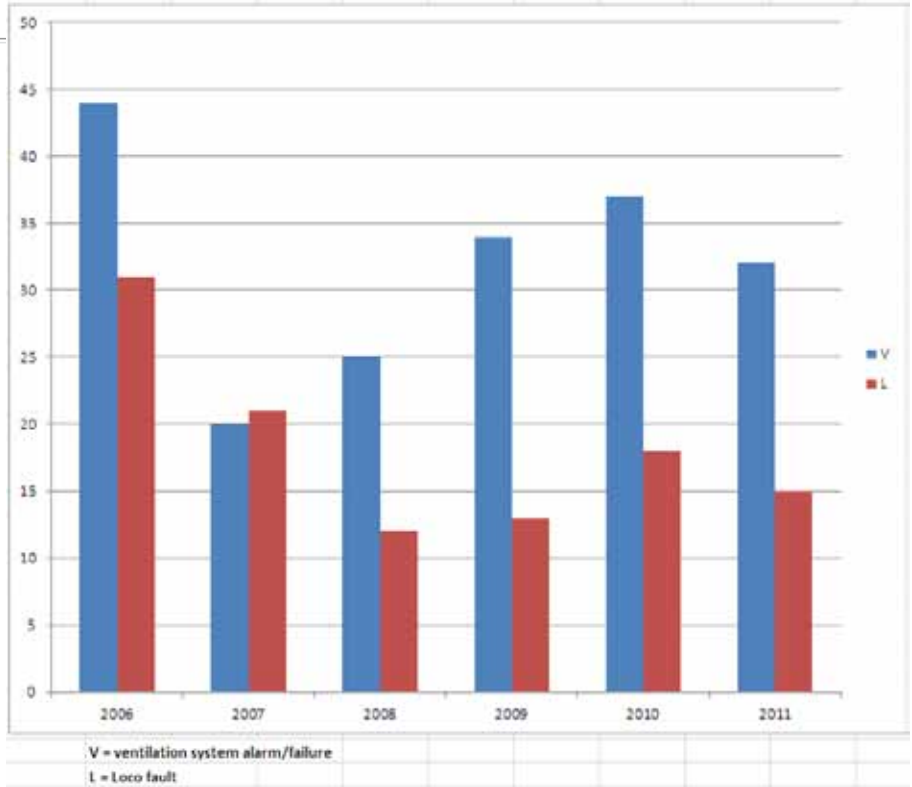


C = Communication	C	1						1
G = Gas monitors	G	3	1					4
L = Loco fault	L	31	21	12	13	18	15	110
M = Train partings	M	3	3	10	3	3	3	25
O = Other	O	1				2	1	4
P = Power failure	P	3					3	6
R = Radio system	R	3	5	9	26	1	8	52
T = Broken rail	T	1	2	3	2	1	7	16
V = ventilation system alarm/failure	V	44	20	25	34	37	32	192
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**Totals**



These graphs illustrate the incidents occuring in the tunnel over the past six years

C = Communication
G = Gas monitors
L = Locomotive fault
M = Train parting
O = Other
P = Power failure
R = Radio system
T = Broken rail
V = Ventilation system alarm or failure



Continued improvements and changes

Fumes:

The fans and door systems have proved to be effective when operational however they have been shown to be persistently unreliable.

The operating procedures particularly for track workers have improved.

Evacuation exercises have taken place, but in passenger services, they need review.

Training has been provided in gas awareness.

PPE is provided, but it has not necessarily been assessed as fit for purpose (gas monitors, masks, clothing, and hearing protection).

Some machines have catalytic converters and scrubbers fitted to control emissions but not all, and there is no dedicated plant with an inventory.

In situations where the ventilation system fails, procedure dictates that the train stops and sets back out of the tunnel.

Fire:

Some DX locomotives have fire detection and shutdown systems.

Communication:

The tunnel phone system has been replaced with a fibre optic system which has improved communication reliability.

Heat and cold:

PPE has been provided.

Regular breaks for hydration occur.

The meeting with track workers in Greymouth, May 2012. (l to r) Pete Fleming, Jim Robinson, Brian Menzies, Chris Shaw, and Trevor Grant.

Remaining challenges

The focus of the working group is set out in the Terms of Reference. It does not include an assessment of environmental issues that might arise; and it is specific to Otira Tunnel. But it does require the working group to:

- Have a health and safety focus for all employees;
- Review the effectiveness of current controls;
- Identify areas for improvement, including working practices; and
- Review interface arrangements between the field and train control.

Reporting on hazards

Train crossing the bridge at the Otira portal.

KiwiRail's Chief executive has signed the Zero Harm workplaces pledge which amongst other things commits him to:

Building workplaces which guarantee reported incidents will be investigated and action taken.

The working group started its process by making an enquiry about the reported incidents in the Otira Tunnel.

Each time an LE is exposed to hazards, from whatever the cause; this exposure should be recorded by KiwiRail. KiwiRail has a recording system, IRIS, which has both an incidents and health and safety reporting system. It operates to ensure compliance with both the Railways Act (NRSS5)[52] and the Health and Safety in Employment Act. A single document which sets out responsibilities and identifies what should be recorded and reported, and under what code, needs to be made freely available to staff. It may be advisable to have one code for Otira Tunnel matters in order to reflect the unique features of working in a tunnel.

An example of the complex approach taken to reporting is: if a fan fails that prevents purging of the tunnel it is regarded as a fault and is not an incident, so is not reported into IRIS by train control; whereas a fan failure while a train is in the tunnel is an incident and would be inputted into IRIS by train control. However, from a health and safety perspective the failure to purge the tunnel may pose a health and safety risk to the employee, depending on the level of fume the employee is exposed to during their journey through the tunnel. Standing down for a period of time may be insufficient to protect the employee from harmful exposure to fumes. NZTA said they would want fan failure with trains in the tunnel to be reported to them as an occurrence under NRSS5.[53]

In early May 2012 a code was added into IRIS for train stalling (STL), so it is foreseen this information would be inputted into IRIS. However, it is then up to Freight personnel to decide whether it would be significant enough to report it to NZTA.

IRIS

There are mixed views about IRIS, some say "it is time consuming", and "I don't have time to input the information", and others say "it is better than what we had before". Not one person could give a comprehensive explanation of the procedures **across** the company for placing information into IRIS.

The continued separation between operational and occupational health and safety is a barrier. It is essential that KiwiRail provide cross company support for a quality health and safety reporting system that has buy in from freight, infrastructure and train control. Even though it has been almost a decade since rail operations fell under the jurisdiction of the HSE Act, the organisation has not integrated the requirements under the HSE Act, alongside requirements under the NRSS5 (occurrence management) system pursuant to the Railways Act. The separation of the business into Toll, Ontrack and United Rail Group is still echoing, with demarcation lines between the divisions within KiwiRail.

The working group has been informed that a web based entry system is being worked on to improve access to the system.

In relation to IRIS, Aaron Temperton said: *"We do not consider it necessary to reinvent the wheel in the context of exploring alternative systems or having a standalone system specific to the Otira Tunnel.*

52 Ian Cotton owns 90% of NRSS5 and Phil O'Connel owns the other 10%. (per communication Brent Gillett to working party May 2012)

53 NZTA KiwiRail meeting 10.5.12 as part of audit.

More so we think that it is important that the existing system is utilised as it is intended."[54] The working party cannot resolve this matter, but notes that there are strong and opposite view points held by personnel within KiwiRail about the reporting system IRIS.

Recommendations:

- ★ *That the reporting system must integrate both operational and occupational health and safety reporting. It must facilitate easy (but complete) reporting, with clear procedures and accountabilities.*
- ★ *That the demarcation along historic business lines of the KiwiRail group must be broken down and a single company reporting culture created.*
- ★ *That all stallings and ventilation failures in the tunnel should be reported to the rail regulator.*

Management of the Tunnel

The unique features of the Otira Tunnel calls for a special role within KiwiRail for the Otira Tunnel operations and safety. The working group has concluded that KiwiRail needs to appoint a senior manager to be responsible for health and safety and operations in the tunnel. This person would have an oversight of both I & E, train control, health and safety, passenger and freight (and may be thus best located within the corporate office of KiwiRail). This role is not a customer service role. The person would need to develop expertise around the tunnel issues (health and safety and operational) and have sufficient seniority to influence outcomes.

Management of the tunnel

Having said that the Otira Tunnel has unique features, there are also learnings for the other two major tunnels (Kaimai and Rimutaka) from this enquiry. The hazards may be different e.g. heat in Kaimai, numbers of passengers in the Rimutaka Tunnel, however, there will be some similarities e.g. reporting issues, confined space experience, fumes and combustion gases. The fact that Otira Tunnel has a ventilation system, and there has been monitoring of the environment could provide useful data for the management of the other tunnels. The Otira Tunnel has a focus group which could be a useful model for the other tunnels. We understand that the Rimutaka Tunnel focus group has recently re-established and the Kaimai Tunnel focus group may have lapsed. The Steering Committee acknowledged that the other tunnels were outside of our Terms of Reference, but recognised that this enquiry could be of assistance for the management of the other tunnels.

Recommendations:

- ★ *That a single very senior person within KiwiRail must own responsibility for the operational, maintenance, health and safety, emergency, document management and reporting issue across all parts of KiwiRail relating to the Otira Tunnel. This person would require appropriate resources in order to be effective in this role.*
- ★ *That the Otira Tunnel focus group remains in place, with representation from all parts of the business and employees. Senior management should attend from time to time.*
- ★ *That the Otira Tunnel focus group formalises its terms of reference and composition and KiwiRail ensures it has sufficient resource to undertake its tasks.*

Track workers in Greymouth with some members of the working group

54 Aaron Temperton email to Hazel Armstrong, 5/4/12.

Reviewed and recommended changes to procedures

★ *That Q130 Otira Tunnel Emergency Procedures along with appendix A and B (dated 22/2/09 with a review date of 1/6/11) and the Rail Operating Procedures section L6.1 Otira Tunnel (approval date 30/6/08 with a review date of 30/6/11) along with the relevant Bulletins be urgently reviewed and that KiwiRail consider amalgamating both L6.1 with procedures for track workers*

★ *That pursuant to the HSE Act and Railways Act, relevant personnel including employees should be involved in this review.*

★ ***Specific recommended changes to the procedures:***

1. L6.1 *– needs to be reviewed to remove any obsolete references, tidied up and simplified.*

2. L6.1 – 2.2.5 *– needs sub headings as the information is hard to read.*

3. L6.1 – 3.2 *– should include references to all fumes, gases and diesel particulates identified by Air Matters.*

4. L6.1 *– does not comply with the WES at 3.2. There should be at least 60 minutes stand down between successive exposures up to the STEL and reaching the STEL should occur no more than four times a day. The procedures need to reflect the WES. This procedure does not allow for the human body to clear itself of the effects of exposure.*

5. L 6.1 - 3.2 *– needs to mention biological monitoring e.g. lung function tests, urine tests following exposure to fumes.*

6. L6.1- 3.2 *– needs to mention the hazards affecting the skin – e.g. results of exposure to nitric acid.*

7. L6.1- 13.1 *– CO 60 and procedures around using the equipment.*

8. L6.1- 4.4 E *– emergency cut and run, the process is lengthy and overly complex, and needs to be re-written to reduce the likelihood of a runaway train.*

9. L6.1 5.8 *– emergency evacuation of passengers. Passengers are advised that the best way of walking out is between the tracks. Currently the underfoot conditions are uneven. Further, the working group is uncomfortable about the recommendation that passengers walk below the train. Walking between the tracks is only recommended when walking above the train. However, a formed walk way is the solution.*

10. Q130 *– need to review emergency equipment and fire flow charts to take into account fumes, e.g. around evacuation.*

11*. – manual door operations is an annex, but did not print out on the controlled document. Add to Q130*

12. 4.9.2 *– delete.*

13. 4.11.1 *– rewrite and tidy up.*

14. 4.13.1 *– Otira Tnnel Focus Group to rewrite.*

Members of the working group (l to r) (standing) Brent Gillett, Ian Cotton, Neil Campbell, Jed O'Donoghue, Mike Williams, Mike Morgan, Phil O'Connell, Wayne Butson. (seated) Karen Fletcher, Hazel Armstrong, Chris Stoop, Aaron Temperton and Brian Armstrong.

15. 9.3 *– flood warning - is it tested?*

16. NRSS3 *– needs to be reviewed by Dr Walls.*

17. L6.1 – 7.1 *– the use of channel 4 should be expanded to cover drivers working alone when they exit the cab when the train has stalled, or for any other reason.*

*1**8. L6.1** – is silent on reporting, as this is covered by NRSS5. For completeness, a section on reporting of incidents/hazards should be included in L6.1 because of the unique features of the tunnel. For example a train stalling in the tunnel is significantly different to a train stalling outside the tunnel. Previously train control regarded a train stalling in the Otira Tunnel as a mechanical issue, it was not regarded as an incident that needed to be recorded or reported.*

Analysis of bench marking

The working group was required to bench mark tunnel safety controls against those used in international railway environments.

Analysis of bench marking information between NZ and USA tunnels show similarities in procedures for operating trains through long tunnels equipped with ventilations systems. While the Cascade Tunnel data is incomplete there is sufficient information to gain comparisons between all three tunnels.

While the Otira Tunnel has the steepest gradient, the Cascade and Moffat Tunnels are longer with heavier trains and more locomotives generating more exhaust gases.

TUNNEL VENTILATION:

- Otira Tunnel - ventilation system draws fresh air from the uphill direction ensuring trains are always moving into clean air.
- Cascade Tunnel - ventilations system blows air into the tunnel from the eastern portal diluting exhaust fumes.
- Moffat Tunnel - while tunnel purge occurs after trains exit at each end, the cooling cycle only operates if there is a lack of train speed /or pressure.

All tunnel purge times are based on total air replacement.

GAS MONITORING:

- Otira Tunnel - Drager Mini Warn monitor.
- Moffat Tunnel - an optical opacity meter and common electrochemical based carbon monoxide meter inside the eastern portal monitoring Air Turbidity at the east and west centres. While there is no gas monitoring in locomotive cabs, crews are trained to use SCBA equipment during train stalls, locomotive failures, broken couplers and door failures or whenever they sense excessive fumes.

TUNNEL LIGHTING:

Both the Moffat and Cascade Tunnels have lighting at equipment refuges. The Otira Tunnel has lighting in the six refuges.

EMERGENCY EQUIPMENT:

There are similarities with emergency equipment available in all tunnels that are part of this bench marking exercise, with the exception of emergency breathing equipment. The key difference is the use of SCBA and the supply of spare air bottles in all refuges in the USA tunnels against the New Zealand use of a full face gas mask with a C20 filter.

EMERGENCY PROCEDURES:

While there are subtle differences in how emergencies are managed, the end result is the same with the evacuation of crews from tunnels in preference to problem solving and remaining with the train.

Process

The Terms of Reference was signed on the 29th February 2012. It provided for a steering committee: Aaron Temperton, general manager, Operations, KiwiRail Freight; Ian Cotton, Rail Operating Standards and Projects manager for KiwiRail Infrastructure & Engineering; Wayne Butson, general secretary of the RMTU.

A working group was made up of Hazel Armstrong, barrister and solicitor as the independent chair; Brent Gillett, manager Operational Risk & Compliance, KiwiRail Freight; Jed O'Donoghue, operations manager, Linehaul, Middleton, KiwiRail Freight; Mike Morgan banker LE and health and safety representative for Otira; Mike Williams, LE and representative for the RMTU on the KiwiRail Industrial Council (KIC); Neil Campbell, acting regional manager for I & E; Brian Armstrong, train manager Tranz Scenic; Chris Stoop, KiwiRail manager, West Coast, KiwiRail Freight; Karen Fletcher health and safety organiser for the RMTU.

The working group has met seven times (between 29th February 2012 and 30th June 2012).

Time table extension

The Steering Committee permitted an extension to the timetable to enable the environmental and personal monitoring to take place. It also understood that the medical monitoring regime would be contingent on the findings from the environmental and personal monitoring.

Consultation

As required by the terms of reference, the working group took steps to ensure it had input from those affected. A survey was sent out electronically to 14 TranzScenic workers and we received four surveys back; we produced hard copies of the survey for LEs in Christchurch and Greymouth (80 LEs in total) and received 17 back from LEs; and we received six survey responses from the gangers in Greymouth. In total 27 responses. The survey was analysed by Jed O'Donoghue and formed part of the input into the hazard identification exercise.

Additionally the working group made a site visit on 12th April to meet with:

- Cass: Barrie Drummond, ganger;
- Greymouth: John Bannerman, track inspector;
- Greymouth: gangers: Peter Fleming, Brian Menzies, Andy Lancaster, Kelvin Prendegast, Jim Robinson, Chris Shaw and Trevor Grant;
- Tamper gang at Rotomanu: Peter Rickerby and George English;
- Otira Tunnel: Lindsay Scott, electrical field engineer I & E, and Bob Williams, leading signals technician;
- We were accompanied into the tunnel by Sean Moran, signals. Telecommunications and Electrical (STE) asset performance manager; the driver was Chris Hogan, signals technician.

The working group also met with:

- Phil O'Connell, national manager HSQE, KiwiRail Freight;
- Rob Dickson, Department of Labour;
- Theo Klok - fleet performance engineer, I & E;
- Peter Steel - general manager Engineering and Standards for I & E;
- Carol McSweeney and Robert Murray occupational hygienists from Air Matters;
- Dr Chris Walls, Chief Medical Officer; and
- Trevor Watts, mines rescue.
- Adrian (Fred) Miles, Greymouth, LE and Health & Safety representitive;
- Murray Young, South Island regional manager, Frieght;

By phone:

- Carl Mills manager Network Operations I & E and Paul Rolton train control manager I & E.

The chair has met with:

- Geoff Young - train controller and had a site visit to train control;
- Dave Gordon - general manager Network Performance I & E;
- Graham Hudson - NZTA;
- Dianne Campton. acting manager health and safety;
- Brian Graham - NZTA; and
- Robyn Horan - national operational safety co-ordinator I & E.

The chair spoke with:

- TranzAlpine staff on the return journey from Otira on 12th April 2012 to Christchurch and sat in the cab with LE John Phillipson.

The chair had phone calls with: Jason Lord, leading track welder and Wayne Houston, ganger, Greymouth renewals gang.

Documentation:

The working group has sought out internal and external reports about the Otira Tunnel and information from other countries where there are similar tunnels. An index of the documents held by the working group has been produced. The collation of relevant documents has been a significant task in itself as there is no single keeper of relevant documents related to the Otira Tunnel.

The working party found that there is a lack of shared knowledge of what documents are held within the organisation. To give an example: the existence of an excellent report written by K Morgan *Working in Tunnels and Gas Safety Instructions (Best Practice Guidelines)* dated 29 August 2011 was not provided to the working party for over two months. Some of the rail operational members of the working party were unaware of its existence.

Document control around the Otira Tunnel could be improved.

The comprehensive resource documents used in this review can be found on KiwiRail's P:Drive in the folder entitled 'Otira Tunnel Review'. This folder contains an index as well as the documents.

Recommendation:

★ *That a single manager be given responsibility for document control over the Otira Tunnel.*

Working Group at TranzLink board room. (l to r) Brian Armstrong, Karen Fletcher, Niel Campbell, Mike Morgan, Mike Williams and Brent Gillett.

The TranzAlpine arriving at Otira

Summary of recommendations

- ★ *That the benefits of electrification are assessed from a health and safety perspective.*
- ★ *That when KiwiRail upgrades the fleet, that consideration is given to ensuring that the locomotive cabs are sealed and air conditioned.*
- ★ *That the air quality in the cab is checked to ensure that the cab air is clean, prior to re-entry, at Arthurs Pass.*
- ★ *That KiwiRail purchases suitable equipment to enable it to download data , store the data and assess exposures for employees, both for regular shift work and following incidents.*
- ★ *That employees monitor oxygen levels, CO, and oxides of nitrogen on every entry to the tunnel.*
- ★ *That personal and environmental monitoring along with centralised reporting occurs for track workers under different work scenarios in the Otira Tunnel e.g. use of plant, use of regulator, tamping, re-railing, laying ballast etc and for LE's and on board staff of the TranzAlpine.*
- ★ *Once the levels are established for different work scenarios, and appropriate controls implemented, then a regime of monitoring would be put in place.*
- ★ *That workers and contractors must undergo annual urinary screening for haematuria.*
- ★ *Triggered evaluation should occur with excess exposure and would focus on respiratory function (questionnaire and lung function) and reported to the RMO. The action point is when exposure reaches 2/3 of the STEL .*
- ★ *That fixed gas monitors are fitted to monitor levels of CO, O2, NO2 in the tunnel at recommended locations.*
- ★ *That train control being able to view gas conditions in the tunnel.*
- ★ *That affected employees, the RMTU, the Otira Focus Group and senior management will be provided with the results of the environmental and personal monitoring.*
- ★ *That KiwiRail keeps records of exposures to employees and the results of health monitoring for each individual employee.*
- ★ *That PPE is fit for purpose, is available and is checked for effectiveness, to protect against the hazards encountered in the tunnel. More data is needed to assess appropriate PPE for oxygen.*
- ★ *Three further sets of data arising from a stall test are considered a minimum. A CO60 filter is more appropriate in the interim until testing is complete.*
- ★ *That procedures comply with Department of Labour Workplace Exposure Standards (WES) guidance, in particular ensuring breaks occur between exposures which reach the Short Term Exposure Level (STEL).*

- *That training in the use of PPE is practically focussed.*
- *That gas awareness training by Mines Rescue be undertaken by banker LE's, train managers, and persons in charge of work groups in the tunnel.*
- *That contractors carry evidence/proof that they are certified to meet KiwiRail's training requirements which also certifies their knowledge of KiwiRail procedures.*
- *That the reliability of fans and doors is both an operational and health and safety issue and failures should be reported in compliance with both NRSS537 and the HSE Act.*
- *That a code specific for ventilation system failure be created for entering into IRIS; and a code created for Otira Tunnel.*
- *That KiwiRail install indicators outside the tunnel at both ends which indicates whether the fans and door are functional.*
- *That workers and contractors are encouraged to shower after a shift.*
- *That is mandatory to shower after an incident in the tunnel and change their clothes prior to returning home, in order to wash off fume, dusts and diesel particulates.*
- *That showers are installed at Arthur's Pass.*
- *That KiwiRail review its purchasing policies and consider retrofitting plant to reduce emissions.*
- *Where the results of monitoring show that the hazard (or hazards) is not being controlled, then all practicable steps must be taken to either eliminate, isolate or minimise the hazard.*
- *That clothing provided is able to prevent burns from touching hot locomotives during the resetting process. In the long term, consideration should be given to fitting modulating governors to coal route locomotives.*
- *Temperature will vary with the time of the year. It is recommended that temperature is seasonally and task-specifically assessed with appropriate steps taken to ensure staff are adequately clothed for the conditions they are operating in.*
- *Where the noise levels are not known, environmental noise measurement must occur. When the noise levels are known and the process remains the same, then the frequency of environmental measurement of noise must occur every five years.*
- *That hearing is tested at least every two years for all workers working in the tunnel, including contractors, according to Department of Labour guidelines.*
- *That PPE is assessed as being fit for purpose.*
- *That KiwiRail provide training to ensure that hearing protection is worn effectively.*
- *That the formed walk way is reinstated and maintained clear of obstructions.*
- *That rail not needed for re-railing should not be left in the tunnel obstructing the walk way.*
- *That lighting of the walk way be installed which can be activated upon demand during an emergency and during work.*
- *The drain covers, both concrete and mesh, must form an alternate safe walking surface.*
- *That coal wagons are covered to reduce coal dust.*
- *That mud spots be given a higher priority for repair and that a fourth banker is trialled to establish whether it would reduce the amount of sand used in the tunnel for traction (because sand is a cause of mud spots).*
- *That emergency procedures which advise passengers to walk in the middle of the track be reviewed, especially the advice to walk out of the tunnel in the middle of the track behind the train as there is a risk of a run-away train if brakes fail during an emergency.*
- *That the bridges across the Rolleston (western) and Bealey (eastern) Rivers be fully decked to enable rescue vehicles access and egress.*
- *That an additional indicator is placed on the south side of the tunnel opposite RDTD, so thatdrivers going in either direction can tell whether the door is open or closed. This would enable the banker LE to know whether the door has closed behind him; and whether the door is open when setting back.*
- *That signs showing the metreage or distance and direction to the nearest tunnel portal be placed on the walkway on the north side of the tunnel.*
- *That any signs and indicators need regular cleaning, which should be scheduled accordingly.*

- *That spring applied park brakes or a similar system are investigated to prevent workers having to manually apply park brakes when in the tunnel.*
- *KiwiRail has an emergency response plan which needs to be reviewed and updated. That a triggered action response (TAR) be established. All of which needs to be regularly reviewed.*
- *That the Otira Tunnel Focus Group:*

  (a) review the emergency equipment that is provided to all staff (including track workers, TranzAlpine staff, banker and locomotive drivers);

  (b) identify any procedures that require amendment, including the briefing that passengers receiveabout the hazards of the tunnel and emergency procedures;

  (c) update the emergency response plan and establish a triggered action response;

  (d) Review the emergency training to assess whether it provides employees with a practical understanding of the environment, their own capabilities, and how emergency procedures should be implemented; and

  (e) That any training resources are reviewed and where necessary updated.
- *That the tamper cab is upwind of the engine whilst working in the tunnel.*
- *That any staff working alone in the tunnel should access Channel 4 pursuant to the procedures. This includes situations where a driver must exit the cab due to a stalling or train stopping for any reason.*
- *That train control should be able to ascertain where a train is located in the tunnel.*
- *That a mouth or throat activated communication device be implemented to improve communication, especially as the driver is wearing hearing protection and a face mask when he is in the tunnel during an emergency.*
- *That interference in Channel 4 communications at Arthur's Pass is resolved by Telecom.*
- *That KiwiRail investigate whether the UHF system that has been installed in the tunnel can be commissioned to provide full radio coverage within the tunnel for emergency situations.*
- *That the work programme for putting fire detection systems and shutdown systems into DXs be accelerated.*
- *That all DXs used in the tunnel must be fitted with fire detection and shutdown systems, this includes DX banker locos and DXs when they are used on a passenger service.*
- *That DFB class locomotives are used for passenger services through the tunnel as they are the least prone to fire.*
- *That continuous track circuiting is considered in the Otira Tunnel to detect broken rails.*
- *That the reporting system must integrate both operational and occupational health and safety reporting. It must facilitate easy (but complete) reporting, with clear procedures and accountabilities.*
- *That the demarcation along historic business lines of the KiwiRail group must be broken down and a single company reporting culture created.*
- *That all stallings and ventilations failures in the tunnel should be reported to the rail regulator.*
- *That a single very senior person within KiwiRail must own responsibility for the operational, maintenance, health and safety, emergency, document management and reporting issue across all parts of KiwiRail relating to the Otira Tunnel. This person would require appropriate resources in order to be effective in this role.*
- *That the Otira Tunnel focus group remains in place, with representation from all parts of the business and employees. Senior management should attend from time to time.*
- *That the Otira Tunnel focus group formalises its terms of reference and composition and KiwiRail ensures it has sufficient resource to undertake its tasks.*
- *That a single manager be given responsibility for document control over the Otira Tunnel.*

- Hazel Armstrong – on behalf of the Working Group and as endorsed by the Steering Group.

Terms of Reference

Wayne Butson, Aaron Temperton and Ian Cotton of the steering committee signing the Terms of Reference.

KiwiRail

Review of Safe Working Procedures for Train Operations in the Otira Tunnel

TERMS OF REFERENCE
23 December 2011

1. Introduction

1.1. The 8.5 km long Otira Rail Tunnel is situated on the Midland line which links the West Coast of the South Island with the Canterbury region on the east coast.

1.2. The tunnel is straight and is constructed to a continuous 1 in 33 gradient

1.3. All trains passing through the tunnel are diesel electric locomotive hauled.

1.4. The key traffic on the line is coal which is transported up the tunnel gradient from west to east.

1.5. Up to seven return coal trains per day can potentially traverse the line in addition to containerised freight and general freight.

1.6. The Tranz Alpine passenger train which is a niche tourist train has a return trip each day through the tunnel.

1.7. The tunnel has a normal daily total of 18 train movements.

1.8. To minimise train stalling through locomotive overheating and shutdown caused by various factors a tunnel ventilation system is used to purge the tunnel of locomotive exhaust gases after each train before a subsequent train is permitted to enter. The purge cycle differs between up and down trains. The purge cycle is influence by fan failure and performance.

1.9. Two fans are installed at the western portal which and are used in conjunction with a tunnel door system which is also installed at the western portal.

1.10 KiwiRail has documented safe working procedures developed in conjunction with our employees, the RMTU and Mines Rescue for train operations and emergency response within the Otira tunnel. A review of the current operating procedures is timely and appropriate.

1.11 The review is required to fully consider the hazards and risks that are currently present and likely to be encountered in the near future (e.g increased train size),and to recommend improvements that can be considered to minimise, isolate or eliminate hazards and prevent harm to employees.

2. Scope

2.1. Review the current safe working procedures for train operations in the Otira tunnel.

2.2. Review the hazards and risks that have been previously identified, identify additional hazards and risks not previously identified, consider future hazards and risks yet to be realised and the effectiveness and efficiency of the current hazard and risk and H&S controls.

2.3. Review all reported occurrences where tunnel emergency procedures have or should have been applied in the past 36 months and assess the effectiveness of current risk controls.

2.4. Review compliance with any relevant instructions, standards, codes of practice, legislation or regulations.

2.5. Review any reports produced in the last 5 years about the Otira Tunnel from agencies such as TAIC, Land Transport, KiwiRail, TELARC etc.

2.6. Review the existing Tunnel engineering and its adequacy to provide seamless egress in an emergency or to provide shelter or safe haven for anybody trapped in the tunnel by any event.

2.7. Propose changes to engineering and procedural controls to effectively manage or eliminate the hazards and risks inherent in the tunnel environment, including monitoring, supervision, training and ongoing assessment requirements to confirm that the controls are effective.

2.8. Review the effectiveness of the tunnel working group to ensure amongst other things that all relevant persons are represented and are able to participate effectively.

2.9. Review the adequacy of existing tunnel emergency evacuation procedures for freight and passenger trains

2.10. Review the reports/results of tunnel evacuation exercises conducted in the past six years and if further information is required to conduct one as part of this review.

2.11. To hold staff interviews to provide opportunity for staff to feed viewpoints into this review.

2.12. Prepare a report on the findings and make recommendations for consideration by the Project Steering Committee by 30 April 2012.

3. Considerations

3.1. Gain an understanding of current safe working systems for train operations in the Otira tunnel, the hazards and risks they control and how they are applied in practise.

3.2. Review and assess hazards and risks which are evident or could be reasonably expected or foreseen within the tunnel environment.

3.3. Review current practices and performance, identify any gaps in hazard and risk management, health and safety and areas/opportunities for improvement. This will

include a focus on procedures, engineering and management of operations as well as actual working practices in the field

3.4. Benchmark tunnel safety controls against those used in international railway environments. Benchmarking comparisons to be agreed with KiwiRail prior to review commencing.

3.5. Review interface arrangements between field operations and KiwiRails National Train Control Centre

3.6. Review overall tunnel safety and existing practices.

3.7. Interview personnel undertaking the task.

3.8. Propose recommendations to improve safety performance.

4. Management

4.1 The project sponsor is the KiwiRail Safety Licence Management Team.

4.2 The project Steering Committee are Aaron Temperton, Ian Cotton (KiwiRail) and Wayne Butson (RMTU).

4.3 The project working group will consist of KiwiRail employees who will provide operational and technical support and RMTU national office nominated representation.

4.4 The project Manager will be appointed by the Steering Committee.

4.5 The deliverables will include a report outlining the current situation, findings and recommendation for engineering, operational and procedural improvements.

29/2/12.

W Butson
29/2/12.

Temperton
29/2/12.

Index of Documents

Review of Safe Working Procedures for Train Operations in the Otira Tunnel June 2012

These documents were reviewed by the working group, and can be found on KiwiRail's P: Drive in the Folder entitled 'Otira Tunnel Review'.

AUTHOR / TITLE		DATE
KiwiRail, Tranz Rail, Ontrack, Toll		
Ontrack	Ontrack Rail Operating Procedures: Section 10 – General Operating Information	Unknown
Ontrack	Ontrack Rail Operating Procedures: Section 11 – Emergency Procedures (Part 12.0)	Unknown
Ontrack	Ontrack Rail Operating Procedures: Section 11 – Emergency Procedures (Parts 30.0-33.6)	Unknown
Ontrack	Otira Tunnel Emergency Procedures Q130 Review Date: 1 June 2011	22.02.09
Ontrack	Rail Operating Procedures: Section L6.1 Otira Tunnel Local Network Instructions	30.06.11
Multiple Authors	National Rail System Standard 5: Occurrence Management	20.11.11
KiwiRail (J Quinn; From Graeme Boomer)	National Rail System Standard 3: Health Assessment of Rail Safety Workers	18.12.09
KiwiRail Bulletin No. 1046: Rail Operating Rules & Procedures Local Instructions: Section L6.1 Otira Tunnel		14.12.11
KiwiRail Risk Management Policy		01.06.11
Tranz Rail	Otira Tunnel Manual Operation of the Door Training Manual	22.02.12
Southern Tunnels Focus Group	Southern Tunnels Focus Group Meeting Minutes	07.12.11
Unknown	Train Partings	02.12-10.05
Tony McManus & Jed O'Donoghue Email Correspondence Re: Incident # 07TG015116		03.06.08
KiwiRail Risk Assessment: Operation of 45 Wagon Coal Trains Between Ngakawau/Rapahoe – Lyttelton (Issue 3)		August
Theo Klok - KiwiRail	DXB & DXR Fire Detection System Operation and Maintenance M9125 (Issue 1)	Unknown
Unknown	Emergency Procedures Otira Tunnel Emergency – Train Manager No. 1's Responsibilities Tranz Scenic South Island Staff Memorandum	28.10.11
KiwiRail Operating Procedures: Otira Tunnel (Draft from Brent Gillett)		29.02.12
Otira Tunnel Focus Group: LE Sub Group	Otira Tunnel Focus Group: LE Sub Group Meeting Minutes	04.10.11
KiwiRail Risk Assessment: Proposed Changes to Otira Tunnel Operation During Radio Outage		27.05.11
SLAS LIC	Meeting Minutes	08.02.11
Tony McManus	Initial Rail Accident & Incident Notification & Email	27.12.03
Tony McManus	Report On Stall and Subsequent Skidback of No. 804 Tranz Alpine in Otira Tunnel 28 March 2004	12.05.04
Toll NZ & Lovetia Cecil	Emails to Tony McManus RE: Fire on Locos	10.01.05-29.12.04
Tony McManus – Tranz Scenic	Emails Re: Stall in Tunnel on 28 November 2005	01.12.05
Tony McManus & Ontrack	Emails Re: Fire on Loco 29 December 2005	04.01.06-29.12.05
Tony McManus	Email Re: Stall in Tunnel on 22 January 2007	23.01.07
Tony McManus	Email Re: Stall in Tunnel on 30 October 2007	31.10.07
Tony McManus	Email RE: Tranz Alpine Stall in Tunnel on 8 November 2007	09.11.07
Tony McManus	Email RE: Stall on 2 December 2007	02.12.07
Tony McManus & GS O'Donoghue Email RE: Stall in Tunnel 10 February 2008 & General Report Summary		11.02.08-10.02.08
Ontrack & BJ Morgan	Occurrence Advice: Locomotive Fire on 8 July 2009 & General Incident Report	08.07.09

Tony McManus	Email RE: Disabled Train in Tunnel 31 March 2010	01.04.10
Philip O'Connell – Tranz Rail Ltd	Rail Services Otira Tunnel Emergency Procedures	01.09.01
Jed O'Donoghue	Enterprise Wide Significant Risk and Hazard Register: Mainline Driving Operations	29.03.12
Annemiek Van Dam – KiwiRail	Tunnel and Gas Safety Instructions	23.03.09
MK Taramai – Tranz Rail	Otira Tunnel Ventilation Project Issues Arising from Meeting with Signals	21.08.97
KiwiRail	Tranz Scenic Safety and Security Handout	Unknown
K Morgan – KiwiRail	Working in Tunnels and Gas Safety Instructions (Best Practice Guidelines) Document No: KRNI-SA-006	29.08.11
KiwiRail	Personal Protective Equipment and Personal Protective Clothing Instruction	07.06.11
KiwiRail	Investigation Report: Mainline Operations Derailment: Tranz Metro Train 23 July 2009	06.10
TollRail	Risk Assessment: Operation of 30 Wagon Coal Trains Between Ngakawau/Rapahoe-Lyttelton	04.05
Triex	Aldehyde Exposure Assessment During Maintenance Operations in the Otira Tunnel for Ontrack	18.08.09
Theo Klok	Work Order for Fire Detection	11.04.12
Ontrack	Ontrack Rail Operating Rules: Rule 90	Unknown
Lee Searle - Spectra Chem	Analytical Fax to Tranz Rail Re: X-Ray Fluorescence Analyses	21.04.98
Walter Rushbrook	Regional Manager I&E Otira Tunnel Briefing Paper	01.10.08
Brent Gillett	Reported Train Stallings in Otira Tunnel	02.12-01.07
Ontrack	Otira Tunnel 155 Incidents July 04 to Feb 12 02.	12-07.04

Forms

KiwiRail	H91 (Incident/Accident) Form	05.10
Tranz Rail	Tranz Rail Incident Report Template	Unknown
KiwiRail	I & E Staff 23 Form	Unknown
KiwiRail	Close Call/Incident Report Form	17.06.11
KiwiRail	Working in Tunnels and Gas Awareness Learner Workbook Version 1.0	23.03.09

Working Group

Jed O'Donoghue	Email & Fire Risk Assessment	04.04.12
Jed O'Donoghue	Fire Risk Assessment for Otira Tunnel Review	11/04/12
Working Group	Charts and Figures Comparing IRIS, Diary and 155	28.03.12
Jed O'Donoghue	Otira Tunnel Safety Review Train Control Response	Unknown
Jed O'Donoghue	Otira Tunnel Safety Review Part One Response	Unknown
Jed O'Donoghue	Otira Tunnel Safety Review Part Two Response	Unknown
Carol McSweeney (Air Matters)	Email Re: STELS and NO as Carcinogens	30.03.12
Dräger	Gas Monitoring Results for KiwiRail Otira Tunnel Project – Prepared for Christopher Stoop	28.03.12
Hazel Armstrong & Neil Campbell	Email Correspondence Re: Updated Report to the Steering Committee	06.12.12

General

"Sperian "	Gas Detection	Unknown
New Zealand Mines Rescue	Exhaust Emissions and Effects on Humans: Gas Monitoring CO, NO – Filter Canister Full Face Mask – Donning Care and Maintenance	Unknown
Unknown	Some Notes about Otira and the Tunnel	Unknown
KiwiRail/New Zealand Mines Rescue	Diesel Exhaust Emission Tunnel Gas Awareness Work Book	01.09.08
Mike K	Email Re: Bank Engine Cab Photo	15.03.12
Unknown	'Coal train locomotive catches fire' Article	29.07.03

TerraNova	BlastGlass Material Safety Data Sheet	Unknown
"Dräger "	Respiratory Filters: Instructions for Use	Unknown
Dräger Sicherheitstechnik	Dräger MiniWarn: Instructions for Use	N/A
Dräger Sicherheitstechnik	Dräger MiniWarn: Technical Handbook	N/A

Department of Labour

New Zealand Parliament	Health and Safety in Employment Act 1992 (Reprint as at 1 July 2011)	N/A
Department of Labour	Workplace Exposure Standards and Biological Exposure Indices July 2011 6th Edition	07.11
Jean Martin (Department of Labour)	Letter to Hazel Armstrong Re: Official Information Request	24.04.12
Rod Dickson (Health & Safety Inspector) (Released under Official Information Act)	Carbon Monoxide Monitoring Otira Rail Tunnel	20.06.95
Rod Dickson (Health & Safety Inspector) (Released under Official Information Act)	Fumes Exposure Incident in Otira Tunnel 23 February 1995	04.09.95
Rod Dickson (Health & Safety Inspector)	Otira Tunnel Mock Door Tests 8-9 November 1995: Report on Carbon Monoxide Monitoring (Released under Official Information Act)	18.12.95
Rod Dickson (Health & Safety Inspector) (Released under Official Information Act)	Letter Re: Rail Tunnels – Health & Safety Issues	07.05.96
Rod Dickson (Health & Safety Inspector) (Released under Official Information Act)	Letter Re: Rail Tunnels – Health & Safety Issues	12.06.96
Occupational Safety and Health Service & Department of Labour	Approved Code of Practice for the Management of Noise in the Workplace	10.02
Occupational Safety and Health Service & Department of Labour	Noise-Induced Hearing Loss of Occupational Origin: A Guide for Medical Practitioners	04.94

New Zealand Transport Agency

NZTA – Telarc	Outline of Ordinary Safety Assessment 2012	04.04.12
NZTA – Telarc	Safety Assessment Report (KiwiRail)	06.10.09
NZTA – Telarc	Safety Assessment Report (Ontrack)	06.11.09
NZTA - Telarc	Assessment Report – Operation of a Rail Safety Management System	10.04.06
Karen Fletcher	Email to Hazel Armstrong Re: Otira Tunnel NZTA Ordinary Safety Assessment	06.12.12

Emergency/ Evacuation Exercises

Unknown	Otira Tunnel Evacuation Exercise Tuesday 7 August Tranz Scenic Debrief	29.08.07
Toll/Ontrack	Otira Tunnel Evacuation Exercise Version 5	07.08.07
Danny Greene	Notes/Observations of the Tunnel Evacuation Exercise Otira Tunnel	24.10.02
Tranz Scenic	Interim Tranz Scenic Report Passenger Train Simulated Derailment in Otira Tunnel	24.10.02
Unknown	Otira Tunnel Evacuation Exercise Special Passenger Train Control Log and Debrief	24.10.02
Carl Mills	Memorandum: Otira Tunnel Emergency Exercise	24.10.02
Unknown	Tunnel Evacuation Exercise Risk Assessment 5 October 2010: Appendices E – G	08.09.10
KiwiRail	Otira Tunnel Evacuation Exercise 5 October 2010 Version 3	10.09.10
Unknown	Otira Tunnel Evacuation 5 October 2010: Actual Timings	05.10.10
John Watson	Report from TM Umpire on Simulated Tunnel Evacuation Passenger Train 5 October 2010	05.10.10
M Morgan & P Ryan (Umpire) Eastern Portal Site Assistant	Check Sheet: Simulated Tunnel Evacuation Passenger Train:	Unknown
Colin Sweeney & Graham Lawn (Umpire) Locomotive Engineer	Check Sheet: Simulated Tunnel Evacuation Passenger Train:	Unknown
Chris Stoop & Bronwyn Woodham (Umpire) Rail Incident Controller	Check Sheet: Simulated Tunnel Evacuation Passenger Train:	Unknown

International

Railway Association of Canada	Circular No. 6: Passenger Train Handling Safety and Emergency Procedures	31.03.00
Railway Association of Canada	Railway Passenger Handling Safety Rules	31.03.00
Brent Gillett	International Benchmarking	06.12
Landroverclub.net	The Mont Blanc Disaster	Accessed 05.12
OECD	OECD Studies in Risk Management: Norway Tunnel Safety	2006