

# Master Specification Part TUN-FIRE-DC2

## Tunnel Evacuation Systems

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## Contents

Contents	3
TUN-FIRE-DC2 Tunnel Evacuation Systems	4
1 General	4
2 Documentation	5
3 Technical requirements	6
4 Control and monitoring requirements	13
5 Tunnel evacuation response plans	14

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# TUN-FIRE-DC2 Tunnel Evacuation Systems

## 1 General

- a) This Master Specification Part sets out the requirements for the design, supply, installation and testing of Tunnel evacuation 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; and
  - iv) the Tunnel evacuation response plan requirements, as set out in section 5.
- b) For the purposes of this Master Specification Part, Tunnel evacuation systems includes the following subsystems:
  - i) Tunnel egress passageway treatment;
  - ii) Tunnel egress passageway doors;
  - iii) exit sound beacons;
  - iv) Tunnel evacuation signage;
  - v) Tunnel illuminated egress signs; and
  - vi) Tunnel egress lighting.
- c) This Master Specification Part does not apply to:
  - i) Tunnel carriageway lighting;
  - ii) Tunnel carriageway static signage;
  - iii) Tunnel egress passageway lighting;
  - iv) Tunnel electronic signs including lane use management system (LUMS) signs and Tunnel incident management signs;
  - v) incident management on Tunnel road and public spaces; or
  - vi) evacuation systems, lighting and signage for services buildings that are underground or above ground.
- d) The design, supply, installation and testing of Tunnel evacuation systems must comply with the Reference Documents, including:
  - i) AS 1319 Safety signs for the occupational environment;
  - ii) AS 1428 Design for access and mobility;
  - iii) AS 1530.4 Methods for fire tests on building materials, components and structures, Part 4: Fire-resistance tests for elements of construction;
  - iv) AS 1670 Fire detection, warning, control and intercom systems - System design, installation and commissioning;
  - v) AS 1905.1 Components for the protection of openings in fire-resistant walls, Part 1: Fire-resistant doorsets;
  - vi) AS 1906.1 Retroreflective materials and devices for road traffic control purposes, Part 1: Retroreflective sheeting;
  - vii) AS/NZS 2293 Emergency lighting and exit signs for buildings;
  - viii) AS 2700 Colour standards for general purposes;

- ix) AS 2822 Acoustics - Methods of assessing and predicting speech privacy and speech intelligibility;
- x) AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules);
- xi) AS 4825 Tunnel fire safety;
- xii) AS 60529 Degrees of protection provided by enclosures (IP Code);
- xiii) AS/NZS 60598.1 Luminaires, Part 1: General requirements and tests;
- xiv) AS 60849 Sound systems for emergency purposes (IEC 60849 MOD);
- xv) IEC 62262 Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code);
- xvi) Austroads AP-R583 Suggested Good Practice for Road Tunnel Emergency Egress Signage;
- xvii) AGRT Part 2: Planning, Design and Commissioning;
- xviii) National Construction Code (NCC); and
- xix) SafeWork Australia - Guide for tunnelling work.

## 2 Documentation

### 2.1 Design Documentation

- a) In addition to the requirements of PC-EDM1 "Design Management", the Design Documentation must include:
  - i) a DDA assessment report, including details of the location and navigation to the Tunnel egress passageway doors;
  - ii) demonstration of the coordination of the exit sound beacons acoustics with TUN-COM-DC1 "Tunnel Voice Communications Systems" and TUN-ME-DC6 "Tunnel Ventilation Equipment";
  - iii) luminaire data sheets for the selected luminaires;
  - iv) the following luminaire test reports, with the tests undertaken by a NATA accredited testing facility in Australia:
    - A. LM-79;
    - B. LM-80;
    - C. TM-21; and
    - D. in-situ temperature measurement testing (ISTMT);
  - v) the luminaire photometric files in both IESNA (.ies) and CIE (.cie) format associated with the LM-79 test; and
  - vi) Tunnel evacuation response plans as required by section 5b)iii).
- b) The LM-79 test required by section 2.1a)iv)A must include following parameters:
  - i) total luminous flux in absolute measurement;
  - ii) luminous efficacy (lumens per watt);
  - iii) luminous intensity distribution polar diagram (candela);
  - iv) correlated colour temperature (CCT);
  - v) colour rendering index (CRI); and

- vi) chromaticity coordinates.

### 3 Technical requirements

#### 3.1 General

- a) The design of the Tunnel evacuation systems must be coordinated to ensure that the location and heights of the Tunnel evacuation systems' devices will allow each device to be clearly visible.
- b) The luminaires used for Tunnel illuminated egress signs and Tunnel egress lighting must:
  - i) have an impact resistance rating not less than IK10 for areas accessible to the general public in accordance with IEC 62262 Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code); and
  - ii) have an impact resistance rating not less than IK08 for areas with restricted access in accordance with IEC 62262 Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code).

#### 3.2 Egress passageway treatments

- a) The circulation space and approach to each side of the egress passageway doors must be in accordance with PR-PF-D1 "Designing for Accessibility".
- b) There must be no grade separation between egress passageways and the pavement.

#### 3.3 Egress passageway doors

- a) Tunnel egress passageways must be fitted with doors on each end of the egress passageway.
- b) Egress passageway doors at entrances to cross passageways must be:
  - i) sliding doors designed to operate and be free moving without sticking or sudden movement under all Tunnel ventilation conditions;
  - ii) fitted with door handles that allow operation by people with a range of abilities in accordance with the outcomes of the DDA assessment report as required by section 2.1a)i);
  - iii) capable of being opened manually with a force of less than 110 N;
  - iv) controlled soft-closing to not cause injury or entrapment;
  - v) unable to be restrained open;
  - vi) fitted with automatic self-closing devices with no locks;
  - vii) able to withstand positive and negative pressures created by passing vehicles, including the associated hardware;
  - viii) fire rated with a fire resistance level the greater of -/120/120 or the level determined based on the Fire Engineering design undertaken in accordance with TUN-FIRE-DC3 "Tunnel Fire Engineering"; and
  - ix) fitted with a switch to enable monitoring by the PMCS to indicate when the door is in the closed position.
- c) The egress passageway doors required by section 3.3a) not at entrances to cross passageways must be in accordance with the performance and functional requirements determined by the Fire Engineering design undertaken in accordance with TUN-FIRE-DC3 "Tunnel Fire Engineering".

### 3.4 Exit sound beacons

- a) Sound beacons must be:
  - i) provided at the entrances to egress passageway doors;
  - ii) capable of providing a directional tone sound;
  - iii) capable of clearly and effectively propagating sound under emergency conditions; and
  - iv) in accordance with AS 1670 Fire detection, warning, control and intercom systems.
- b) Sound beacons acoustics must be designed to:
  - i) provide an audible tone throughout the Tunnel during emergency operations;
  - ii) achieve at least 10 dB (average) above the ambient noise level for tones;
  - iii) achieve an average level not exceeding 105 dB for tones; and
  - iv) be intelligible accounting for other in-Tunnel noise sources and the Tunnel acoustics.
- c) Sound beacons must have multiple sound tones that can be selectable from the PMCS.
- d) Sound beacons must be capable of being synchronised with other sound beacons.
- e) Sound beacons must be zoned to enable different tones to be provided between incident and non-incident areas.
- f) The sound beacon system must incorporate self-diagnostics.

### 3.5 Tunnel evacuation signage

#### 3.5.1 Egress point signage

- a) Egress passageway entrances from Tunnel carriageways must include:
  - i) an enlarged “running man” exit sign pictogram on each side of the egress passageway entrance oriented to indicate the exit direction; and
  - ii) a circular egress passageway identifier on the Tunnel side of the egress passageway door.
- b) The enlarged “running man” exit sign pictogram required by section 3.5.1a)i) must be:
  - i) in accordance with AS/NZS 2293 Emergency lighting and exit signs for buildings;
  - ii) Class 400 retro-reflective in accordance with AS 1906.1 Retroreflective materials and devices for road traffic control purposes, Part 1: Retroreflective sheeting; and
  - iii) 2 m high and a suitable width to maintain the pictogram proportions.
- c) The egress passageway identifier required by section 3.5.1a)ii) must:
  - i) be Class 400 retroreflective in accordance with AS 1906.1 Retroreflective materials and devices for road traffic control purposes, Part 1: Retroreflective sheeting;
  - ii) be located horizontally in the centre of the egress passageway door and above the height of the door handle;
  - iii) have the egress passageway number in white on a red background; and
  - iv) have characters with a minimum height of 300 mm.
- d) Egress passageway entrances from Tunnel carriageways must have a green and white chevron pattern provided on:
  - i) the egress passageway entrance area; and
  - ii) the Tunnel walls adjacent to the egress passageway entrance area.

- e) The green and white chevron pattern required by section 3.5.1d) must have the:
  - i) green and white stripes at 45 degrees to the vertical;
  - ii) green stripes at 200 mm width;
  - iii) green stripes in colour code G21 (Jade) in accordance with AS 2700 Colour standards for general purposes;
  - iv) white stripes at 100 mm width;
  - v) white stripes as commercially available white paint colour;
  - vi) white stripes converging on a horizontal axis through the centre of the door handle;
  - vii) white stripes with a vertical axis through the leading (opening) edge of the door;
  - viii) green and white stripes continued on both sides of the egress passageway door on to the Tunnel walls adjacent to the egress passageway entrance area for a width of at least 700 mm; and
  - ix) green and white stripes continued on to the Tunnel walls above the egress passageway entrance area for a width of at least 700 mm.

### 3.5.2 Egress passageway door signage

- a) Egress passageway doors must be provided with fixed signs on the Tunnel side (external face) of the door including:
  - i) a “running man” exit sign pictogram; and
  - ii) an “Emergency exit door alarmed” sign.
- b) The “running man” exit sign pictogram required by section 3.5.2a)i) must have:
  - i) a minimum size of 600 mm x 600 mm in accordance with AS/NZS 2293 Emergency lighting and exit signs for buildings; and
  - ii) a visual configuration in accordance with Table 4.2 of Austroads AP-R583 Suggested Good Practice for Road Tunnel Emergency Egress Signage.
- c) The “Emergency exit door alarmed” sign required by section 3.5.2a)ii) must have:
  - i) a minimum sizing of 300 mm x 150 mm; and
  - ii) a visual configuration in accordance with Table 4.2 of Austroads AP-R583 Suggested Good Practice for Road Tunnel Emergency Egress Signage.
- d) Egress passageway doors must be provided with fixed signs on the egress passageway side (internal face) of the door including:
  - i) a “Danger look out for moving vehicles” sign; and
  - ii) an egress passageway identifier sign.
- e) The “Danger look out for moving vehicles” sign required by section 3.5.2d)i) must have:
  - i) a minimum sizing of 450 mm x 300 mm in accordance with AS 1319 Safety signs for the occupational environment; and
  - ii) a visual configuration in accordance with Table 4.3 of Austroads AP-R583 Suggested Good Practice for Road Tunnel Emergency Egress Signage.
- f) The egress passageway identifier sign required by section 3.5.2d)ii) must have:
  - i) a minimum lettering height of 150 mm; and
  - ii) a visual configuration in accordance with Table 4.6 of Austroads AP-R583 Suggested Good Practice for Road Tunnel Emergency Egress Signage.



- g) Egress passageway doors must be provided with fixed signs on both sides of the door including:
  - i) a “Slide to open” sign using both words and pictogram; and
  - ii) a “Fire door do not obstruct” sign.
- h) The “Slide to open” sign required by section 3.5.2g)i) must have:
  - i) a minimum size of 300 mm x 100 mm; and
  - ii) a visual configuration in accordance with Table 4.2 of Austroads AP-R583 Suggested Good Practice for Road Tunnel Emergency Egress Signage.
- i) The “Fire door do not obstruct” sign required by section 3.5.2g)ii) must have:
  - i) a minimum size of 380 mm x 225 mm in accordance with AS 1319 Safety signs for the occupational environment; and
  - ii) a visual configuration in accordance with Table 4.2 of Austroads AP-R583 Suggested Good Practice for Road Tunnel Emergency Egress Signage.

### 3.5.3 Egress passageway signage

- a) Within the egress passageway fixed signs must be provided including:
  - i) a “You are in a safe place we know you are here” sign located in a prominent position immediately inside the entrance to an egress passageway;
  - ii) a retro-reflective “running man” pictogram exit sign in accordance with Table 3.2 of AS/NZS 2293.3 Emergency lighting and exit signs for buildings; and
  - iii) an “Emergency telephone” sign indicating the location of the help phone within the egress passageway.
- b) The “You are in a safe place we know you are here” sign required by section 3.5.3a)i) must have:
  - i) a minimum size of 1000 mm x 1000 mm;
  - ii) a minimum lettering height of 100 mm; and
  - iii) a visual configuration in accordance with Table 4.3 of Austroads AP-R583 Suggested Good Practice for Road Tunnel Emergency Egress Signage.
- c) The “Emergency telephone” sign required by section 3.5.3a)iii) must have:
  - i) a minimum size of 300 mm x 450 mm; and
  - ii) a visual configuration in accordance with Table 4.4 of Austroads AP-R583 Suggested Good Practice for Road Tunnel Emergency Egress Signage.

### 3.5.4 Refuge space signage

- a) Refuge spaces must be provided with fixed signs including:
  - i) wheelchair access symbol painted on the floor to identify the refuge space with a minimum size of 800 mm x 1300 mm in accordance with AS 1428 Design for access and mobility; and
  - ii) a “You are in a safe place we know you are here” sign located in a visible location within the refuge space.
- b) The “You are in a safe place we know you are here” sign required by section 3.5.4a)ii) must have:
  - i) a minimum size of 1000 mm x 1000 mm;
  - ii) a minimum lettering height of 100 mm; and

- iii) a visual configuration in accordance with Table 4.4 of Austroads AP-R583 Suggested Good Practice for Road Tunnel Emergency Egress Signage.

## 3.6 Tunnel illuminated egress signs

### 3.6.1 General

The following Tunnel illuminated egress signs must be provided:

- a) in-Tunnel directional exit signs; and
- b) Tunnel emergency exit signs and strobe light.

### 3.6.2 In-Tunnel directional exit signs

- a) In-Tunnel directional exit signs must be:
  - i) used to identify the egress route towards egress passages;
  - ii) provided in accordance with the requirements of AS/NZS 2293 Emergency lighting and exit signs for buildings;
  - iii) spaced at a maximum of 30 m intervals;
  - iv) positioned on the same Tunnel wall as the emergency exit doors;
  - v) mounted at a consistent height that is between the top of the traffic barrier and 500 mm above the top of the traffic barrier;
  - vi) flush mounted where wall panelling is used or utilise a low-profile design to prevent encroachment on the traffic envelope in the absence of wall panelling;
  - vii) of a suitable height and width to maintain the pictogram proportions in accordance with AS/NZS 2293 Emergency lighting and exit signs for buildings;
  - viii) supplied from the Tunnel essential power; and
  - ix) provided with backup power supply for a minimum of 90 minutes.
- b) In-Tunnel directional exit signs must show the distance to the closest egress passageway in each direction as part of the in-Tunnel directional exit sign.
- c) The in-Tunnel directional exit sign luminaires must be:
  - i) not illuminated under normal conditions; and
  - ii) provided with the ability for the PMCS to dynamically control each sign to illuminate only that part of the in-Tunnel directional exit sign indicating the correct evacuation direction.

### 3.6.3 Tunnel emergency exit signs and strobe light

- a) Egress passageway entrances must be provided with emergency exit signs for identification of egress points during emergency conditions.
- b) Each emergency exit sign required by section 3.6.3a) must include:
  - i) an illuminated exit sign; and
  - ii) a high-powered strobe light.
- c) The emergency exit signs required by section 3.6.3a) must:
  - i) be mounted such that they are visible above every door of each Tunnel emergency egress point and egress passageway;
  - ii) have the exit sign pictogram continuously illuminated under normal operations; and
  - iii) have the exit sign pictogram, the strobe light and the downlight illuminated in the event of an emergency or a power failure.

- d) The emergency exit sign required by section 3.6.3a) must:
  - i) be of the triangular style with the “running man” exit sign pictogram on each visible triangle side on a standard white trans-illuminated area outside the areas of a green background in accordance with AS/NZS 2293 Emergency lighting and exit signs for buildings;
  - ii) be continuously illuminated with internal integrated LED lights in accordance with AS/NZS 2293 Emergency lighting and exit signs for buildings;
  - iii) be certified as compliant with AS/NZS 2293 Emergency lighting and exit signs for buildings;
  - iv) supplied from the Tunnel essential power; and
  - v) be provided with a backup power supply for a minimum of 90 minutes.
- e) The emergency exit sign required by section 3.6.3a) must have a strobe light:
  - i) located on top of the emergency exit sign (not on the triangular pictogram diffuser);
  - ii) of a Xenon type;
  - iii) with a colour and strength as required by the fire engineering process undertaken in accordance with the TUN-FIRE-DC3 “Tunnel Fire Engineering”; and
  - iv) with an IP rating of IP66 in accordance with AS 60529 Degrees of protection provided by enclosures (IP Code).

## 3.7 Tunnel egress lighting

### 3.7.1 General

The following Tunnel egress lighting must be provided:

- a) egress passageway alcove lighting;
- b) low level emergency luminaires; and
- c) low level egress guidance lighting.

### 3.7.2 Egress passageway alcove lighting

- a) Egress passageway alcove areas must be provided with egress passageway alcove lighting.
- b) The egress passageway alcove lighting required by section 3.7.2a) must be:
  - i) LED linear profile luminaires;
  - ii) capable of illuminating the egress passageway door area to assist pedestrians to locate the egress passageway door in the event of a fire or smoke incident;
  - iii) capable of providing 400 lux minimum average vertical illuminance on the egress passageway door with a minimum uniformity of 0.5;
  - iv) a L90 B10 lifespan not less than 50,000 hours;
  - v) supplied from the Tunnel essential power; and
  - vi) provided with a backup power supply for a minimum of 90 minutes.
- c) Luminaires for the egress passageway alcove lighting must:
  - i) be installed with mechanical and vandal-resistant fixing and mounting accessories;
  - ii) not use adhesive fixing or mounting; and
  - iii) be removable for maintenance and without damaging luminaires and mounting surfaces.

### 3.7.3 Low level emergency luminaires

- a) Low level emergency luminaires must be:
  - i) provided along the entire length of Tunnel walls with egress passageway doors;
  - ii) mounted at a consistent height that is approximately the height of the traffic barriers and below the directional exit signage;
  - iii) full cut-off type that emits zero luminous flux above the horizontal to the luminaire;
  - iv) able to provide illuminance of egress passageways at a minimum lux level at the floor in accordance with AS/NZS 2293 Emergency lighting and exit signs for buildings;
  - v) capable of providing 2.5 lux minimum illuminance at any point and uniformity not less than 0.3:
    - A. across a 1 m wide section from the toe of the vehicle barrier outwards onto the Tunnel carriageway surface, and
    - B. along the entire length of the Tunnel wall;
  - vi) supplied from the Tunnel essential power; and
  - vii) provided with a backup power supply for a minimum of 90 minutes.
- b) Low level emergency luminaires must be:
  - i) flush mounted with the wall panelling where wall panelling is used;
  - ii) utilise a low-profile design to prevent encroachment on the traffic envelope in the absence of wall panelling; or
  - iii) flush mounted within the vehicle barriers.

### 3.7.4 Low level egress guidance lighting

- a) Low level egress guidance lights must be provided in Tunnels:
  - i) on the walkway floor or Tunnel walls at a consistent height that is approximately the height of the traffic barriers;
  - ii) in the proximity of each egress passageway door; and
  - iii) with 10 lights at 1.2 m spacing on each side of the alcove.
- b) Low level egress guidance lights must be provided in egress passageways:
  - i) on the egress passageway floor or walls at a consistent height with a maximum height of 500 mm above the floor; and
  - ii) at 1.2 m spacing between both egress passageway doors.
- c) Low level egress guidance lights must be:
  - i) inductively coupled enabling replacement without any need to access electrical wiring;
  - ii) supplied from the Tunnel essential power;
  - iii) provided with a backup power supply for a minimum of 90 minutes; and
  - iv) individually controllable by the PMCS.
- d) Low level egress guidance lighting must be:
  - i) flush mounted with the walkway floor; or
  - ii) the Tunnel wall panelling where wall panelling is used or utilise a low-profile design to prevent encroachment on the traffic envelope in the absence of wall panelling.

### 3.8 Environmental requirements

Tunnel evacuation system equipment must have the following ingress protection ratings in accordance with AS 60529 Degrees of protection provided by enclosures (IP Code):

- a) IP42 for electrical equipment within plant and equipment rooms;
- b) IP65 for equipment within the Tunnel; and
- c) IP66 for any electrical equipment which may be subject to high pressure washing during Tunnel wall cleaning or within the spray zone of the deluge system.

## 4 Control and monitoring requirements

### 4.1 General

- a) The Tunnel evacuation systems must integrate with the PMCS for control and monitoring.
- b) The Tunnel evacuation systems must be capable of providing the following status information:
  - i) the mode of operation where supported by the device (automatic / manual / disabled);
  - ii) the current state appropriate for the device, for example, on, off, scene displayed, or level selected; and
  - iii) any fault or event status.
- c) Tunnel egress lighting and Tunnel illuminated egress signs must be provided with automatic testing and monitoring facilities as required in TUN-FAC-DC1 "Requirements for Tunnel Facilities".

### 4.2 Fault monitoring

- a) The Tunnel evacuation systems must be continuously monitored for device status.
- b) A fault with one or more devices within the Tunnel evacuation systems must raise an alarm or event on the PMCS.
- c) Fault information provided must include:
  - i) the unique device identification;
  - ii) the device type;
  - iii) the device location; and
  - iv) fault description.

### 4.3 Exit sound beacon control and monitoring

Sound beacons required by section 3.4 must:

- a) be capable of being individually monitored and controlled by the PMCS;
- b) be capable of having selectable sounder tones changed remotely from the PMCS;
- c) report their status (operational / fault);
- d) have the following modes of operation:
  - i) automatic;
  - ii) manual; and
  - iii) maintenance;

- e) be capable of being enabled and disabled as part of an automatic evacuation sequence initiated from the PMCS when in automatic mode;
- f) be capable of being enabled and disabled from the PMCS when in manual mode; and
- g) be capable of being enabled and disabled from the PMCS when in maintenance mode.

## 4.4 Tunnel egress signs control and monitoring

### 4.4.1 In-Tunnel directional exit signs

In-Tunnel directional exit signs required by section 3.6.2 must be individually controlled and monitored by the PMCS.

### 4.4.2 Tunnel emergency exit sign strobe light

Tunnel emergency exit sign strobe lights required by section 3.6.3 must be capable of being individually controlled and monitored by the PMCS.

## 4.5 Tunnel egress lighting control and monitoring

### 4.5.1 Egress passageway alcove lighting

Egress passageway alcove lighting required by section 3.7.2 must be able to be controlled and monitored by the PMCS:

- a) individually per egress passageway alcove; and
- b) as a group per Tunnel.

### 4.5.2 Low level emergency luminaires

Low level emergency luminaires required by section 3.7.3 must be able to be controlled and monitored as a group per Tunnel bore.

### 4.5.3 Low level egress guidance lighting

Low level egress guidance lights required by section 3.7.4 must be individually controlled and monitored by the PMCS.

## 5 Tunnel evacuation response plans

- a) The Contractor must develop Tunnel evacuation response plans as part of the PMCS response plans required by TUN-PMCS-DC1 "Tunnel Plant Monitoring and Control Systems".
- b) The Tunnel evacuation response plans required by section 5a) must:
  - i) be developed through formally facilitated workshops with the TMC and other stakeholders including representatives of the Emergency Services;
  - ii) take account of the operation of the individual Tunnel evacuation system devices and groups of devices in different operational scenarios where the evacuation of Tunnel occupants may be is required; and
  - iii) be submitted with the Design Documentation for approval.