Master Specification
Part TUN-FIRE-DC1

Tunnel Fire Detection and Suppression Systems

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Government of South Australia
Department for Infrastructure and Transport

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Document Management

 This is a controlled document and it will be updated and reissued as approved changes are made.

Contents

TUN-FIRE-DC1 Tunnel Fire Detection and Suppression Systems

1 General

a) This Master Specification Part sets out the requirements for the design, supply, installation and testing of Tunnel fire detection and suppression systems including:

i) the documentation requirements, as set out in section 2;

ii) the technical requirements, as set out in section 3;

iii) the control and monitoring requirements, as set out in section 4;

iv) the reliability, Design Life, and functionality safety requirements, as set out in section 5;

v) the Witness Point requirements, as set out in section 6; and

vi) the verification and testing requirements, as set out in section 7.

b) For the purposes of this Master Specification Part, Tunnel fire detection and suppression systems includes the following subsystems:

i) Tunnel fire suppression, including:

A. deluge type fixed fire suppression system;

B. Tunnel hydrant system;

C. sump fire foam suppression system;

D. fire hose reels;

E. portable fire extinguishers;

F. emergency equipment cabinets; and

G. water supply for fixed fire suppression systems;

ii) Tunnel fire detection, including:

A. automatic incident detection system;

B. linear heat detection system; and

C. smoke detection system; and

iii) plant room fire detection and suppression, including:

A. systems for primary plant rooms;

B. systems for secondary plant rooms;

C. systems for Tunnel egress passageways;

D. systems for equipment rooms in egress passageways;

E. systems for services passageways;

F. gaseous fire suppression system requirements;

G. Tunnel Fire Control System (FCS); and

H. Tunnel Emergency Services facilities.

c) This Master Specification Part does not apply to:

i) fire detection and suppression systems in areas separate from the Tunnel infrastructure;

ii) lowered motorway hydrant systems;

iii) the supply specification of the automatic incident detection system (refer to RD-ITS-S5 “Imaging Equipment”);

iv) the design, supply, installation and testing of sump fire foam suppression systems (refer to TUN-ME-DC1 “Tunnel Hydraulics Treatment and Pumping”); or

v) the supply specification of Tunnel smoke detection sensors (refer to TUN-ME-DC5 “Supply of Tunnel Air Monitoring Instrumentation”).

d) The design, supply, installation and testing of Tunnel fire detection and suppression systems must comply with the Reference Documents, including:

i) AS/NZS 1221 Fire hose reels;

ii) AS 1668.1 The use of ventilation and air conditioning in buildings, Part 1: Fire and smoke control in buildings;

iii) AS 1670.1 Fire detection, warning, control and intercom systems - System design, installation and commissioning, Part 1: Fire;

iv) AS 1670.3 Fire detection, warning, control and intercom systems - System design, installation and commissioning, Part 3: Fire alarm monitoring;

v) AS 1670.4 Fire detection, warning, control and intercom systems - System design, installation and commissioning, Part 4: Emergency warning and intercom systems;

vi) AS 1670.5 Fire detection, warning, control and intercom systems - System design, installation and commissioning, Part 5: Special Hazards Systems;

vii) AS/NZS 1841 Portable fire extinguishers;

viii) AS 1851 Routine service of fire protection systems and equipment;

ix) AS 1906.1 Retroreflective materials and devices for road traffic control purposes, Part 1: Retroreflective sheeting;

x) AS 2118.1 Automatic fire sprinkler systems, Part 1: General systems;

xi) AS 2118.3 Automatic fire sprinkler systems, Part 3: Deluge systems;

xii) AS 2118.9 Automatic fire sprinkler systems, Part 9: Piping support and installation;

xiii) AS 2304 Water storage tanks for fire protection systems;

xiv) AS 2419.1 Fire hydrant installations, Part 1: System design, installation and commissioning;

xv) AS 2419.2 Fire hydrant installations, Part 2: Fire hydrant valves;

xvi) AS 2419.3 Fire hydrant installations, Part 3: Fire brigade booster connections;

xvii) AS 2419.4 Fire hydrant installations, Part 4: Storz fittings for firefighting purposes;

xviii) AS 2441 Installation of fire hose reels;

xix) AS 2444 Portable fire extinguishers and fire blankets - Selection and location;

xx) AS 2941 Fixed fire protection installations - Pumpset systems;

xxi) AS/NZS 3500 Plumbing and drainage;

xxii) AS 3786 Smoke alarms using scattered light, transmitted light or ionization;

xxiii) AS/NZS 4087 Metallic flanges for waterworks purposes;

xxiv) AS 4214 Gaseous fire-extinguishing systems;

xxv) AS 4312 Atmospheric corrosivity zones in Australia;

xxvi) AS 4428.3 Fire detection, warning, control and intercom systems - Control and indicating equipment, Part 3: Fire brigade panel;

xxvii) AS 4428.4 Fire detection, warning, control and intercom systems - Control and indicating equipment, Part 4: Emergency intercom control and indicating equipment;

xxviii) AS 4428.6 Fire detection, warning, control and intercom systems - Control and indicating equipment, Part 6: Alarm signalling equipment;

xxix) AS 4428.16 Fire detection, warning, control and intercom systems - Control and indicating equipment, Part 16: Emergency warning control and indicating equipment;

xxx) AS 4825 Tunnel fire safety;

xxxi) AS 7240 Fire detection and alarm systems (set);

xxxii) AS 60034.1 Rotating electrical machines, Part 1: Rating and performance;

xxxiii) AS 60849 Sound systems for emergency purposes;

xxxiv) AS/NZS IEC 60079.10.1 Explosive atmospheres, Part 10.1: Classification of areas - Explosive gas atmospheres;

xxxv) AS ISO 9906 Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1, 2 and 3; and

xxxvi) National Construction Code (NCC).

e) Without limiting the obligation to comply with the document to the extent they form Reference Documents in other Master Specification Parts, the following guidance documents must be considered and applied to the extent required by Law and to meet the Contractor's Best Industry Practice obligations:

i) Australasian Fire and Emergency Service Authorities Council, 2018, Fire Safety for Road Tunnels, (AFAC Publication No. 3003);

ii) Austroads Guide to Road Tunnels Part 2: Planning Design and Commissioning;

iii) ISO 3864 Graphical symbols - Safety colours and safety signs;

iv) ISO 7010 Graphical symbols - Safety colours and safety signs - Registered safety signs;

v) FM Global datasheet 3-7 Fire Protection Pumps;

vi) NFPA 20 Standard for the Installation of Stationary Pumps for Fire Protection;

vii) NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems;

viii) SafeWork Australia Guide for Tunnelling Work 2013;

ix) SAMFS Equipment Specification 001 Storz Couplings, Adaptors & Reducers;

x) SAMFS Built Environs Section Policy No. 006 - Control & Indication for Diesel & Electric Fire Pumps;

xi) SAMFS Built Environment Section Policy No. 14 - Above Ground Water Storage Tanks for Fire Fighting Purposes; and

xii) SAMFS Built Environs Section Policy 037 Fire Alarm Conditions of Connection.

2 Documentation

2.1 Design Documentation

In addition to the requirements of PC-EDM1 "Design Management", the Design Documentation must include:

a) a fire detection and fire suppression strategy report that includes:
   i) software to be used for the design calculations and modelling;
   ii) calculation and modelling methodologies to be used for the design;
   iii) calculation methodologies for system RAMS analysis as required by section 5.1a);
   iv) format for submission of calculations and modelling to the Principal;
   v) Tunnel fire detection and suppression control and functionality strategy;
   vi) proposed zoning of the deluge system and alignment with detection systems;
   vii) proposed deluge nozzle type and spray distribution;
   viii) proposed deluge valve locations and maintainability access provisions;
   ix) proposed deluge valve control configuration;
   x) proposed gaseous agent type and commercial availability of the agent;
   xi) proposed fire alarm notifications and the mechanism for transmitting these;
   xii) proposed Fire GUI style, interface, layout and locations;
   xiii) proposed fire detection control and indicating equipment style, interface, layout and locations;
   xiv) proposed Emergency Services facility layout and locations; and
   xv) proposed emergency equipment cabinet mounting, layout and locations;
b) a fire detection and fire suppression Design Report that includes:
   i) equipment selections and associated datasheets and technical details;
   ii) system arrangements and associated design descriptions;
   iii) evidence that the design will be consistent with other Tunnel projects in South Australia;
   iv) hydraulic calculations and modelling results for all fixed fire suppression systems;
   v) drift assessment due to in-Tunnel airflows for the selected deluge nozzle;
   vi) hazardous area assessment compliance for the sump fire foam suppression system in accordance with the requirements of TUN-ME-DC1 “Tunnel Hydraulics Treatment and Pumping”;
   vii) evidence of the deluge system high-temperature performance when exposed to fire;
   viii) MTTR and MTBF calculations for each system component;
   ix) availability and reliability calculations for each system;
   x) detailed system functional descriptions and control system requirements;
   xi) a coordinated services drawing set that includes:
      A. fire detection and suppression systems overlaid with all other Tunnel services; and
      B. indication of all required minimum clearances between other Tunnel services;
   xii) the design location of the water supply system;
   xiii) agreements with SAMFS for the following:
      A. fire hydrant outlet arrangements;
      B. emergency equipment cabinet mounting, location and layouts;

C. the water supply system pump sets;

D. the location and functionality of all fire detection control and indicating equipment;

E. the location and functionality of Fire GUIs; and

F. fire alarm notifications and the mechanism for transmitting these; and

xiv) the location, access and general arrangement of the Emergency Services facilities;

c) the deluge fire suppression system release valve control arrangement, as required by section 3.2.1f);

d) Tunnel hydrant system outlet arrangements, as required by section 3.2.2d);

e) details of Tunnel hydrant system cabinet mounting, location and interior layouts, as required by section 3.2.2g);

f) details of emergency equipment cabinet mounting, location and interior layouts, as required by section 3.2.6g);

g) SA Water certification regarding the water supply system incoming point of mains water supply capacity, reliability and availability as required by section 3.2.7d);

h) details of the gaseous suppression system design and suppressant proposed to be used, as required by section 3.4.7c);

i) details of fire alarm notifications and the mechanism for transmitting such alarms, as required by section 3.5.1f);

j) as part of the Preliminary Design Documentation, details of the nominated FCS, including supporting documentation, as required by section 3.5.1i);

k) schematic drawings for the FCS, as required by section 3.5.1m);

l) details of the fire detection, control and indicating equipment locations, layouts, interface, and functionalities, as required by section 3.5.2c);

m) details of the Fire GUI locations, layouts, interface, and functionalities, as required by section 3.5.3d);

n) details of Emergency Services facility locations, access and general arrangements, as required by section 3.6.1b);

o) details of Tunnel hydrant booster cabinet arrangements and locations, as required by section 3.6.1e);

p) hardstand and SAMFS vehicle access details, as required by section 3.6.1f); and

q) a Tunnel fire detection and suppression functionality report as required by section 4.1a).

2.2 Construction Documentation

In addition to the requirements of PC-CN3 “Construction Management”, the Construction Documentation must include:

a) certification of the supplied deluge nozzles, as required by section 3.2.1d); and

b) approval and certification documentation for gaseous fire suppression systems in accordance with AS 4214 Gaseous fire-extinguishing systems as required by section 7.5b).

3 Technical requirements

3.1 Design requirements

Tunnel fire detection and suppression systems must be designed and provided:

a) in accordance with the systems engineering requirements and the analysis for reliability, availability, maintainability, and safety (RAMS) in accordance with PC-EDM6 “Systems Engineering Management”;

b) based on the specifics of the Tunnel design and Tunnel location; and

c) based on the Fire Engineering design undertaken in accordance with TUN-FIRE-DC3 “Tunnel Fire Engineering”.

3.2 Tunnel fire suppression systems

3.2.1 Deluge fire suppression system

a) An automated deluge-based fire suppression system must be provided which:

i) complies with the requirements of AS 2118.3 Automatic fire sprinkler systems, Part 3: Deluge systems; and

ii) delivers 100% coverage for all Tunnels including:

A. any enclosed carriageways;

B. any enclosed on or off ramps;

C. any enclosed merges and diverges;

D. any structures at portals that create an enclosed extension of the Tunnel; and

E. any maintenance or breakdown bays that are integral to the Tunnel carriageways.

b) The deluge fire suppression system must provide a water application rate that is the greater of:

i) 10 mm per minute; and

ii) the requirements of the Contractor’s Fire Engineering design.

c) The deluge fire suppression system must:

i) provide coverage for the Tunnel carriageway surface area measured between the concrete traffic barriers installed to each side of the carriageway including any merge and diverge gores;

ii) provide a water application rate that is uniform (+10% - 0%) across all operating zones;

iii) ensure that the design water application rate is achieved at zone interfaces and the most hydraulically disadvantaged areas of all zones;

iv) account for the longitudinal air velocity induced by the Tunnel carriageway ventilation system to manage smoke during its fire mode operation;

v) allow for the elevated temperature conditions that would occur in the event of a Tunnel fire without suffering premature failure;

vi) ensure that the design application rate is achieved within 60 secs of deluge activation;

vii) be arranged as a continuous series of longitudinal zones which are coincident with the arrangement of the automatic incident detection system detection zones and any other Tunnel carriageway fire detection systems;

viii) facilitate the simultaneous discharge across any 3 zones at the design application rate; and

ix) be provided with pressure reducing valves to manage head induced by the Tunnel longitudinal alignment.

d) The deluge fire suppression system nozzles must be approved for operation as a deluge nozzle by either FM Global (FM) or Underwriter Laboratories Inc (UL). The Contractor must

submit evidence of the FM or UL approvals of the deluge nozzles as part of the Construction Documentation.

e) The deluge fire suppression system release valves must comprise 2 independently controlled deluge solenoids with:

   i) one deluge valve solenoid controlled by the PMCS PLC; and

   ii) one deluge valve solenoid controlled by the FCS.

f) The deluge fire suppression system release valve control arrangement must be submitted as part of the Design Documentation.

g) The deluge fire suppression system release valves must:

   i) be provided with a manual release; and

   ii) be Readily Accessible in spaces protected from traffic impact and the effects of fire (2-hour fire separated from the Tunnel carriageways).

h) The deluge fire suppression system zone lengths must be:

   i) maximised and have a minimum length of 20 m; and

   ii) consistent across the entire length of the Tunnel carriageways.

i) The deluge fire suppression system water supply pipework must be:

   i) entirely separate from the hydrant system supply pipework;

   ii) arranged as a ring main;

   iii) configured such that the failure of a section of pipe forming part of the deluge fire suppression system ring does not affect system performance; and

   iv) provisioned to accommodate all thrust loads.

j) The deluge fire suppression system must be provided with instrumentation that reports the supply pipework water flow and pressure to the PMCS.

k) The instrumentation required by section 3.2.1j) must:

   i) be located within the main deluge fire suppression system main supply pipework;

   ii) be located coincident within the deluge fire suppression system main supply pipework;

   iii) use separate instruments to measure flow and pressure; and

   iv) be Readily Accessible for maintenance and testing outside of the carriageway.

l) The deluge fire suppression system cross connections must:

   i) be at a maximum spacing of 480 m; and

   ii) occur via Tunnel egress passageways.

m) The deluge fire suppression system isolation valves must be:

   i) motorised isolation valves provided at a maximum spacing of 480 m;

   ii) provided with limit switches to monitor valve position;

   iii) able to be operated manually; and

   iv) Readily Accessible in locations protected from traffic.

n) The deluge fire suppression system arrangement must allow the manual operation of isolation valves protected from the effects of fire (2 hour fire separated from the Tunnel carriageways) to enable fallback use by the SAMFS.

o) The deluge fire suppression system must be arranged to allow the remote testing of motorised valves without the flow of water onto the Tunnel carriageway.

p) The deluge fire suppression system must be provided with dedicated redundantly configured pressure boosting pumps.

q) Control and indication of the deluge pumps must be in accordance with the SAMFS Built Environs Section Policy No. 006 - Control & Indication for Diesel & Electric Fire Pumps.

r) The deluge fire suppression system pressure boosting pumps must:

i) draw water from common fire water storage tanks, supplying both the deluge and hydrant systems;

ii) start automatically when fire mode is activated;

iii) automatically maintain the required pressure in the system; and

iv) have pressure measured via redundantly configured pressure sensors.

s) The deluge fire suppression system pressure boosting pumping design must include at least one standby pump at each pumping facility (N+1).

t) The deluge fire suppression system is not required to allow for pressure boosting by SAMFS.

u) The deluge fire suppression system pipework arrangements must:

i) be coordinated with other Tunnel services;

ii) allow the efficient aerodynamic performance of jet fans;

iii) allow the required lux distribution from Tunnel lighting;

iv) not impede signage sight lines; and

v) be located to allow maintenance access to all other Tunnel services.

v) The deluge fire suppression system pipework must be provided with electric solenoid valves to facilitate self-draining following discharge of the deluge.

w) The deluge zone extents must be marked and sequentially numbered using signage permanently applied to the Tunnel lining or wall panelling.

x) The deluge zone extents signage required by section 3.2.1w) must be Class 1 in accordance with the requirements of AS 1906.1 Retroreflective materials and devices for road traffic control purposes, Part 1: Retroreflective sheeting.

3.2.2 Tunnel hydrant system

a) A Tunnel hydrant system must be provided which:

i) complies with the requirements AS 2419.1 Fire hydrant installations, Part 1: System design, installation and commissioning; and

ii) provides full hydrant coverage for all Tunnel carriageways including:

A. any enclosed carriageways;

B. any enclosed on or off ramps;

C. any enclosed merges and diverges;

D. any structures at portals that create an enclosed extension of the Tunnel; and

E. any maintenance or breakdown bays that are integral to the Tunnel carriageways.

b) Tunnel hydrant system outlets must be:

i) double-headed; and

ii) Storz hermaphrodite type in accordance with SAMFS requirements.

c) Tunnel hydrant system outlets must be located:

i) on the Tunnel exit door side of the Tunnel carriageways;

ii) within 4 m of each Tunnel exit door, on the downstream side in the direction of vehicle travel;

iii) at a maximum spacing of 60 m;

iv) within 10 m outside of the Tunnel portals or any structures at portals creating an extension of the Tunnel carriageways; and

v) within Tunnel hydrant cabinets.

d) Tunnel hydrant system outlet arrangements must be submitted as part of the Design Documentation.

e) Tunnel hydrant system cabinet doors must:

i) not extend into the traffic envelope when in the open position;

ii) automatically latch in the open position; and

iii) be provided with switches to monitor their status (open or closed).

f) Tunnel hydrant system cabinets must be:

i) manufactured from grade 316 stainless steel and be integrated with any architectural lining system so as to enable mechanised wall washing to be efficiently completed;

ii) identified by statutory fire system signage with Class 1 retroreflective symbols in accordance with the requirements of AS 1906.1 Retroreflective materials and devices for road traffic control purposes, Part 1: Retroreflective sheeting; and

iii) provided with a unique sequential cabinet identification number, with the numbering regime commencing at the entrance portal of each Tunnel bore.

g) The Tunnel hydrant system cabinet mounting, location and interior layouts must be submitted with the Design Documentation.

h) The Tunnel hydrant system must:

i) allow for the simultaneous operation of 3 outlet heads at 10 L/s per head;

ii) achieve an outlet pressure of no less than 700 kPa for operation of the 3 most hydraulically disadvantaged hydrant outlet heads;

iii) limit the pressure at any Tunnel hydrant outlet head to no more than 1200 kPa; and

iv) be provided with pressure reducing valves to manage head induced by the Tunnel alignment.

i) The Tunnel hydrant system pressure and flow requirements must be achieved by the system pumps or when boosted by a SAMFS appliance.

j) The Tunnel hydrant system must be provided with instrumentation that reports the supply pipework water flow and pressure to the PMCS.

k) The instrumentation required by section 3.2.2j) must:

i) be located within the main Tunnel hydrant system main supply pipework;

ii) be located coincident within the Tunnel hydrant system main supply pipework;

iii) use separate instruments to measure flow and pressure; and

iv) be readily accessible for maintenance and testing outside of the carriageway.

l) The Tunnel hydrant system supply pipework must be:

i) entirely separate from the deluge fire suppression system supply pipework;

ii) arranged as a ring main;

iii) configured such that the failure of a section of pipe forming part of the Tunnel hydrant system ring main does not affect system performance; and

iv) provisioned to accommodate all thrust loads.

m) The Tunnel hydrant system ring main cross connections must:

i) be at a maximum spacing of 480 m; and

ii) occur via the Tunnel egress passageways.

n) The Tunnel hydrant system isolation valves must be:

i) motorised isolation valves provided at a maximum spacing of 480 m;

ii) provided with limit switches to monitor valve position;

iii) able to be operated manually; and

iv) readily accessible in locations protected from traffic.

o) The Tunnel hydrant system arrangement must allow the manual operation of isolation valves protected from the effects of fire (2 hour fire separated from the carriageways) to enable fallback use by SAMFS.

p) The Tunnel hydrant system must be arranged to allow the remote testing of motorised valves without the flow of water onto the Tunnel carriageway.

q) The Tunnel hydrant system must be provided with redundantly configured, dedicated pressure boosting pumps.

r) Control and indication of hydrant pumps must be in accordance with the SAMFS Built Environs Section Policy No. 006 - Control & Indication for Diesel & Electric Fire Pumps.

s) The Tunnel hydrant system pressure boosting pumps must:

i) draw water from common fire water storage tanks, supplying both the deluge fire suppression system and the Tunnel hydrant system;

ii) start automatically when fire mode is activated;

iii) automatically maintain the required pressure in the system; and

iv) have pressure measured via redundantly configured pressure sensors.

t) The Tunnel hydrant system pressure boosting pumps design must include at least one standby pump at each pumping facility (N+1).

u) The Tunnel hydrant system must be arranged to allow for pressure boosting by SAMFS.

v) The Tunnel hydrant system must be entirely separate from any lowered motorway hydrant systems.

3.2.3 Sump fire foam suppression system

a) Tunnel drainage sumps must be provided with hydrocarbon vapour detection in accordance with the requirements of TUN-ME-DC1 “Tunnel Hydraulics Treatment and Pumping”.

b) Tunnel drainage sump must be provided with fire foam suppression systems in accordance with the requirements of TUN-ME-DC1 “Tunnel Hydraulics Treatment and Pumping”.

3.2.4 Fire hose reels

a) Fire hose reels must comply with the requirements of:

i) AS/NZS 1221 Fire hose reels; and

ii) AS 2441 Installation of fire hose reels.

b) Fire hose reels with 36 m long hoses must be provided within each Tunnel hydrant cabinet required by section 3.2.2.

c) The fire hose reel water supply must be sourced from the Tunnel hydrant system mains.

3.2.5 Portable fire extinguishers

a) All portable fire extinguishers must comply with the requirements of:

i) AS/NZS 1841 Portable fire extinguishers; and

ii) AS 2444 Portable fire extinguishers and fire blankets - Selection and location.

b) Portable dry powder (ABE) extinguishers, with a capacity of 4.5 kg, must be provided within each emergency equipment cabinet required by section 3.2.6.

c) Portable CO_2 extinguishers, with a capacity of 5 kg, must be provided within each emergency equipment cabinet required by section 3.2.6.

3.2.6 Emergency equipment cabinets

a) Emergency equipment cabinets must be:

i) provided in compliance with the requirements of the DDA;

ii) arranged such that each item is accessible and operable without having to remove other items;

iii) manufactured from grade 316 stainless steel;

iv) designed and installed to prevent the accumulation of water within them; and

v) arranged so as to enable mechanised wall washing to be efficiently completed.

b) Emergency equipment cabinet doors must:

i) not extend into the traffic envelope when in the open position;

ii) automatically latch in the open position; and

iii) be provided with switches to monitor its status (open or closed).

c) Emergency equipment cabinets must be located:

i) on the left-hand side (that is adjacent to lane 1 relative to the direction of vehicle travel) of the Tunnel carriageways;

ii) at a maximum spacing of 60 m;

iii) at approximately the same chainage as the Tunnel hydrant system outlets as required by section 3.2.2; and

iv) within 10 m outside of the Tunnel portals or any structures at portals creating a covered extension of the Tunnel carriageways.

d) Emergency equipment cabinets must, as a minimum, contain:

i) one portable dry powder fire extinguisher, as required by section 3.2.5b);

ii) one portable CO_2 fire extinguisher, as required by section 3.2.5c); and

iii) 2 IP65 single phase 230 V 10 A switched socket outlets.

e) Emergency equipment cabinets must be provided with interior lighting which:

i) automatically switches on by the opening of the cabinet doors; and

ii) is powered from an essential services supply.

f) Emergency equipment cabinets must be provided with:

i) statutory fire system signage with Class 1 retroreflective symbols in accordance with the requirements of AS 1906.1 Retroreflective materials and devices for road traffic control purposes, Part 1: Retroreflective sheeting;

ii) a unique sequential cabinet identification number with the numbering regime commencing at the entrance portal of each Tunnel bore; and

iii) identification numbers that are discernible through the CCTV system.

g) Emergency equipment cabinet mounting, location and interior layouts must be submitted with the Design Documentation.

3.2.7 Water supply

a) The water supply system must consist of:

i) storage tanks;

ii) mains infill;

iii) pipework and valves;

iv) pumps;

v) metering;

vi) level control; and

vii) monitoring systems.

b) The water supply system and associated infrastructure must comply with the requirements of:

i) AS 2118.1 Automatic fire sprinkler systems, Part 1: General systems;

ii) SAMFS Built Environment Section Policy No. 14 - Above Ground Water Storage Tanks for Fire Fighting Purposes; and

iii) the Contractor's Fire Engineering design.

c) The water supply system incoming point of mains water supply must be supported with SA Water certification as to its capacity, reliability and availability.

d) The water supply system certification required by section 3.2.7c) must be submitted with the Design Documentation.

e) The water supply system must service adjacent bores forming the same Tunnel project.

f) The water supply system minimum capacity must jointly allow for:

i) the simultaneous operation of 3 Tunnel hydrant outlet heads for 4 hours; and

ii) the simultaneous operation of 3 deluge zones for one hour.

g) The water supply system storage tanks must be sized and arranged to allow for any required inspections or maintenance whilst maintaining the required flow and duration capability.

h) The water supply system design must combine the Tunnel fire suppression water supply system with water supply requirements for any surface infrastructure associated with the Tunnel.

i) The incoming water supply system isolation valves must be provided with limit switches to monitor valve position.

j) The water supply system must be provided with a means of monitoring, controlling and providing level indication and alarm notification for each water supply system storage tank.

k) The water supply system mains water supply must be able to completely refill the entire volume required for both deluge fire suppression system required by section 3.2.1 and the Tunnel hydrant system required by section 3.2.2, within 18 hours.

l) The water supply system tank must be provided with direct connections to SAMFS hydrant boosting assemblies in accordance with section 3.6.1c).

m) The water supply system must provide direct connections to SA Water mains supply at each SAMFS Tunnel hydrant boosting facility.

3.3 Tunnel fire detection systems

3.3.1 Automatic incident detection

The automatic incident detection system forming part of the Tunnel fire detection system must comply with the requirements of RD-ITS-S5 “Imaging Equipment”.

3.3.2 Linear heat detection

a) The linear heat detection system must be provided and function:

   i) in accordance with the Contractor’s Fire Engineering design; and

   ii) as a means of Tunnel interior air temperature monitoring.

b) The linear heat detection system zoning must align with:

   i) deluge zones along the length of the Tunnel carriageways; and

   ii) the detection zone boundaries of any other Tunnel fire detection systems provided.

c) The linear heat detection system must have the ability to accurately detect a fire incident within:

   i) a nominated zone (or adjacent zones) within the Tunnel; and

   ii) 5 m of the source allowing for the impact of convective heat transport by in-Tunnel airflows.

d) The linear heat detection system must be:

   i) redundantly arranged with no prospective single points of failure; and

   ii) provided to detect faults within the optic fibre cables to within 5 m of the fault.

e) The linear heat detection system must be capable of triggering alarms at:

   i) multiple user-configurable temperature settings; and

   ii) a user configurable rate of temperature rise.

f) The linear heat detection system alarm signals must be transmitted in less than 2 secs.

g) The linear heat detection system must measure temperature with

   i) an accuracy of +/-0.1°C at the centre point of any detection zone; and

   ii) a cycle time of less than 10 secs across all detection zones within a single Tunnel bore.

h) The linear heat detection system cabling arrangements must:

   i) enable each zone or a grouping of zones to be isolated for maintenance activities; and

   ii) be clear of obstructions and services that could result in shielding of radiant heat or cause any delay in the linear heat detection activation.

i) The linear heat detection system must be installed in accordance with:

   i) the cabling manufacturer’s requirements; and

   ii) the Contractor’s Fire Engineering design requirements.

3.3.3 Tunnel smoke detection

a) Tunnel smoke detection system sensors must be designed, supplied and installed in accordance with TUN-ME-DC5 “Supply of Tunnel Air Monitoring Instrumentation”.

b) Tunnel smoke detection system sensors must be installed in locations determined by the Contractor’s Fire Engineering design.

c) Tunnel smoke detection system sensors must be located to:

   i) mitigate false alarms from heavy vehicle exhaust; and

   ii) accurately detect smoke within the Tunnel accounting for the full range of in-Tunnel airflows.

d) The Tunnel smoke detection system controllers must be provided in locations that facilitate ease of maintenance access outside the Tunnel carriageway.

3.4 Plant room fire detection and suppression systems

3.4.1 General

a) Plant rooms forming part of the Tunnel infrastructure must be provided with fire detection and suppression systems suitable for their type, use and criticality, as set out in sections 3.4.2 to 3.4.7 (as applicable).

b) Plant room fire detection and suppression system requirements are based on the plant rooms having a fire resistance level to prevent fire spread that is suitable for their type and use.

c) Plant room fire detection and suppression systems must be provided for:

   i) primary plant rooms;

   ii) secondary plant rooms;

   iii) Tunnel egress passageways;

   iv) equipment rooms accessed via Tunnel egress passageways; and

   v) services passageways.

3.4.2 Primary plant rooms

a) All electrical power, control and communications infrastructure rooms that could incur major damage or loss due to fire, whose loss would then result in either Tunnel closure or degraded levels of operability or safety, must be classed as primary plant rooms.

b) Primary plant rooms must be provided with:

   i) aspirating smoke detection;

   ii) a secondary means of detection;

   iii) automatic gaseous suppression systems covering the room and all associated spaces, including any underfloor cable vaults; and

   iv) fire extinguishers suitable for the room type and use as defined by the Contractor’s Fire Engineering design.

c) The aspirating smoke detection and secondary detection required by section 3.4.2b) must be configured as a “double knock” for reliable operation of the gaseous suppression system.

3.4.3 Secondary plant rooms

a) All rooms containing equipment and systems where major damage or loss due to fire may not result in extended Tunnel closure or a significant degradation in operability or safety must be classed as secondary plant rooms.

b) Secondary plant rooms must be provided with:

i) smoke detection suitable for the room type and use as defined by the Contractor's Fire Engineering design;

ii) fire extinguishers suitable for the room type and use as defined by the Contractor's Fire Engineering design; and

iii) fire suppression systems as required by the Contractor's Fire Engineering design.

3.4.4 Tunnel egress passageways

a) Tunnel egress passageways must be provided with smoke detection.

b) Each Tunnel egress passageways must be a minimum of one zone in accordance with the Contractor's Fire Engineering design.

3.4.5 Equipment rooms accessed via Tunnel egress passageways

Equipment rooms accessed via Tunnel egress passageways must be provided with smoke detection zones separate from the Tunnel egress passageways.

3.4.6 Services passageways

a) Services passageways must be provided with fire detection and suppression systems in accordance with the Contractor's Fire Engineering design.

b) Services passageways must be provided with zoned and addressable fire detection with a detection resolution suitable for their use and length.

3.4.7 Gaseous fire suppression systems

a) Gaseous suppression systems must be:

i) of the "full flooding" type;

ii) be approved for use in South Australia; and

iii) provided with power supply and battery backup in accordance with AS 1670 Fire detection, warning, control and intercom systems - System design, installation and commissioning.

b) Gaseous suppression systems must use suppressant gas that:

i) is of the environmentally "clean" type;

ii) have zero ozone depletion potential;

iii) have 100 year global warming potential of less than 10;

iv) is non-proprietary; and

v) is readily available in South Australia for the purposes of rapid replenishment.

c) The gaseous suppression system design and proposed suppressant used must be submitted as part of the Design Documentation.

d) The gaseous suppression system design must include all necessary automated warning signage alerting any occupants prior to discharge so as to ensure their safe withdrawal from the room about to be flooded by gas.

e) The gaseous suppression systems and room ventilation systems must be coordinated to ensure appropriate operation of the ventilation during and after suppression.

f) The gaseous suppression system release must not activate until:

i) both aspirating detection system and secondary detection system confirm a fire event; or

ii) manual activation occurs.

3.5 Fire control system

3.5.1 General

a) The FCS must comply with the requirements of AS 7240 Fire detection and alarm systems.

b) The Contractor must identify in the Design Documentation any non-compliances of the FCS with AS 7240 Fire detection and alarm systems.

c) The FCS must be configured, installed, tested, certified, and approved in accordance with SAMFS Built Environs Section Policy 037 - Fire Alarm Conditions of Connection.

d) The FCS must provide both automated and manually initiated control as required by the Contractor's Fire Engineering design.

e) The FCS must activate an alarm to SAMFS using the alarm signalling equipment required by section 3.5.1f) when PMCS reports fire mode is active.

f) Fire alarm notifications and the mechanism for transmitting such alarms must:

i) comply with the requirements of SAMFS for fire alarm notifications; and

ii) be submitted with the Design Documentation.

g) The FCS must start the deluge fire suppression system and Tunnel hydrant pumps when commanded by the PMCS through enabling the start pumps signal.

h) All elements of the FCS must:

i) be commercially available within Australia;

ii) be locally supported within Australia by the original equipment manufacturer (OEM);

iii) not be published as being retired by the OEM;

iv) have demonstrated functionality and performance on road tunnel infrastructure projects of a comparable size and complexity to the Project; and

v) be supported by a pool of Australian practitioners capable of providing technical support independent of the OEM.

i) The nominated FCS, including supporting documentation, must be submitted with the Preliminary Design Documentation.

j) The FCS interface (Fire GUI) must comprise a logically configured HMI providing an intuitive easy to navigate operational environment.

k) An FCS style guide must be developed and submitted to the Principal for approval, which constitutes a **Hold Point**. Submission of Preliminary Design Documentation related to the FCS and procurement of any aspect of the FCS must not take place until the Hold Point has been released.

l) The FCS style guide required by section 3.5.1k) must take account of:

i) commonality with existing Fire GUIs and SCADA implementations already in use at the TMC;

ii) intended use of the Fire GUIs by SAMFS and Department operators;

iii) current Best Industry Practices; and

iv) human factors analysis.

m) Schematic drawings for the FCS must be submitted with the Design Documentation that are:

i) detailed to the level of all field devices connected to the FCS and any other connected systems and devices;

ii) detailed to the level of how all field device I/O is connected to the FCS and any other connected systems and devices;

iii) provide all I/O details of all field devices connected to the FCS and any other connected systems and devices; and

iv) are kept updated through all stages of the Project including as-built details.

n) The schematic drawings required by 3.5.1m) must be in a format and level of detail agreed with the Principal.

3.5.2 Fire detection control and indicating equipment

a) The FCS must include fire detection, control and indicating equipment.

b) The fire detection, control and indicating equipment required by section 3.5.2a) must be located and have the functionalities required by:

i) the SAMFS; and

ii) the Contractor's Fire Engineering design.

c) The fire detection, control and indicating equipment locations, layouts, interface, and functionalities must be submitted as part of the Design Documentation.

3.5.3 Fire GUIs

a) The FCS must include Fire GUIs.

b) The Fire GUI locations and functionalities must comply with:

i) the requirements of SAMFS; and

ii) the Contractor's Fire Engineering design.

c) The Fire GUIs must be consistent:

i) across the Project; and

ii) with other South Australian Tunnel projects.

d) The Fire GUI locations, layouts, interface, and functionalities must be submitted as part of the Design Documentation.

e) The Fire GUI must monitor the following systems:

i) the Tunnel fire detection systems required by section 3.3; and

ii) the plant room fire detection and suppression systems required by section 3.4.

f) The Fire GUI must allow for the monitoring and control of the Tunnel fire suppression systems required by section 3.2.

g) The Fire GUI must provide facility to command PMCS controlled ventilation systems as agreed with SAMFS in accordance with the Contractor's Fire Engineering design.

h) The Fire GUI must provide facility to command PMCS controlled deluge solenoid valves to be deenergised.

i) The Fire GUI must display the status of fire related devices provided by the PMCS as defined in section 4.2c).

j) The Fire GUI must display linear heat detection system temperature information on a zone basis in an arrangement that is:

i) acceptable to SAMFS; and

ii) consistent across the Project.

3.5.4 Linear heat detection

a) The FCS must pass linear heat detection alarms to the PMCS.

b) If a linear heat detection alarm passed to the PMCS is not acknowledged within a user configurable time the FCS must initiate a deluge release.

c) FCS initiation of the deluge must automatically start the greater of:

i) 2 deluge zones (incident zone and downstream zone); or

ii) deluge zones in accordance with Contractor's Fire Engineering design.

3.6 Emergency Services facilities

3.6.1 General

a) Emergency Services facility provisions for fire intervention purposes must satisfy the requirements of:

i) SAMFS; and

ii) the Contractor's Fire Engineering design.

b) Emergency Services facility locations, access and general arrangements must be submitted as part of the Design Documentation.

c) Tunnel hydrant system booster cabinets must be located:

i) at each Tunnel entry portal with connection for mains water supply; and

ii) at the water supply facility with connection to both the mains water supply and the tank supply.

d) Tunnel hydrant booster cabinets must contain:

i) remote hydrant pump controls;

ii) water storage tank level indication; and

iii) an Emergency Services telephone system handset.

e) Tunnel hydrant booster cabinet arrangements and locations must be submitted as part of the Design Documentation.

f) Hardstand and SAMFS vehicle access details must be submitted as part of the Design Documentation.

g) Hardstands must be located adjacent to SAMFS access roads and no more than 8 m from and directly facing the boosting facility.

h) SAMFS access roads must be at least 6 m wide to allow one SAMFS appliance to drive past another parked appliance.

i) SAMFS access roads must be sufficient to allow SAMFS appliances to arrive to Emergency Services facilities and depart without requiring the appliance to reverse.

j) Emergency Services telephones must be provided in accordance with TUN-COM-DC1 "Tunnel Voice Communications Systems".

k) Emergency Services telephone system handset must be provided at locations including:

i) TMC incident response room;

ii) TMC Traffic Control Room;

iii) BTMC Traffic Control Room;

iv) egress passageways;

v) at each Tunnel entry portal;

vi) at each Emergency Services staging area;

vii) at locations agreed with SAMFS; and

viii) at other locations identified in the Contract Documents.

l) Emergency Services telephones must automatically connect to the TMC traffic control room.

3.6.2 Emergency Services information points

a) ESIPs must be provided to allow Emergency Services personnel to access information and services vital for the effective management of motorway incidents and emergencies.

b) ESIPs must be provided within 50 m of each Emergency Services staging area located near the portals.

c) ESIPs provisions must satisfy the requirements of:

i) SAMFS; and

ii) the Contractor's Fire Engineering design.

d) At each ESIP, Emergency Services must have access to:

i) at least 6 simultaneous CCTV video streams displayed on monitors;

ii) the status and location of Tunnel fire alarms;

iii) the location of active deluge zones;

iv) the status of Tunnel ventilation systems;

v) the status of other Tunnel systems including:

A. water supplies;

B. water booster pumps;

C. active evacuation announcements; and

D. evacuation system status; and

vi) an Emergency Services telephone system handset.

e) The status and location information required by section 3.6.2d) must be shown on a monitor using a GUI.

f) Department operators must be able to:

i) control the displayed CCTV video streams at each ESIP from the Traffic Control Room;

ii) control the displayed status and location information at each ESIP from the Traffic Control Room; and

iii) confirm the correct operation of each ESIP using video surveillance systems.

g) The displayed CCTV video stream at each ESIP must:

i) be displayed with a resolution of at least 1920 x 1080 (Full HD); and

ii) allow the CCTV video stream to be viewed and interpreted from a distance of up to 1.5 m.

h) The Tunnel system status and location information at each ESIP must:

i) be displayed with a resolution of at least 1920 x 1080 (Full HD); and

ii) allow the status and location information to be read and interpreted from a distance of up to 1.5 m.

i) ESIPs must have an In-Service Availability of at least 99.9%.

4 Control and monitoring requirements

4.1 Functionality

a) A Tunnel fire detection and suppression functionality report must be developed that includes the following for the Tunnel fire detection and suppression systems:

   i) sufficient detail to be a standalone report that does not require reference to other documentation in order to be used for operational purposes and control system programming;

   ii) coordination of the functionality of the fire detection and suppression strategy;

   iii) narrative and schematic descriptions of the functionality for each system;

   iv) equipment interlocking methodology required for safe equipment operation;

   v) fail-safe operation of all mechanical devices;

   vi) functionality for duty sharing of duty and standby equipment;

   vii) functionality to compensate for unhealthy and unavailable equipment;

   viii) input/output lists for each instrument and sensor; and

   ix) input/output lists for equipment that includes event and alarm triggers.

b) The Tunnel fire detection and suppression functionality report required by section 4.1a) must be submitted as part of the Design Documentation.

4.2 FCS control and monitoring

a) The FCS and PMCS PLC must be interfaced for the exchange of data via an open protocol.

b) The FCS must exchange data with the PMCS PLC as required by the Contractor's Fire Engineering design.

c) The FCS must report to the PMCS the status of all devices connected to the FCS including:

   i) FCS controlled valves;

   ii) FCS deluge solenoid valve outputs;

   iii) manual valves monitored by the FCS;

   iv) instruments monitored by the FCS;

   v) deluge pumps;

   vi) hydrant pumps;

   vii) fire water tank levels;

   viii) FCS alarms or events;

   ix) linear heat detection zone alarms;

   x) linear heat detection zone temperatures; and

   xi) linear heat detection fault and status indications.

d) The FCS must accept the following commands and indications from the PMCS:

   i) current PMCS mode;

   ii) fire alarm acknowledged;

iii) activate deluge zone (per deluge zone);

iv) PMCS monitored fire related valve status;

v) PMCS controlled deluge solenoid valve status;

vi) air speed and direction in each Tunnel ventilation section; and

vii) start deluge pumps.

e) The FCS must provide ventilation commands to the PMCS in accordance with the Contractor's Fire Engineering design.

f) The FCS must be able to provide commands to the PMCS to deenergise PMCS controlled deluge solenoid valves.

4.3 Deluge fire suppression control and monitoring

a) Deluge fire suppression system motorised valves must be controlled and monitored by the PMCS PLC.

b) Deluge fire suppression system flow and pressure instruments must be monitored by PMCS PLC.

4.4 Tunnel hydrants control and monitoring

a) Tunnel hydrant system motorised valves must be controlled and monitored by the PMCS PLC.

b) Tunnel hydrant system flow and pressure instruments must be monitored by PMCS PLC.

c) Tunnel hydrant system cabinet doors must be monitored by the PMCS PLC including;

i) door open; and

ii) door closed

4.5 Emergency equipment cabinet control and monitoring

Emergency equipment cabinet door status must be monitored by the PMCS PLC including:

a) door open; and

b) door closed.

4.6 Water supply control and monitoring

a) Water supply system motorised valves must be controlled and monitored by the PMCS PLC.

b) Water supply system mains infill valves must be controlled and monitored by the PMCS PLC.

c) Water supply system water level must be monitored by the PMCS PLC.

d) Water supply system specific pumps, where provided, must be controlled and monitored by the PMCS PLC.

4.7 Plant room fire detection and suppression

4.7.1 Tunnel egress passageways

Tunnel egress passageways' smoke detection systems must be provided as a means of triggering automatic shutdown of any dedicated pressurisation facilities servicing the Tunnel egress passageways on detection of smoke as required by the Contractor's Fire Engineering design.

4.7.2 Aspirating smoke detection

Aspirating smoke detection systems must be configured with multiple alarm levels using guidance from AS1670.1 Fire detection, warning, control and intercom systems - System design, installation and commissioning, Part 1: Fire, including the following:

a) first stage alarm to raise a signal for personnel working in the area to investigate;

b) second stage alarm to raise a pre-alarm condition to the FCS;

c) third stage alarm to initiate evacuation of personnel working in the area; and

d) fourth stage alarm as an input to the gaseous fire suppression release defined by section 3.4.2c).

5 Reliability, Design Life, and functional safety requirements

5.1 Reliability and functional performance

a) The Tunnel fire detection and suppression systems must be designed and provided to comply with the systems engineering requirements and the analysis for reliability, availability, maintainability and safety (RAMS) in accordance with PC-EDM6 “Systems Engineering Management”.

b) The failure of any element of the FCS must not adversely impact the function or performance of the remainder of the FCS.

5.2 Design Life

a) The Tunnel fire detection and suppression systems must:

   i) use components and materials that are suitable for the specific Tunnel environment and installation conditions; and

   ii) be designed to achieve a minimum Category 3 in accordance with AS 4312 Atmospheric corrosivity zones in Australia.

b) The Tunnel fire detection and suppression systems installed in the Tunnel carriageway must be able to withstand high-pressure wall washing without any impact on the performance, the function or surface finish.

c) The Tunnel fire detection and suppression system signage within the Tunnel carriageway must be Class 1 type in accordance with the requirements of AS 1906.1 Retroreflective materials and devices for road traffic control purposes, Part 1: Retroreflective sheeting.

6 Hold Points and Witness Points

a) Table TUN-FIRE-DC1 6-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.

b) Table TUN-FIRE-DC1 6-2 details the review period or notification period, and type (documentation or construction quality) for each Witness Point referred to in this Master Specification Part.

Table TUN-FIRE-DC1 6-1 Hold Points

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
3.5.1k)	FCS style guide	Documentation	90 days review

Table TUN-FIRE-DC1 6-2 Witness Points

Section reference	Witness Point	Documentation or construction quality	Review period or notification period
7.1b)	Tunnel fire detection and suppression systems testing and commissioning	Construction quality	20 days notification

7 Verification requirements and records

7.1 General

a) Testing and commissioning procedures and documentation must be in accordance with the requirements of:

i) PC-CN1 “Testing and Commissioning”;

ii) all system component manufacturer and supplier recommendations;

iii) the Contractor’s Fire Engineering design; and

iv) the requirements of AS 4825 Tunnel fire safety.

b) The Principal and SAMFS must be invited to attend the progressive inspection, testing and approval of each system of the Tunnel fire detection and suppression systems testing and commissioning, which will constitute a **Witness Point**.

7.2 Fire Control System

a) In addition to the testing and commissioning required by section 7.1a), the FCS must include:

i) fully functional mock-ups of the Fire GUIs prepared as part of the Level 0 testing and commissioning; and

ii) the Fire GUIs must be demonstrated during Level 0 testing and commissioning to be fully compliant with the FCS style guide required by 3.5.1k) including:

A. screen layouts and appearance of information;

B. dynamic features such as indications and buttons;

C. navigation between screens;

D. administration function including logging in and logging out;

E. alarm screens; and

F. system status screens.

7.3 Tunnel fire suppression systems

7.3.1 Deluge system

a) Deluge fire suppression system commissioning and acceptance testing must be undertaken within each independent Tunnel bore.

b) Deluge fire suppression system commissioning must test every deluge zone individually.

c) Deluge fire suppression system commissioning required by section 7.3.1b) must demonstrate that water will correctly issue from each deluge zone upon the individual initiation of each zone by:

   i) the PMCS; and

   ii) the FCS.

d) Deluge fire suppression system acceptance testing must include operation performance evaluation of the 3 most hydraulically disadvantaged adjacent zones (with all 3 zones operating simultaneously).

e) Deluge fire suppression system acceptance testing must include operation performance evaluation of the widest zone and 2 adjacent zones (with all 3 zones operating simultaneously).

f) Deluge fire suppression system acceptance testing must use collection pans with a minimum width of 0.5 m and a minimum length of 0.5 m.

g) Deluge fire suppression system acceptance testing must include pans that must collect water for a period of operation of at least 3 mins.

h) Deluge fire suppression system acceptance testing must use a minimum of 8 collection pans positioned in each operating deluge zone.

i) Deluge fire suppression system acceptance testing must use multiple collection pans located in the operating zones to demonstrate both application rate and uniformity requirements have been achieved.

j) Deluge fire suppression system acceptance testing must use collection pans within each operating deluge zone which must be positioned at least 2 m from any other collection pan.

k) Deluge fire suppression system acceptance testing must be repeated a minimum of 4 times with different collection pan locations.

l) Deluge fire suppression system water application rate acceptance must be based on a measured water application rate of 10 mm per minute uniformly (+10% -0%) across all operating zones.

m) Deluge fire suppression system zone control must be tested in each tunnel bore to verify the mapping of the integrated deluge control through each system including:

   i) incident (automatic incident detection);

   ii) fire detection (linear heat detection and smoke detectors); and

   iii) CCTV for each fire detection zone.

n) Deluge fire suppression system commissioning must verify that remote deluge testing can be performed without the need for personnel to be located in the Tunnel.

o) Deluge fire suppression system commissioning must verify that post testing pipe drainage can be achieved without the need for personnel to be located in the Tunnel.

p) Deluge fire suppression system commissioning must verify remote testing of all motorised valves can be achieved with no flow of water onto the Tunnel carriageway.

q) Deluge fire suppression system pumps must be tested in accordance with SAMFS Built Environs Section Policy No. 006 - Control & Indication for Diesel & Electric Fire Pumps.

7.3.2 Tunnel hydrants

a) Tunnel hydrant systems must be tested and commissioned in accordance with the requirements of:

   i) SAMFS Built Environs Section Policy No. 006 - Control & Indication for Diesel & Electric Fire Pumps; and

   ii) AS 2419.1 Fire hydrant installations, Part 1: System design, installation and commissioning.

b) Tunnel hydrant systems must be commissioned to demonstrate that the water flowrate and pressure requirements for a range of hydrant locations, including the most hydraulically disadvantaged hydrants, that have been agreed with the Principal.

c) Tunnel hydrant systems must be fully drained of water following testing and commissioning.

7.4 Tunnel fire detection systems

7.4.1 General

Tunnel fire detection systems must be commissioned in accordance with the requirements of AS 1670 Fire detection, warning, control and intercom systems.

7.4.2 Tunnel smoke detection

a) The Tunnel smoke detection system performance must be demonstrated using cold smoke tests such as flares or other suitable smoke generating equipment.

b) The Tunnel smoke detection system performance must be demonstrated for a range of in-Tunnel airflow velocities and position of the smoke source along the length of the Tunnel.

7.5 Plant room fire detection and protection systems

a) Testing and commissioning of gaseous fire-extinguishing systems forming part of the plant room fire detection and protection systems must be in accordance with this section 7.5.

b) Approval and certification documentation for gaseous fire suppression systems as required by AS 4214 Gaseous fire-extinguishing systems must form part of the Construction Documentation.

c) Gaseous fire suppression systems must be tested and commissioned in accordance with the requirements of AS 4214 Gaseous fire-extinguishing systems.

d) Gaseous fire suppression system testing and commissioning must include room leakage or integrity testing to ensure the minimum extinguishing concentration hold time can be achieved.