NZTA S08: 2023

Specification for the Management of Tunnels

WAKA KOTAHI
NZ TRANSPORT AGENCY

Te Kāwanatanga o Aotearoa
New Zealand Government

1 INTRODUCTION

This specification defines the key requirements of the main roles and responsibilities for the delivery of safe, effective tunnel management on the State Highway network.

Tunnel Management includes the end-to-end consideration of all aspects of tunnels: overarching safety, testing, inspection, maintenance, and operational requirements. It also includes any associated assets software and telecommunications systems.

These requirements have been developed from the following documents (refer to clause 0):

(a) PIARC 2012R12EN Recommendations on management of maintenance and technical inspection of road tunnels

(b) PIARC 2022R34EN Good Practices in Maintenance and Traffic Operation of Heavily Trafficked (Urban) Road Tunnels

(c) AS1851: Maintenance of Fire Protection Systems and equipment

(d) NZS 4541: Automatic Fire Sprinkler Systems

(e) AS 1670.4 2004: Fire Detection, Warning and Intercom systems

(f) CM430: Maintenance of road tunnels

(g) CETU Guide to road tunnel safety documentation

Inspection procedures for the tunnel and tunnel approach structures are covered under the Waka Kotahi NZ Transport Agency specifications S6 *Bridges and other highway structures inspection policy* (NZTA S6). Geotechnical Structures are similarly covered by *NZTA S7: Geotechnical structures inspection policy*.

This specification has two parts: Part l Tunnel management requirements and Part ll Tunnel inspection and testing requirements.

2 COVERAGE OF THE SPECIFICATION

For the purposes of this specification, tunnels shall be as defined as:

(a) Any covered roadway less than 80m in length is considered an underpass and is therefore not covered by this specification. However, it should be noted that any enclosed structure between 30-80m long can experience similar fire characteristics as for a longer tunnel. In such circumstances the appropriate parts of this specification shall be applied to such underpass structures.

(b) Any tunnel between 80m and 240m in length shall be subject to the requirements of this specification, if there is mechanical ventilation or a fixed fire suppression system installed, or if it is otherwise deemed to be subject to the requirements of this specification by the Transport Agency's Lead Advisor Structures. Otherwise, the requirements will be determined on a case-by-case basis.

(c) For all tunnels over 240m in length, the requirements of this specification shall apply.

3 RELATED DOCUMENTS

3.1 Waka Kotahi NZ Transport Agency

(a) NZ Transport Agency (2017) NZTA S6 Bridges and other highway structures inspection policy. Wellington

(b) NZ NZ Transport Agency (2022) NZTA S7 Geotechnical structures inspection policy. Wellington

(c) NZ NZ Transport Agency (2012) Guide to road tunnels. Wellington

3.2 World Road Association (PIARC)

(a) World Road Association (PIARC) 2012R12EN Recommendations on management of maintenance and technical inspection of road tunnels

(b) World Road Association (PIARC) 2022R34EN Good Practices in Maintenance and Traffic Operation of Heavily Trafficked (Urban) Road Tunnels
(c) World Road Association (PIARC) 2019R05EN Introduction to the RAMS concept for road tunnel operations
(d) World Road Association (PIARC) 2016R01EN Best practice for life cycle analysis for tunnel equipment
(e) World Road Association (PIARC) 2012R14EN Life cycle aspects of electrical road tunnel equipment
(f) World Road Association (PIARC) 2021 LR01EN Improving road tunnel resilience, considering safety and availability

3.3 Other

(a) Austroads Guide to road tunnels Part 2 Planning, design and commissioning
(b) Standards New Zealand NZS 4541: Automatic fire sprinkler systems
(c) Standards New Zealand AS/NZS 3580.18:2017 Methods for sampling and analysis of ambient air. Part 18 Measurement of road tunnel air quality
(d) Standards Australia AS 1851: Maintenance of fire protection systems and equipment
(e) Standards Australia AS 1670.4 2004: Fire detection, warning and intercom systems
(f) Highways England CM430: Maintenance of road tunnels
(g) Centre d'Etudes des Tunnels (CETU) Guide to road tunnel safety documentation
(h) New Zealand Government Ministry for the Environment 2020. Measuring emissions: A guide for organisations: 2020 Detailed guide
(i) Austrian Research Organisation RVS 13.03.41 Strassentunnel – Betriebs-Und Siccherheitseinrichtungen

4 ROLES AND RESPONSIBILITIES

4.1 Tunnel Manager

Waka Kotahi will appoint a Tunnel Manager for each tunnel from the beginning of the preliminary design phase and throughout the life of the tunnel.

For proposed tunnels, the Tunnel Manager is to be consulted during preliminary and subsequent tunnel stages to:

(a) provide input into the tunnel concept of operations (including maintenance) development of the safety file.
(b) give a whole of asset life overview of the tunnel, and its role within the wider road network (by liaison with the Transport Operations Centre (TOC) Operations Manager).
(c) be part of the acceptance and handover process during the commissioning and testing phase.

Following construction, and for existing tunnels covered by this specification, the Tunnel Manager is responsible for that tunnel's management to ensure the following:

(d) relevant safety documentation (Safety File) is compiled, including the relevant inputs from the TOC and Tunnel Operation Managers, Emergency Services
(e) risk analyses
(f) relevant inputs from the Technology Team with regard to the tunnel telecommunications and SCADA systems
(g) act upon the findings of inspection and testing reports as necessary (refer clause ~~0~~5.2).

The principal duties of the Tunnel Manager are to ensure that:

(h) The Safety File (refer Appendix A) is compiled and updated.
(i) the required tunnel management plans, asset management plans, operational plans, safety plans, risk registers, fire life safety risk assessments, emergency management plans are in place, up to date and being fully implemented.
(j) the fire and life safety systems of the tunnel are serviceable, reliable, available and are operating within the operating parameters of the Safety File. When they are operating in a degraded mode, the Tunnel Manager is to ensure that the TOC Operations Manager is informed as soon as possible.
(k) inspection, testing and maintenance plans are prepared and approved.
(l) the tunnel's equipment and systems are inspected, tested, operated, maintained and repaired to the required compliance standards and levels of service set out in the Tunnel Asset Management Plan (TAMP) and Safety File.
(m) all statutory obligations are maintained current, i.e. that the systems that are subject to building warrant of fitness (BWoF) under the Building Act 2004, and any other systems required to comply with relevant statutory legislation are maintained for compliance unless an official departure is obtained.
(n) operational staff and relevant emergency services are trained according to the operational plans with periodic emergency event exercises for tunnel staff, operators and the emergency services. Exercise event reports are prepared, and any follow up actions closed out.
(o) coordination with the emergency services and incident and accident evaluation occurs.
(p) an annual safety report is prepared. This is to include the incident and accident data and analysis and recommendations on tunnel asset management and traffic control (if necessary) to avoid tunnel incidents and accidents. This report is to be delivered to the Regional System Manager, the Principal Tunnels Engineer and the Lead Structures Advisor.
(q) Serious fire incident and accidents (involving FLS systems response) are investigated and evaluated in liaison with the TOC Operations Manager and the Safety Officer and debriefs and reporting undertaken to the System Manager, and relevant emergency services for their information and comment.
(r) Within one month of a significant tunnel fire incident or accident occurring, the Tunnel Manager, in liaison with the TOC Operations Manager is to prepare a debrief incident report that records the circumstances of the incident and send the debrief incident report to the Safety Officer for their

evaluation and reporting and the System Manager, and relevant emergency services for their information and comment.

(s) A continuous improvement process is in place to ensure that all aspects of the tunnel management are optimised.

(t) Tunnel sustainability, resilience and security plans are prepared.

(u) Tunnel preliminary and final annual plan requests as well as the three yearly NLTP funding requests are prepared and submitted in accordance with SM018. These requests will cover items within the scope of this specification.

(v) The Tunnel Manager is to support the Transport Technology Operations Team in the management of technology assets (see detail in clause0). The Tunnel Manager will set up an annual meeting to review the Technology Team's plan for system updates in the coming year and to discuss the asset management plan for technology assets associated with the tunnel. Any proposed changes to ITS items related to the tunnel are to be agreed with the Waka Kotahi Technology team.

4.2 Transport Operations Centre Operations Manager

The day-to-day real-time operations of tunnels and their systems (including but not limited to incident and emergency response coordination, fault and alarm monitoring) is the responsibility of the regional Transport Operations Centre (TOC) or Local Tunnel Operational Control Room. Each TOC or Local Tunnel Operational Control Room will assign a person, for the purposes of tunnel operations, to be designated as identified as the TOC Operations Manager.

The TOC Operations Manager is responsible for the safe real-time operation of the tunnel, all approaches and exits and for ensuring that:

(a) operators are available to carry out the functions of the day to day running of tunnels real time operations and incident response

(b) liaison with the Tunnel Manager to ensure that traffic operational and emergency procedures for when the tunnel is open, are in place and maintained, and for preparing and managing a general operations plan and any associated operational procedures and plans (refer to Waka Kotahi NZ Transport Agency's *Guide to road tunnels* for detail)

(c) contribute to and carry out the real time operations in accordance with the Safety File

(d) incident coordination and liaison are undertaken with Incident and emergency response teams (Fire and Emergency New Zealand (FENZ), New Zealand Police, Ambulance Services and Civil Defence (optional)) in conjunction with the Tunnel Manager and Tunnels Operations Manager

(e) operator training and development is undertaken

(f) incident and accident data are collected and routine reports on trending and data are sent to the Tunnel Manager and Waka Kotahi

(g) fault and alarm reporting are sent to the tunnel maintenance teams in line with agreed fault, priority, reporting and level of service timescales

(h) incident and accident debriefs, and reporting are undertaken. Within one month of a significant tunnel road accident or incident occurring, the TOC Operations Manager, in liaison with the Tunnel Manager is to prepare a debrief incident report that records the circumstances of the incident and send the debrief incident report to the System Manager, Tunnel Manager, Safety Officer and relevant emergency services for their information.

Some tunnel control systems (for example servers, workstations, video walls, DYNAC, SIDERA, FLIR, Vidsys and the fibre backbone network), including hardware, software, licensing, maintenance and performance, may be managed directly by Waka Kotahi. The TOC Operations Manager is to support Waka Kotahi in the management of these assets.

4.3 Technology Team

The Technology team is responsible for the operation and maintenance of a variety of transport technologies such as the ATMS system (DYNAC) and the ITSN network. These may differ between tunnels. The Technology team are to:

(a) Prepare and agree a RACI with the Tunnel Manager

(b) Carry out an annual review with Asset Manager to identify and update changes including the RACI

(c) Advise on technical standards

(d) Ensure the ongoing availability of tunnel ITS components noting the maintenance contractor is responsible for routine maintenance.

(e) Liaison with TOCs and tunnel managers

4.4 Tunnel Mechanical and Electrical Engineer

An individual is to be designated the Tunnel Mechanical and Electrical (M&E) Engineer for each tunnel or tunnel maintenance contract responsible for M&E elements. This engineer is to have:

(a) suitable experience of the supervision of M&E equipment installation, operation, inspection, testing and maintenance in tunnels, and experience working in a multi discipline environment.
(b) be able to evaluate the condition and functional performance of M&E equipment in tunnels.
(c) a good knowledge of applicable standards, codes and guidelines for tunnel construction and operation pertaining to M&E features.
(d) As a minimum, the Tunnel M&E Engineer should hold an appropriate tertiary qualification.

The Tunnel M&E Engineer is to:

(e) maintain overall management and technical supervision of the tunnel M&E equipment and building element inspection and maintenance programme scheduled by the Tunnel Manager
(f) take responsibility for the technical competence of all personnel or contractors involved in M&E and ITS equipment inspection and testing, building element inspections and maintenance activities.
(g) take responsibility for ensuring the integrity of all M&E and ITS equipment and building elements in the tunnels advised by the Tunnel Manager and Tunnels Operation Manager
(h) consult with Competent Persons, specialist staff and contractors as necessary.
(i) review or appoints design engineers to review relevant M&E and ITS equipment (in consultation with the Technology Team) and building element inspection and testing reports.
(j) Verify compliance with Waka Kotahi ITS Standards and Specifications with / to Transport Technology or seek departures from the standards.

Inspection, testing and maintenance shall be carried out by Competent Persons (see clause 4.6). The roles and responsibilities of the Tunnel M&E Engineer may be carried out by or delegated to others (e.g. where a tunnel operations manager is in place), provided that these roles and duties are fully documented in the Tunnel Asset Management Plan (TAMP), in line with this specification.

4.5 Tunnel Operations Manager

The day-to-day operations of tunnel assets and systems are the responsibility of the Tunnels Operation Manager.

The Tunnels Operations Manager is responsible for the safe operation of the tunnel assets including those on all approaches and exits and for ensuring that:

(a) In conjunction with the Tunnel Manager, and Tunnel M&E Engineer, that the tunnel's systems and equipment are inspected, tested, maintained and repaired to the required compliance requirements, levels of service or within degraded modes set out in the TAMP and Safety File.
(b) there are appropriate responses to any tunnel asset breakdown or malfunction and that the tunnel is operating within its minimum operating procedures.
(c) traffic operational and emergency procedures are in place, in accordance with the Waka Kotahi NZ Transport Agency's *Guide to Road Tunnels.*
(d) incident coordination and liaison is undertaken with emergency response teams (incident response teams, FENZ, Ambulance Services, Civil Defence and New Zealand Police) in conjunction with the Tunnel Manager and TOC Operations Manager
(e) incident and accident data are collected and routine reports on trending and data are sent to the Tunnel Manager and Waka Kotahi
(f) fault and alarm reporting received from TOCs are prioritised and actioned in accordance with the level of service timescales and minimum operating parameters set out in the safety file.
(g) incident and accident debriefs, and reporting is undertaken. Within one month of a significant tunnel road accident or incident occurring, the Operations Manager, in liaison with the TOC Operations Manager is to prepare a debrief incident report that records the circumstances of the incident and send the debrief incident report to the Regional System Manager, Tunnel Manager, Safety Officer and relevant emergency services for their information and reporting.

4.6 Competent Persons

Inspection, testing and maintenance of M&E (including ITS) systems and equipment shall, unless otherwise approved by the Tunnels M&E Engineer, is to be carried out by competent persons with a current Practising Licence issued by the approved Registration Board. The competencies will be in accordance with the relevant New Zealand Qualifications Authority (NZQA) framework. This could be trade certification or technician (e.g. Electrical Service Technician) or similar approved certification. The competency qualifications and certification of each competent person is to be included in the annual tunnel safety report.

The M&E (including ITS) works includes the following systems: fire detection, warning, protection systems and equipment; power supply and distribution; lighting; control systems; security; environmental devices and plant as well as traffic control devices required during a tunnel incident.

4.7 Tunnel Safety Officer

The Tunnel Safety Officer provides independent reviews and recommendations to the Tunnel Manager regarding safety in the tunnel following a significant incident. The Tunnel Safety Officer should be a member of the Waka Kotahi Tunnels Safety Group but could be an independent consultant providing they have experience in tunnel operations. They are not involved in the day-to-day operations or maintenance of the tunnel but have experience in the safe management of tunnels.

The Tunnel Safety Officer's role provides the National Manager Maintenance and Operations with assurance that the TOC Operations Manager and the Tunnel Manager are operating the tunnel safely at all times for all users and operational staff.

The Tunnel Safety Officer is independent with regard to all road tunnel safety issues. The Tunnel Safety Officer is not constrained by operational pressures or budgets and thus provides independent recommendations to the National Manager Maintenance and Operations concerning safety in the tunnels.

The Tunnel Safety Officer performs the following tasks:

(a) In conjunction with the Tunnels Manager and the TOC and Tunnel Operations Managers is informed of the coordination with the Emergency Services and verifies that operational and emergency response plans are in place.
(b) Verifies to the National Manager Maintenance and Operations that safety documentation and associated operational plans have been prepared satisfactorily and communicated to the Emergency Services, TOCs and tunnel operational resources.
(c) Verifies to the National Manager Maintenance and Operations that operational staff are trained and takes part in the periodic emergency exercises.
(d) Takes part in the evaluation of any serious incident or accident as referred to by the Tunnel Manager (see clause 4.1(q) above. Reviews the incident evaluation report, prepared by the Tunnels Manager, and verifies to the National Manager Maintenance and Operations that the incident has been closed out and recommendations circulated to relevant parties.
(e) Following the occurrence of a significant incident, accident or a planned exercise drill, the Tunnel Safety Officer reviews the Tunnel Manager's evaluation report and notifies the National Manager Maintenance and Operations of their recommendations.

4.8 Tunnel Safety Group

The Tunnel Safety Group comprises of appointed qualified persons from: Tunnel Managers, TOC Operations Managers, Tunnels Operation Managers, Tunnel Safety Officers, Technology Team, FENZ and tunnel design and operations experts as required.

This group is to:

(a) Every 3 years, to carry out a periodic review of the Safety File including a review of the operations of the tunnel systems and to recommend any changes to the level of service (refer clause 0).
(b) Every 9 years, to carry out a major safety assessment of the tunnel systems and operations (including fire life safety) and to recommend any upgrades or changes to the level of service.

The non-core members of the team will be appointed by the Lead Advisor Structures and the Principal Tunnels Engineer.

4.9 Tunnel Building Officer / Inspector

An individual is to be designated the Tunnel Building Officer / Inspector for each tunnel or tunnel maintenance contract for building elements. This officer is to have:

(a) experience of the construction, inspection and maintenance of building structures, and is to be able to interpret their condition in terms of functional requirement.
(b) at least 10 years relevant experience.
(c) a relevant qualification in building construction.

The Tunnel Building Inspection Officer / Inspector:

(d) maintains overall management and technical supervision of the building inspection and maintenance programme for the tunnel buildings scheduled by the Tunnel Manager.
(e) takes responsibility for technical competence of all personnel involved in inspections.
(f) takes responsibility for the functional integrity of all tunnel buildings advised by the Tunnel Manager.
(g) takes responsibility for consulting with specialist staff when necessary.
(h) ensures that the schedule of tunnel buildings and the inspection requirements are appropriate and comply with this specification.
(i) either reviews or appoints a Design Engineer to review all tunnel building inspection reports.
(j) approves all tunnel building inspection reports.

4.10 Other Specialist Staff

In any situation where identification of any design or plant operation issues outside the competence of the normal tunnel roles, a specialist must be engaged to advise them.

This could include but not limited to:

(a) Design Engineer.
(b) Telecommunications Engineer.
(c) PLC/ Network / Systems Engineer.

4.11 Multiple Roles

The functional roles and responsibilities between the Tunnel Manager and M&E Engineer and also between the M&E Engineer and Tunnels Operation Manager can be combined or some functions transferred from one position to the other providing: the roles are clearly outlined in either the TAMP or the annual tunnel report; the personnel involved satisfy the required qualifications; and that all functional role requirements and responsibilities are fully covered.

All roles and multiple roles can apply across different tunnels.

5 OPERATION AND MAINTENANCE OF TUNNELS

5.1 General

There are six main elements involved in the operation and management of the tunnels. They are:

(a) The Safety File.
(b) A RAMS system (Reliability, Availability, Maintainability & Safety).
(c) Tunnel Asset Management System (TAMP) (including the LCMP).
(d) Tunnel Sustainability.
(e) Tunnel Resilience.
(f) Tunnel Security.

5.2 Safety File

5.2.1 Records

A Safety File shall be developed and maintained for every tunnel.

The Safety File is to be stored in a Core Share Folder with access being granted to all participants involved in the operation and maintenance of the tunnel, including the Emergency Services.

The File shall be developed and maintained in accordance with Appendix A.

5.2.2 Emergency Exercises

Emergency exercises are to be planned in consultation with the local emergency services providers (FENZ, Police, Ambulance) and the local TOC Operations Manager. The purpose of an exercise is to primarily demonstrate the integration of the response with the emergency services procedures for the road tunnel, together with the correct operation of all safety and emergency equipment. It is also to identify areas where there are gaps or potential for improvements as part of a continuous improvement regime.

5.3 Reliability, Availability, Maintainability, Safety (RAMS)

5.3.1 General

The principles of a RAMS system are to be considered for the maintenance and operation of e tunnels. Guidance for a RAMS system can be found in World Road Association (PIARC) 2019R05EN *Introduction to the RAMS concept for road tunnel operations.* A rigorous approach as specified in EN 50126 / IEC62278 is not necessary. However, the main intention is that all four aspects (reliability, maintainability, availability and safety) of the tunnel devices, equipment and systems are considered for the design, operation and maintenance of the tunnel.

5.3.2 Reliability

For the purposes of this specification, reliability is defined as the probability of a product, component or system performing its intended function, under stated conditions, without failure for a given period of time. The elements which require measurement and reporting are listed in Appendix B.

A legacy register is to be maintained that lists unresolved issues that weren't closed off or were only discovered after the construction / refurbishment handover. Also, a fault register is to be implemented which stores all system faults and alarms. This is to be stored on an appropriate database to allow for future analysis.

Appendix B sets out target minimum reliability requirements.

5.3.3 Availability

For the purposes of this specification, in a RAMS context, availability is defined as the ability of an item, product, component or system to be in a state to perform its required function (including when it is in a degraded mode), over a given period.

The Tunnel Manager is to determine the availability of the tunnel to road users by calculating the non-availability in hours due to maintenance, incidents and emergency exercises. The availability is also to be reported annually and should be stated in percentage (%) of the total maximum availability (8760 hours). The periods in degraded mode should be recorded.

The Transport Technology Operations team will report to the Tunnel Manager all relevant availability metrics and KPI data for ITS and ITSN systems.

5.3.4 Maintainability

For the purposes of this specification, maintainability is defined as the ability of a component or system to be maintained or repaired (excluding when it is in a degraded mode) within a stated period, so it can be returned to its required functionality.

Any new tunnel works are to be designed and installed such as to minimise the disturbance to the tunnel operations and to ensure that maintenance works can be carried with ease and minimal cost. This can be achieved by minimising the amount of equipment and controls in the tunnel, having the control boxes easily accessible (i.e. in Control Rooms or cabinets off the highway), having modular systems (e.g. plug and play) and employing air extraction methods for air quality monitoring.

5.4 Asset Management

5.4.1 Tunnel Asset Management Plan

A Tunnel Asset Management Plan (TAMP) is to be prepared and maintained (with associated plans and documentation). See the Waka Kotahi NZ Transport Agency's *Guide to road tunnels* for details.

The TAMP is to document the performance and condition of the M&E assets together with the ITS assets in consultation with the Waka Kotahi Technology Team. It is to incorporate a 30-year life cycle maintenance and renewals forecast schedule based on baseline maintenance and installation/renewal costs.

The TAMP is to be updated every three years to coincide with the preparation of the 3 yearly annual plan for the National Land Transport Plan (NLTP) submission including the 30-year life cycle schedule for the tunnel civil, electrical, mechanical, ITS items and equipment. It is to be completed in consultation with the Technology Team with regard to ITS items and equipment.

The baseline for the forecast schedule should be the date of the opening of the tunnel after its construction or last major refurbishment. Where available, the costs used should be aligned with the actual construction / refurbishment or maintenance / renewal costs. Expected lifespans for equipment are given in Appendix C.

The forecast should identify future significant and major refurbishments in order that the works can be optimised because of the limited specialist skill pool available for tunnel works, in each region and also to harmonise the works nationally.

The condition ratings are to be assessed in accordance with RVS *13.03.41 Strassentunnel – Betriebs-Und Siccherheitseinrichtungen*

Guidelines for Lifecycle analysis can be found in:

(a) PIARC 2016R01EN Best practice for life cycle analysis for tunnel equipment
(b) PIARC 2012R14EN Life cycle aspects of electrical road tunnel equipment.

5.4.2 Confirmation of Maintenance

Confirmation that scheduled maintenance work has been carried out is to be recorded in the relevant asset management system. This is to include the cost, description, quantity and timing of the completed work other than routine maintenance.

5.5 Sustainability and Environmental Requirements

5.5.1 Sustainability Plan

The tunnels are to be operated and maintained in accordance with Waka Kotahi's requirements for sustainability, including those related to climate change. A sustainability plan is to be developed, to measure and report on:

(a) total tunnel energy usage (both electricity and fuel), and the associated CO_2 emissions.
(b) fuel usage and km travelled of maintenance vehicles, and the associated CO_2 emissions.
(c) total water usage (testing and maintenance).

The plan should outline how to calculate the CO_2 emissions (measured as annual tonnes of carbon dioxide equivalent (tonnes CO_2-e)) associated with the tunnel's operation and maintenance activities. The plan should calculate a CO_2 emissions baseline together with financial costs and identify opportunities for reducing emissions. This could include initiatives such as ventilation on demand (VoD), LED lighting and traffic green waves. The emissions are to be calculated using the Ministry for the Environment guide: *Measuring Emissions: A guide for organisations, 2022 Detailed Guide*.

5.5.2 In-Tunnel Air Quality

The Tunnel Manager is responsible for the operational in-tunnel air quality monitoring undertaken in accordance with the following requirements:

(a) Air quality monitoring sensors shall be installed, calibrated and monitored by suitably qualified specialists in accordance with the manufacturers' requirements and relevant good practice.
(b) The siting of air quality monitoring sensors is to be determined in the design phase, by the Tunnel Manager in consultation with the Transport Agency's environmental and urban design team. An

extractive monitoring system should be used where possible to allow for the easy maintenance of the equipment. The design shall demonstrate that due consideration has been given of the need to demonstrate compliance with relevant in-tunnel air quality criteria in locations representative of the air breathed by tunnel users as well as maintenance, power, data capture, safety and security requirements relating to the equipment.

(c) Data shall be reviewed, analysed and reported by a suitably qualified specialist. A continuous record of results shall be routinely archived. Performance requirements for data capture and reporting frequencies shall comply with NZ Road Tunnel Air Quality Monitoring Systems guidance (based on AS/NZS 3580.18.

(d) Air quality and monitoring requirements shall comply with New Zealand Road Tunnel Air Quality Monitoring Systems guidance (based on AS/NZS 3580.18).

(e) Where there is a monitoring equipment malfunction, it is acceptable for a delay before repairing and calibrating the equipment, provided a ventilation regime is in place, based on past traffic and air quality data and analysis, which mitigates any risk of the allowable air quality levels being breached. These occurrences are to be recorded in the annual tunnel safety report.

5.5.3 Environmental Monitoring

In addition to traffic and ventilation monitoring systems there will also be a number of requirements for monitoring environmental and meteorological parameters in and around tunnels, for example air quality, noise, wind speed and direction, water usage and water discharge quality.

All monitoring data must be subject to an appropriately documented quality assurance and control regime. Raw and processed data should be securely stored and archived for future analysis. Further advice on monitoring should be sought from Waka Kotahi's Transport Services Programme and Standards (in particular the Structures team, Asset Management team and Environment and Sustainability team).

5.6 Resilience Requirements

5.6.1 Resilience Plan

A resilience plan is to be produced, taking into account the reliability and availability requirements to ensure the tunnel meets the resilience requirement of: *The ability to keep the tunnel available for traffic on an acceptable safety level, under various circumstances, notably disruptions to the normal conditions.*

Guidelines for a resilience plan can be found in World Road Association (PIARC) 2021 LR01EN *Improving road tunnel resilience, considering safety and availability*.

5.7 Security Requirements

A security plan for the tunnel, tunnel ancillary buildings and associated tunnel assets is to be produced. This is to incorporate a Security Response Plan and the outcomes from the periodic (nominally 2-yearly) Site Security Assessments carried out by the Waka Kotahi Land Transport Security Operations team.

Part II: Tunnel Inspection, Testing and Assessment

6 SCOPE

The elements to be inspected, tested or assessed are as follows:

6.1 Tunnel Mechanical and Electrical Equipment

All equipment and systems associated with operations, plant monitoring and control, traffic, communications and safety including but not limited to:

(a) Ventilation.
(b) air conditioning.
(c) Lighting.
(d) fixed fire suppression systems.
(e) drainage and pumping.
(f) fire safety and emergency response systems and alarms.
(g) communication and traffic control systems, including CCTV and AVID systems, remote controls and closures, traffic barriers, VMS, FMS, CMS, LCS, OHD, PA and RRB.
(h) tunnel operation and plant control systems including SCADA, ATMS and ITSN.
(i) monitoring systems (e.g. air quality, wind speed, noise, sensors, SCADA).
(j) power supply and distribution.
(k) water supply and distribution.

6.2 Tunnel Building Elements

Building elements of tunnels and associated control buildings, and other civil elements of tunnels, including:

(a) stairs, walkways and ladders, and access systems.
(b) screeds, roofs, downpipes, gutters, panels, doors, louvres, surface finishes and coatings.
(c) variable message signs, speed limit/lane control signs.
(d) other civil elements, including pavement, kerb, pits, line markings, barriers.
(e) suspended ceilings, cladding and panel elements.

6.3 Exclusions

The following items are not covered by this specification. Apart from Routine Surveillance Inspections, all structural parts of the tunnel are separately covered by NZTA S6) including:

(a) portals, structural linings, suspended ceilings, cladding and panel supports.
(b) associated service buildings, and plant rooms and civil structures including water and detention tanks.
(c) anchors supporting plant and equipment, and primary lining anchors.
(d) ventilation shafts.
(e) Tunnel pavement

Other structures, adjacent to tunnels, such as approach walls are also covered by NZTA S6. Geotechnical structures are covered in NZTA:S7.

7 INSPECTION AND TESTING PLAN

7.1 Requirements

Each tunnel is to have an Inspection and Testing plan as part of their Tunnel Asset Management Plan. The plan is to be a risk- based assessment taking into account the following:

(a) Importance.
(b) Functionality.

(c) performance and regulatory requirements.
(d) spare parts availability.
(e) technical obsolescence.
(f) expected lifespan.

The inspection and testing plan should detail the inspection objective, time schedule, inspection team including personnel qualification, access requirements, inspection areas, inspection and testing procedures and methodologies, inspection tools and tests, health and safety plan, safety equipment, traffic management and other specific requirements for the inspection. In assessing the importance of elements, they should be classified as compensatory or non-compensatory (refer clauses 7.2 and 7.3) and are to be identified in the plan.

Previous inspection and testing reports and existing tunnel records are to be reviewed as part of the inspection and testing planning.

The approved inspection and testing plan should be reported to the relevant System Manager.

7.2 Compensatory elements

Compensatory elements are those elements whose unavailability, malfunction or failure may be temporarily compensated by other types of equipment or operational measures, e.g.; RRB when the PA or VMS are available, air quality pollution sensors, AVID cameras.

7.3 Non compensatory elements

Non compensatory elements are those elements whose unavailability, malfunction or failure cannot be temporarily compensated by the system redundancy or other types of equipment or operational measures.eg: jet fans for smoke control, main electricity supplies.

8 CATEGORIES OF INSPECTIONS, TESTING AND ASSESSMENTS

8.1 Mechanical & Electrical (including ITS & ITSN)

8.1.1 Initial inspection and testing

An initial inspection is to be undertaken to establish the inspection file record and the baseline conditions for the tunnel. For new tunnels or a tunnel subject to a major refurbishment, the initial inspection shall be performed prior to opening to traffic to the public.

For existing tunnels, the initial inspection shall be performed within 24 months of the publication of this version of the specification, at a time to set an appropriate baseline to tie in with the periodic assessments and/or the triennial NLTP annual planning; or prior to the handover to a new maintenance contractor.

As a minimum, the initial inspection and testing should comprise of an appropriate number of observations and measurements to determine the physical and functional condition of the tunnel. These inspections and tests are intended to be comprehensive and cover tunnel M&E equipment, tunnel building elements and tunnel structure. The results are to be recorded.

The initial inspection and testing, before opening, is part of the commissioning process and is described in Austroads *Guide to road tunnels Part 2 Planning, design and commissioning*.

The initial tunnel inspection establishes the baseline conditions of the tunnel, and it is used to verify the initial tunnel inventory data. The baseline results can be used to evaluate changes over time to the tunnel systems and to help identify trends.

8.1.2 Routine surveillance inspection

Routine surveillance inspections are regular, informal inspections for obvious deficiencies that could lead to accidents or unnecessarily high maintenance costs. Common examples include, but are not limited to:

(a) collision damage

(b) road settlement
(c) water seepage
(d) defective equipment, signals and controls
(e) adequacy of signs and road marking
(f) movement or cracking of tunnel lining and tunnel portal walls
(g) structural elements involved in a major accident, chemical spillage or fire.

Although these may be informal, keeping basic records of routine surveillance inspection concerns is required.

The scope of routine surveillance inspections will depend on whether the tunnel is manned or unmanned, the tunnel informational systems which exist and how they are monitored.

8.1.3 Building warrant of fitness (BWOF) inspection and testing

For tunnels and control buildings with Compliance Schedules and 'specified systems' (i.e. life safety systems) installed, inspection, testing and maintenance activities will need to be carried out on behalf of the Transport Agency (the 'owner') to obtain a BWOF as required by the Building Act 2004. Any additional record keeping, or administrative activities required for compliance shall be undertaken.

Where required, the annual BWOF inspection and testing shall be certified by an independent qualified person (IQP).

Where a tunnel is exempt from BWOF requirements, any alternative compliance management processes, additional record keeping, or administrative activities, required for compliance shall be defined in the Inspection and Testing Plan.

Depending on the particular element, the frequency of inspection and testing is likely to reflect its criticality or functionality. This should cover any requirement or frequency required for a normal general inspection and testing.

8.1.4 General inspection and testing

General inspections and testing are thorough, visual inspections and testing of representative parts of the road tunnel and its equipment. The inspection and testing shall include an assessment of the condition of the tunnel M&E equipment and building elements.

Specific general inspection and testing requirements and procedures appropriate to each tunnel are to be developed. There is no need to duplicate the general inspection and testing if they have already been carried out as part of the BWOF inspection and testing, and providing the scope and frequencies are comparable with those of the approved inspection and testing plan. Refer to clause 7.1.

8.1.5 End to end interface fire system testing

The fire safety system is to have annual end to end interface testing to verify its integrity.

Every device / sensor in the mode table is to be triggered and the associated functional responses observed and recorded.

The triggering of these devices can be simulated with only a small proportion physically triggered.

The number of devices / sensors to be triggered can be assessed from its performance based on analysis of the previous test data.

8.1.6 Periodic assessment

Periodic Assessments are carried out every three years to coincide with the preparation of the 3 yearly Annual Plan for the NLTP submission. They generally coincide with the general inspection and testing, condition rating. They involve reviewing the Safety File: assessing all of the inspection, testing and operation records. The safety of the tunnel is assessed against its original approved reference condition or at its most recent major commissioning state.

8.2 Tunnel Building Elements

8.2.1 Routine surveillance inspection

As for Routine Surveillance Inspection in clause 8.1.2.

8.2.2 General inspection

As for General Inspection in NZTA Specification S6.

8.2.3 Principal inspection

As for Principal Inspection in NZTA Specification S6.

8.3 Major Safety Assessment

Major Safety Assessments comprise a closer and more detailed examination of all parts of the tunnel. The associated inspection and testing will most likely involve removal of cladding, casings, mountings to fans etc in order to gain access.

The inspections shall include an assessment of condition of the M&E equipment, systems and building elements. The BWOF requirements are to be reviewed and modified as appropriate.

The assessment will include a review of the tunnel design and operations including the safety file, inspections and testing and operation records, against its original approved reference condition or at its most recent major commissioning state. It also involves reviewing and addressing any deficiencies, improvements or practices which can improve or optimise the reliability, availability, maintainability, safety, sustainability and resilience of the tunnel against best tunnel operation and maintenance practice while also providing value for money.

As part of the review, reference is to be made to all relevant as-built drawings and maintenance and operation manuals for the road tunnel.

The Major Safety Assessment coincides with the third periodic assessment after the initial detailed inspection.

9 STANDARD OF TUNNEL INSPECTION AND TESTING

Inspection and testing for M&E elements shall, unless otherwise specified, be carried out to the standard defined in the publications:

(a) AS 1851: Maintenance of Fire Protection Systems and equipment
(b) NZS 4541: Automatic Fire Sprinkler Systems
(c) AS 1670.4 2004: Fire Detection, Warning and Intercom systems
(d) CM 430 *Maintenance of road tunnels*.

Where there may be conflict between these guidance documents and this specification, this specification shall take precedence unless otherwise specified in the Compliance Certificate.

10 INSPECTION AND TESTING FREQUENCY

The various categories of inspections and the frequency with which they are to be undertaken are listed in Appendix D and Appendix E and described in Clause 8.

Note that separate requirements for inspection may be included within the Inspection and Testing plans and the maintenance manuals for each tunnel.

The frequency of inspection and testing may be influenced by the environmental and operating conditions within the road tunnel, and the limited life and possible warranty conditions of certain M&E equipment.

Inspection and testing of Many items of M&E equipment will not be specifically required as routine servicing or testing will have achieved this objective.

Should inspection and testing reveal a serious ongoing hazard or defect affecting traffic operation or safety, then the Tunnel Manager and Operations Manager are to be informed immediately, and any mitigations or degraded mode of operation agreed and implemented.

11 REPORTING

11.1 Tunnel Inspection

Each inspection is to be reported in a format agreed with the Tunnel Manager.

Principal, periodic and building elements inspection reports are to contain the details of all inspections and investigations carried out. The reports are to include information on whether or not the part of the road tunnel inspected complies with the level of serviceability required by the operational plans and, if parts of the road tunnel do not comply, a description of how that tunnel fails to so comply and a recommendation of the measures (if any) to be adopted in order to increase that tunnel's safety is to be provided. Maintenance work, further detailed investigation or changes to the inspection regime are to be recommended as appropriate.

Each tunnel report, with recommendations, are to be sent to the Tunnel Manager.

If the results of any inspection show that emergency action is required, the Tunnel M&E/Structure Inspection Engineer is to immediately advise the Tunnel Manager and the Operations Manager, who is to implement agreed appropriate action as necessary.

Inspection reports and recommendations should be reviewed and evaluated by qualified personnel. The Regional System Manager, Operations Manager, Tunnel Manager and Tunnel M&E/Structure Inspection Engineer should be part of the evaluation team. Further special inspections, tests and specialist staff may be required to evaluate the results.

11.2 Mechanical and Electrical Equipment Database

The Tunnel Manager is to ensure that any changes required to any database of M&E equipment and building elements are undertaken for the specific tunnel.

11.3 Structures Database

Changes required to the asset owner's database, including the addition of structures, are to be reported to the Tunnel Manager on the necessary input forms.

The Tunnel Manager is to be responsible for approving the addition of structures to the database. Inspections are to be used to verify the data fields in the structures database and also to complete any missing data fields.

12 RECORDS

12.1 Tunnel Mechanical and Equipment Records

The Tunnel M&E Inspection Engineer is to maintain the files of tunnel M&E equipment and building element inspection records and maintenance, so that a continuous history of the M&E equipment in each tunnel is available.

The Tunnel M&E Inspection Engineer is to also maintain, for each tunnel, procedures for tunnel M&E equipment and building element inspections including specific access requirements, equipment requiring specific inspection and frequency of inspection.

12.2 Tunnel Building Element Records

The Tunnel Structure Inspection Engineer is to maintain the files of tunnel building element inspection records and maintenance, so that a continuous history of each tunnel is available.

The Tunnel Structure Inspection Engineer is to also maintain, for each tunnel, procedures for tunnel building element inspections including specific access requirements, features requiring specific inspection and frequency of inspection.

APPENDIX A

Safety File

1 Purpose

To provide a holistic approach which encompasses all of the participants involved in specific elements of the operation, maintenance and emergency response of the tunnel to ensure that they have an awareness of all aspects of the tunnel safety systems and procedures in order to efficiently implement the appropriate measures when required.

Safety is not just a matter of infrastructure and safety can only be achieved from a holistic approach. The composition of a typical Safety File in the operational phase is as shown in Figure 1 below.

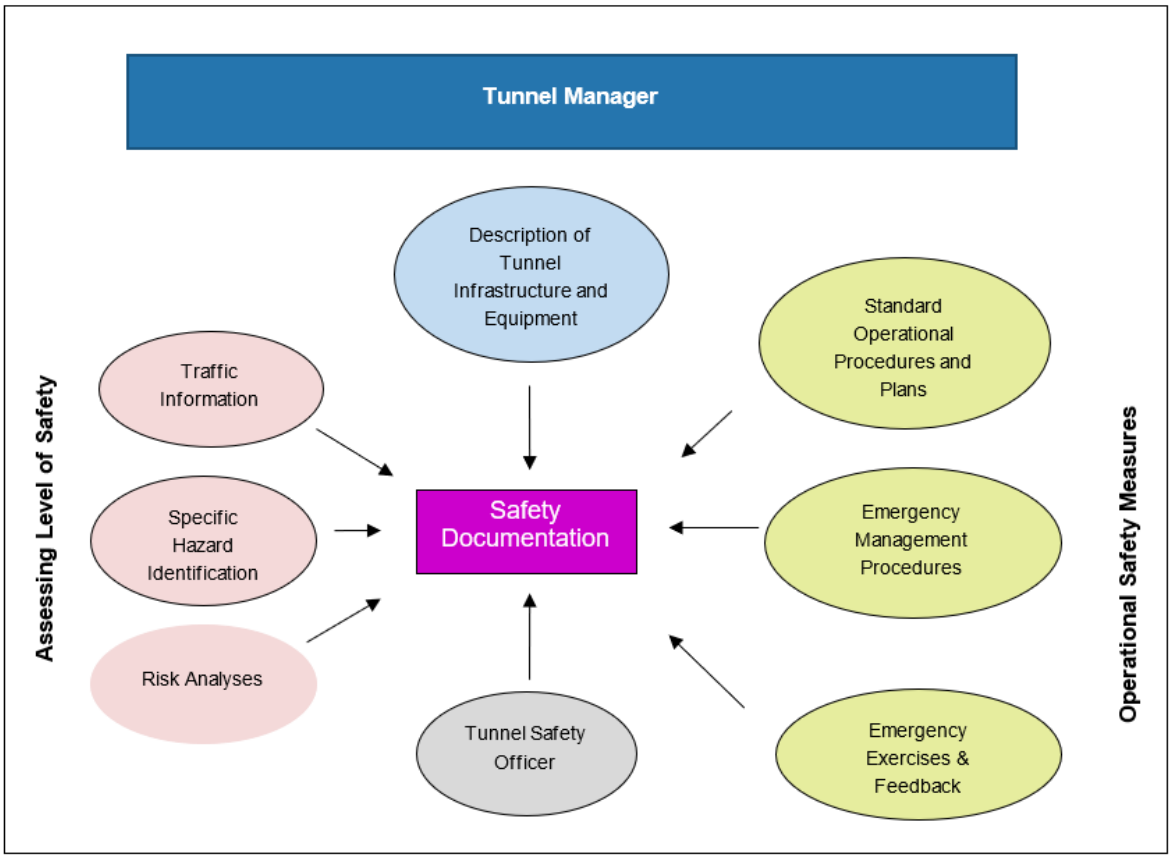

Figure 1: Typical Safety File

2 Tunnel Manager

The Tunnel Manager role is as described in clause 4.1. They have responsibility for the Safety File.

3 Tunnel Safety Officer

The Safety Officers role is as defined in clause 4.7.

4 Frequency of updates

The Safety File is to be updated, at a minimum annually, or when there has been a significant change in a contributing element.

5 Description of Tunnel Infrastructure and Equipment

This describes all elements in the tunnel as well as how they work. It is where the Tunnel Asset Management Plan, including all drawings, specifications, design reports, manuals and all records of commissioning, maintenance and inspection and testing reside.

6 Operational Safety Measures

6.1 Standard Operational Procedures and Plans

This contains all non-emergency operating procedures and plans for the tunnel including the minimum operating procedures (MoPs). These procedures would have been would have originally been created by the tunnel designer in liaison with the TOC Operations Manager. The MoPs are originally created by NZTA in liaison with the tunnel designer.

6.2 Emergency Management Procedures

There are two aspects to this. The Emergency Response Plan (ERP) for the fire life safety (FLS) aspects and the non FLS aspects e.g. crash in tunnel, breakdown, pedestrians in tunnel etc. The original FLS emergency response procedures will have been created by the tunnel designer in liaison with FENZ. This are most likely to be embedded in the SCADA (DYNAC) operating procedures.

The non-FLS emergency response procedures should originally have been created by the designer in liaison with the TOC Operations Manager. Post commissioning, additional procedures can be added by the TOC Operations Manager but must be approved by the Tunnel Manager.

FENZ's tunnel fire SoPs are to be included as well so all participants have a holistic view of emergency procedures.

6.3 Emergency Exercises and feedback

This includes all details and reports on emergency exercises. It also contains all reports on incidents and the lessons learnt from them. It should also contain an analysis of incidents and malfunctions and reports as part of a continuous improvement process.

7 Assessment of Level of Safety

7.1 Traffic Information

This includes historical, current and projected traffic in the tunnel (AADT & HGVs). It should also contain data relating to over height vehicle incidents, congestion and where possible also traffic speeds in the tunnel. Where applicable it should also include details of traffic devices which affect the free flow of traffic in or out of the tunnel. This should also include all relevant traffic regulatory requirements such as tunnel bylaws.

7.2 Specific Hazard Identification

This should include a list of all likely hazards in the tunnel whether they be traffic (e.g., breakdowns etc), environmental (e.g., flooding, fog, etc), equipment or SCADA /ITSN malfunction and personnel deficiencies (e.g., insufficient training, operator error, etc).

7.3 Risk Analyses

This contains all risk analyses including QRAs and bowtie analysis showing all lines of defence (mitigations/ safety devices). This also includes data relating to DGV detection and hazard studies of other hazardous carriers which may use the tunnel including comparative QRA analyses.

The bowtie analysis follows the Swiss cheese safety model (Figure 2) but the format can vary according to the analysis. Figure 3, Figure 4 and Figure 5 indicate different approaches.

The fire life safety risk assessment is to be updated at three yearly intervals.

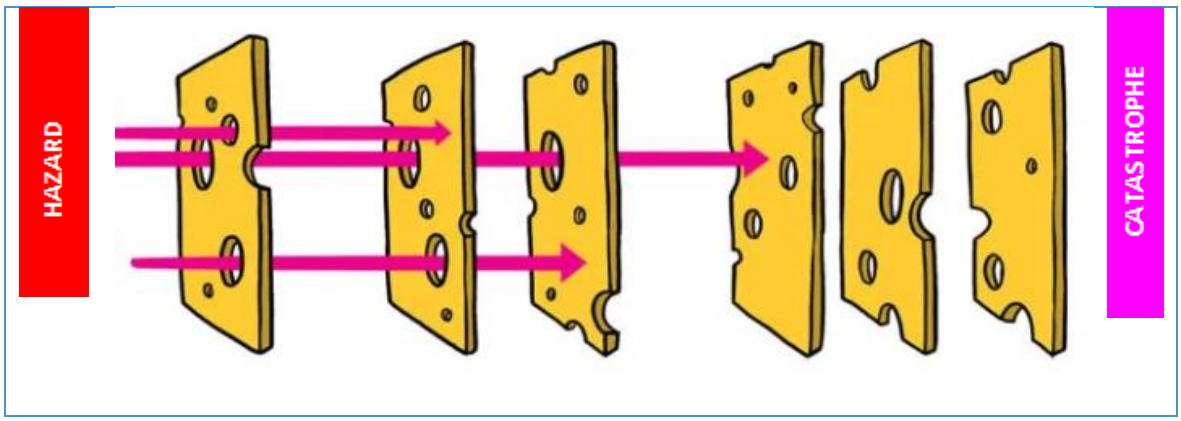

Figure 2: Typical Swiss Cheese Safety Model

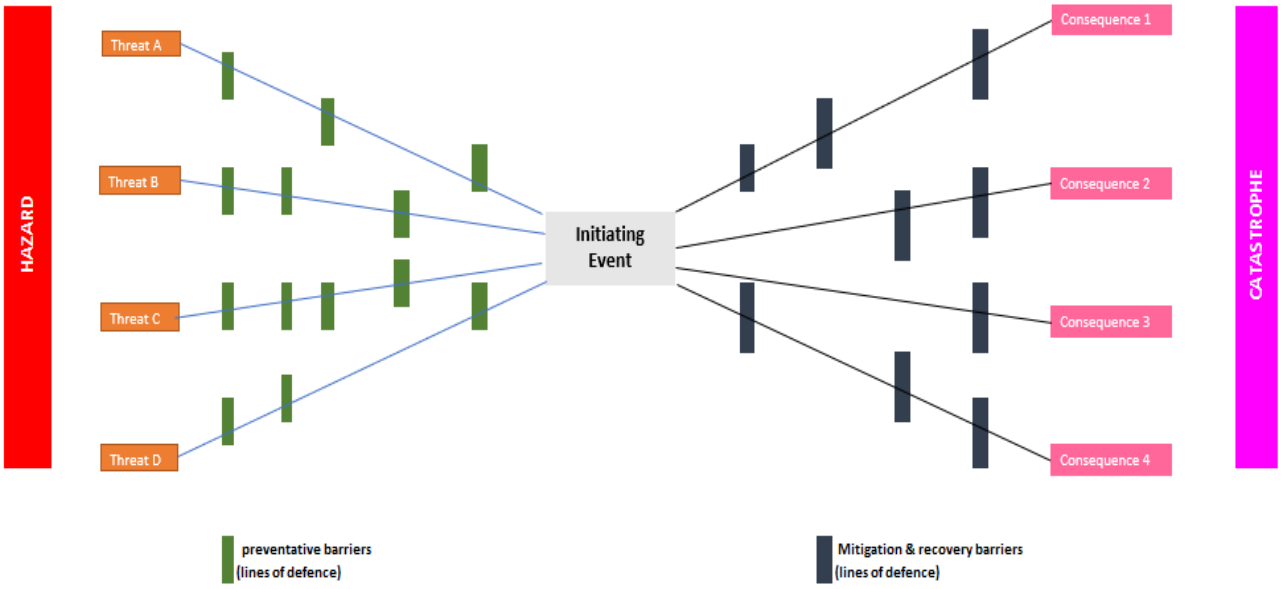

Figure 3: Typical Bowtie for Industrial Plant / Tunnel

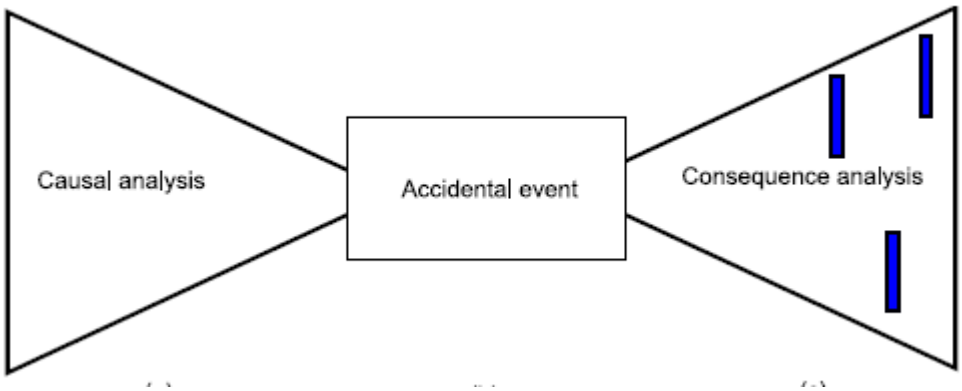

Figure 4: Typical causal - Consequence analysis

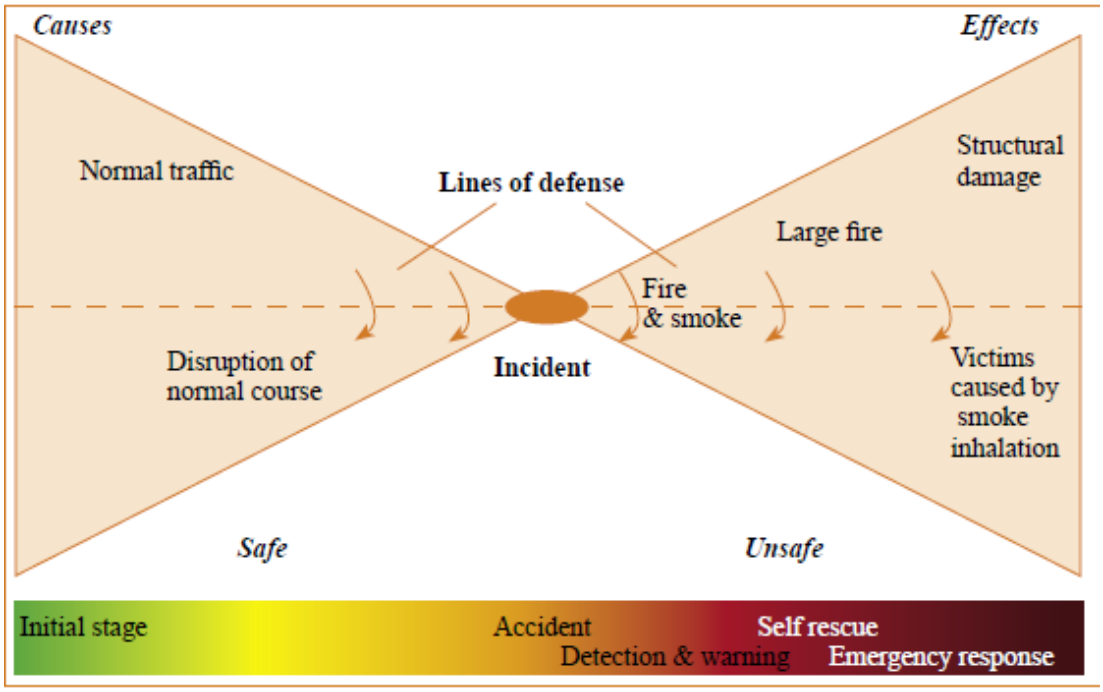

Figure 5: PIARC Bowtie Safety Model for Tunnels

APPENDIX B

Target Minimum Reliability Requirements

System or Item	Reliability Required (%)
TCMS	99.99
ITSN network	99.9
Power Supply	99.9
Power Supply (with N+1 redundancy)	98
PLC/ TMS	99.99
Traffic Barriers	99.9
OHD	98

AVIDS - minimum detection rates

Event	Detection rate (%)	Frequency of false alarms (FA / camera / day)	Detection delay (seconds)
Stopped vehicle	> 98	0.05	<12
Appearance of fumes/ smoke	> 95	0.025	<10
Congestion	> 97	0.025	<10 to 20
Vehicle in wrong direction	> 90	0.05	<2 to 5
Pedestrian in tunnel *	> 90	0.05	<10
Debris on road	> 80	0.05	<20
Slow vehicle	> 90	0.15	<5 to 10

APPENDIX C

Expected Lifespan of Tunnel M&E and building elements

Element	Years
Transformers	50
Switchgear	30
Emergency Power aggregates	20
HV Power Cables	50
Power Cables	40
Cables Comms	40
Cable ducts	50
Cable Ladders	50
Emergency Generators	25
UPS sets	15
Batteries Ni Cad	20
Batteries lead (gel)	10
Batteries lead (acid)	15
Jet fans	30
Jetfans - bearings	20
Axial fans	30
Axial fans - M&E parts	20
Variable Speed Drives (VSD)	25
Dampers	20
Cameras	15
Camera - control system	20
Camera - cabling	20
PA speakers	15
PA - control system	20
PA cabling	20
RRB	20
RRB - antenna, cables	20
Linear Heat Detectors	20
Fire Wire	15
Fire Alarm Panel	20
Manual Fire Alarm system	15
Control Buildings	
Air conditioning units	20
Gas Suppression System	20
Gas Suppression System - bottles	10
Fire Detectors	20
PLC	18
Security System	20

Element	Years
ECG	10
Luminaires	20
Lamps - HPS (hours)	41,000
lamps - Fluro (hours)	55,000
LEDs	15
LED Controllers	10
Photometers	15
Emergency exit lights	10
cross passage lighting	20
ECBD (in EEC)	20
Control Buildings	10
Air Quality Monitors NOx, CO	15
Air Quality Monitors visibility	15
Air Velocity Monitor	20
Water supply pipes (buried)	100
Water supply pipes (elevated)	50
Hydrants	50
Hose reels	20
Pipework (water)	40
EEC Cabinets	30
Deluge Valves	20
Deluge pressure valves	15
Deluge - pipework	40
Smart Studs (induction cable)	20
Fire Extinguishers	20
Smart Studs	15
LCS signs	15
VMS signs	15
CMS signs	20
Traffic Barriers	20
Overheight detection system	15
Traffic warning signals	20
Induction loops	13

APPENDIX D

Tunnel inspection and testing requirements (M&E and building elements)

Category of inspection / inspection and testing / assessment	Minimum frequency of inspection / testing	Personnel involved (minimum requirements)	Reporting
Initial detailed inspection and testing	For new tunnels, once prior to opening to traffic to the public. For existing tunnels, to be performed once within 24 months of the 2022 version of this specification and agreed with the Tunnel Manager.	. M&E Engineer / Tunnel Operations Manager / Competent Persons / Tunnel Building Inspection Engineer Tunnel M&E Engineer, Tunnel Manager or a competent person as appointed by the Tunnel Manager for existing tunnels.	In a format agreed with the Tunnel Manager
Routine surveillance inspection			
M&E equipment	The highest frequency of: as determined by risk assessment and agreed with the Tunnel Manager; or as stated in Appendix E.	Tunnel Operations Manager / Competent persons	As required
Building elements (eg doors, floors, stairs, ladders, cladding, roofs)	As determined from asset owner's manual information and through risk assessment, and agreed with the Tunnel Manager and Principal, but not less than annually.	Tunnel Operations Manager/ Tunnel Building Inspection Engineer	As required
General Inspection/ inspection and testing			
M&E equipment	The highest frequency as determined by risk assessment and agreed with the Tunnel Manager; or as stated in Appendix E.	M&E Engineer / Tunnel Operations Manager / Competent Persons	As required
Building elements (eg doors, floors, stairs, ladders, cladding, roofs)	2 yearly or as determined from asset owner's manual information or through a risk assessment agreed with the Tunnel Manager and Principal.	Tunnel Building Inspection Engineer	As required

Periodic assessment			
M&E equipment	3 yearly	Tunnel Safety Group	As required
Principal Inspection / Inspection and testing			
Building elements (eg doors, floors, stairs, ladders, cladding, roofs)	6 yearly unless otherwise as determined from asset owner's manual information and through risk assessment and agreed with the Tunnel Manager and Principal.	Tunnel Operations Manager / Tunnel Building Inspection Engineer	As required
Major Safety assessment			
Tunnel Structure, M&E equipment & building elements	9 yearly	Tunnel Safety Group	As required
Special Inspection			
M&E equipment	Immediately after a significant incident affecting the tunnel such as tunnel fire, major crash involving tunnel elements or an earthquake≥ MM VI, or as otherwise determined by risk assessment and agreed with the Tunnel Manager	M&E Engineer / Tunnel Operations Manager / Competent Persons	As required
Building elements (eg doors, floors, stairs, ladders, cladding, roofs)	Immediately after a significant incident affecting the tunnel such as tunnel fire, or an earthquake≥ MM VI, or as otherwise determined by risk assessment and agreed with the Tunnel Manager.	Tunnel Building Inspection Engineer	As required

APPENDIX E

Maximum Inspection and Testing frequencies for M&E elements

Plant / Plant Part	Initial detailed inspection	Routine Surveillance Inspection Frequency	General Inspection Frequency (months)	Functional Testing Frequency (Months)	Type of test	Conditional Rating (months)	General Inspection & Testing /Periodic Assessment (months)	Notes
Transformers	General	Annually	Annually	36	-	36	36	Performed by Electricity Utility Company
Switchgear / Switchboards	General	Annually	Annually	24	Thermography	36	36	
HV Power Cables	General	Annually	Annually	36	-	36	36	
Power Cables	General	Annually	Annually	36	-	36	36	
Cables Comms	General	Annually	Annually	-	-	36	36	
Cable ducts	General	Annually	annually	-	-	36	36	
Cable Ladders	General	Annually	annually	-	-	36	36	
Emergency Generators	General	Annually		1 12	Test Run Blackout test	36	36	
Distribution boards	General	With cleaning	Annually	24	Thermography	36	36	
UPS sets	General	With tunnel closure	With Function testing	12	Functional control test	36	36	
Batteries Ni Cad	General	With tunnel closure	With Function testing	12	Battery test	36	36	
Batteries lead (gel)	General	With tunnel closure	With Function testing	12	Battery test	36	36	
Batteries lead (acid)	General	With tunnel closure	With Function testing	12	Battery test	36	36	
ECG	General	With tunnel closure	With cleaning	-	-	36	36	
Luminaires	General	With tunnel closure	With cleaning / Annually	-	-	36	36	
Lamps - HPS (hrs)	General	With tunnel closure	With cleaning	-	-	36	36	
lamps - Fluro (hrs)	General	With tunnel closure	With cleaning	-	-	36	36	
LEDs	General	With tunnel closure	With cleaning	6	Functional control test	36	36	
LED Controllers	General	With tunnel closure	With cleaning	6	Functional control test	36	36	
Luminescent meter	General	With tunnel closure	With tunnel closure	12	Calibration	36	36	
Lighting System	General	With tunnel closure	With tunnel closure	6	Functional control test	36	36	Light functionality requirements checked as part of fire emergency system testing

Plant / Plant Part	Initial detailed inspection	Routine Surveillance Inspection Frequency	General Inspection Frequency (months)	Functional Testing Frequency (Months)	Type of test	Conditional Rating (months)	General Inspection & Testing /Periodic Assessment (months)	Notes
Photometers	General	With tunnel closure	With cleaning	12	Calibration	36	36	
Emergency exit lights	General	With tunnel closure	With cleaning	12	Functional control test	36	36	
Cross passage lighting	General	With tunnel closure	With cleaning	12	-	36	36	
ECBD (in EEC)	General	With tunnel closure	With cleaning	12	thermography	36	36	
Jet fans	General	With tunnel closure	With cleaning	12	Vibration tests	36	36	
Jetfans - bearings	General	With tunnel closure	With tunnel closure	20,000hrs	Relubrication / Functional control test	36	36	
Axial fans	General	With tunnel closure	With cleaning	12	Functional control test	36	36	
Axial fans - M&E parts	General	With tunnel closure	With cleaning	12	Functional control test	36	36	
Dampers	General	With tunnel closure	With cleaning	12	Functional control test	36	36	
Cameras	General	With cleaning	With cleaning	12	Functional control test	36	36	
Camera - control system	General	With cleaning	With cleaning	12	Functional control test	36	36	
Camera - cabling	General	With cleaning	With cleaning	-	Functional control test	36	36	
PA speakers	General	With cleaning	With tunnel closure	12	Functional control test	36	36	
PA - control system	General	With tunnel closure	With tunnel closure	12	Functional control test	36	36	
PA cabling	General	Annually	With tunnel closure	-	Functional control test	36	36	
RRB	General	With tunnel closure	With tunnel closure	6	Functional control test	36	36	
RRB - antenna, cables	General	Annually	With tunnel closure	12	Functional control test	36	36	
Linear Heat Detectors	General	6 monthly	With tunnel closure	12	Functional control test	36	36	
Fire Wire	General	6 monthly	With tunnel closure	12	Functional control test	36	36	
Fire Alarm Panel	General	With tunnel closure	With tunnel closure	12	Functional control test	36	36	
Manual Fire Alarm system	General	With tunnel closure	With tunnel closure	-	Functional control test	36	36	
Air Quality Monitors NOx, CO	General	With tunnel closure	6	12	Functional control test / calibration	36	36	
Air Quality Monitors visibility	General	With tunnel closure	6	12	Functional control test / calibration	36	36	
Air Velocity Monitor	General	With tunnel closure	12	12	Functional control test / calibration	36	36	

Plant / Plant Part	Initial detailed inspection	Routine Surveillance Inspection Frequency	General Inspection Frequency (months)	Functional Testing Frequency (Months)	Type of test	Conditional Rating (months)	General Inspection & Testing /Periodic Assessment (months)	Notes
Water supply pipes (buried)	General	-	-	-	-	36	36	Check waterflow
Water supply pipes (exposed)	General	6 monthly	Annually	12	-	36	36	
Water supply pump	General	6 monthly	Annually	12	Functional control test		36	
Backflow Preventers	General	6 monthly	Annually	12	Functional control test	36	36	
Watermain valves	General	Quarterly	Annually	12	Functional control test	36	36	
Hydrants	General	With tunnel closure	Annually	12	Functional control test	36	36	
Fire Hose Reels	General	With tunnel closure	Annually	12	Functional control test	36	36	
EEC Cabinets	General	With tunnel closure	6 monthly	-	-	36	36	
Deluge Valves	General	With tunnel closure	Annually	12	Functional control test	36	36	
Deluge pressure valves	General	With tunnel closure	Annually	12	Functional control test	36	36	
Deluge - pipework	General	With functional testing	Annually	12	-	36	36	
Deluge Nozzles	General	With functional testing	Annually		-	36	36	
Smart Studs	General	With tunnel closure	6 monthly	*12*	Functional control test	36	36	
LCS signs	General	With tunnel closure	Annually	*12*	Functional control test	36	36	
VMS signs	General	With tunnel closure	Annually	*12*	Functional control test	36	36	
CMS signs	General	With tunnel closure	Annually	*12*	Functional control test	36	36	
Traffic Barriers	General	With tunnel closure	Annually	*12*	Functional control test	36	36	
Overheight detection system	General	With cleaning	Annually	*12*	Functional control test	36	36	
Traffic warning signals	General	With cleaning	Annually	*12*	Functional control test	36	36	
Induction loops	General	With tunnel closure	Annually	*12*	Functional control test	36	36	
Control Buildings M&E								
Air conditioning units	General	Quarterly	Annually	quarterly	Functional control test	36	36	

Plant / Plant Part	Initial detailed inspection	Routine Surveillance Inspection Frequency	General Inspection Frequency (months)	Functional Testing Frequency (Months)	Type of test	Conditional Rating (months)	General Inspection & Testing /Periodic Assessment (months)	Notes
Gas Suppression System	General	Quarterly	Annually	12	Functional control test	36	36	
Gas Suppression System - bottles	General	Quarterly	Annually	-	-	36	36	
Fire Extinguishers	General	Quarterly	Annually	12	-	36	36	
Fire Detection System	General	With tunnel closure	Annually	12	Functional control test	36	36	
PLC	General	With tunnel closure	Annually	12	Functional control test	36	36	
Security System	General	Quarterly	Annually	12	Functional control test	36	36	

APPENDIX F

Acronyms

AVID	Automatic Video Incident Detection
AS	Australian Standard
ATMS	Advanced Transport Management System
BWoF	Building Warrant of Fitness
CCTV	Closed Circuit Television
CETU	Centre d'Études des Tunnels (French Centre for Tunnel Studies)
CMS	Changeable Message Sign
EN	European Standard
FENZ	Fire Emergency New Zealand
FMS	Fixed Message Sign
IEC	International Electrotechnical Commission
IQP	Independent Qualified Person
ITS	Intelligent Transport System
ITSN	Intelligent Transport System Network
KPI	Key Performance Indicator
LCMP	Life Cycle Management Plan
LCS	Lane Control Sign
LED	Light Emitting Diode
M&E	Mechanical & Electrical
NLTP	National Land Transport Plan
NZS	New Zealand Standard
NZTA	Waka Kotahi NZ Transport Agency
NZQA	New Zealand Qualifications Authority
OHD	Over Height Detection
PA	Public Address
PIARC	Permanent International Association of Road Congresses (World Roading Association)
PLC	Programmable Logic Controller
RACI	Responsible Accountable Consulted Informed
RAMS	Reliability Availability Maintainability Safety
RRB	Radio Rebroadcast
RVS	Richtlinien und Vorschriften für das Straßenwesen (Guidelines and regulations for road traffic -Austrian)
SCADA	Supervisory Control and Data Acquisition
TAMP	Tunnel Asset Management Plan
TOC	Transport Operation Centre
VoD	Ventilation on Demand