

TRANSPORT FOR NSW (TfNSW)

QA SPECIFICATION R158

ROAD TUNNEL AND UNDERPASS LIGHTING

NOTICE

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REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 0		First issue	GM, IC Bernie Chellingworth	14.07.08
Ed 1/Rev 1	Guide Notes 1.1, 3.1	<i>Notes to Tender Documenter</i> moved from Clauses 1.1, 3.1, 5.1, 5.2 and 6.5 to Guide Notes. Clauses reworded to make them generic.	GM, IC M Andrew	16.10.09
Ed 1/Rev 2	Global	“high pressure sodium lamps” changed to “twin arc high pressure sodium lamps”.	GM, CPS	12.11.13
Ed 1/Rev 3	5.1	Minimum output for twin arc HPS lamps specified.	GM, CPS	21.11.13
Ed 1/Rev 4	Global	References to “Roads and Maritime Services” or “RMS” changed to “Transport for NSW” or “TfNSW” respectively.	DCS	22.06.20

GUIDE NOTES

(Not Part of Contract Document)

USING SPECIFICATION R158

In assessing tunnel or underpass lighting designs, due consideration should be given to requirements of the light fitting such as the method of installation, access for servicing and other maintenance requirements.

To minimise maintenance risks, it is preferable to source light fittings from an established tunnel/underpass lighting manufacturer with a proven record in the manufacture and supply of tunnel/underpass light fittings.

Cost efficiencies can be realised in the life of the asset by identifying potential problems in the areas of installation, servicing and maintenance. Examine access equipment requirements, traffic control and working time limitations.

Optimising asset decision making can be realised by utilizing people with extensive design experience in tunnel/underpass lighting luminaires and adopting rigorous quality control of manufactured equipment.

This document will need to be customised by the Tender Documenter for each specific project. Customisation requires the insertion of additional information that is project specific or supplementary to the project works.

Existing Services

The Tender Documenter should give consideration to the suitability of existing services and equipment. Supplementary technical specifications may be required to cover the upgrading or provision of replacement main switchboards, distribution boards and control panels.

Depending on the nature of the project, consideration should be given to carrying out a condition assessment of the existing electrical service mains supply. If the findings of the assessment determine that the electrical service mains supply will need to be upgraded, then such works may be included as part of the Contract.

Clause 3.1 Design Criteria

The Tender Documenter should amend the design criteria to suit the project characteristics.

Where details of the wall surfaces are known, they should be included in the criteria.

Clause 5.1 Tunnel Luminaires - General

Where the Design Service Provider offers lamps other than those specified in Clause 5.1 e.g. 36W tubular fluorescent, in an effort to comply with AS/NZS 1158.5, an independent technical assessment on the merits of the design proposal conducted by a suitably qualified person should be sought as to whether it is an acceptable design.

Clause 5.2 Spare Parts

The spare parts quantities stated in clause 5.2 will need to be adjusted to suit the length of tunnel or underpass.

Clause 6.5 Tunnel Emergency Lighting

The provision of emergency lighting in service passageways, control rooms, machinery or plant rooms should be considered where applicable. Such systems must comply with the requirements of the Building Code.

TECHNICAL REFERENCE NOTES

The following notes are intended to provide guidance on the application of this Specification. They do not form part of the Specification.

Clause 5 Design

Sub-clause 5.1 Design Criteria

The TfNSW must specify the design criteria in accordance with AS/NZS 1158.5 “Lighting for roads and public spaces - Part 5: Tunnels and underpasses”, to enable the Contractor to commence the design phase of the tunnel lighting. This can either be accomplished by amending Clause 3.1 or specifying the design criteria in a separate document.

Design speed: Specify tunnel or underpass road speed.

Road surface characteristics: R3 Q_o 0.7.

Maintenance factor value:

If the tunnel is principally for use by motor cars, or if it is an underpass with good ventilation, then 0.8 is appropriate, e.g. Sydney Harbour Tunnel or Devlin Street at Top Ryde.

If the tunnel has high proportion of heavy goods vehicles, or there is lane changing and braking, or uphill gradients, then 0.7 is appropriate, e.g. M5 East Tunnel, Domain Tunnel or Crafers in Adelaide.

Traffic volume:

Specify whether “Light”, “Medium” or “High”.

“Light” is less than or equal to 100 vehicles per hour.

“Medium” is more than 100 vehicles per hour and less than 1,000 vehicles per hour.

“High” is more than or equal to 1,000 vehicles per hour.

Operating temperature: Nominal temperature specified is between 0 and 40 degrees Celsius.

Vertical surfaces including walls and safety barriers:

Wall linings will be provided by the building contractor to a height of (*insert dimension*) m above the safety barrier and must be of minimum 60 % diffuse reflectance.

or

Wall surfaces are off-form concrete. A diffuse reflectance value of 30% maximum must be used in the lighting design.

or

Wall surfaces is unfinished sandstone. A diffuse reflectance value of 10% maximum must be used in the lighting design.

or

Description and reflectivity of whatever material is used (e.g. Devlin Street, Top Ryde).

Wall brightness and associated reflectivity is as important as the road surface for the comfort and perception of motorists. When there are good reflective surfaces, e.g. Sydney Harbour Tunnel, less energy is expended lighting the walls.

With low reflectance wall surfaces the equivalent amount of light applied to the road has to be used on the walls to create equal brightness, e.g. M2 Tunnel at Epping.

If walls are to be off form concrete they should be painted, e.g. Mascot Tunnel.

Sub-Clause 3.2 Tunnel Access Zone

Values for 90th percentile sky luminance are those measured in Sydney by Sydney University's Dr S Hayman for his PhD thesis. This is supported by Dr A Fisher in his study for TfNSW on relighting Mascot Tunnel.

The 20 second duration time is in accordance with draft standards from CEN and British Standard. (20 secs @ 60 km per hr = 333 m, @ 80 km per hr = 444 m).

Change the maximum space distance from 200 mm to 300 mm to permit the option of a twin arc high pressure sodium (HPS) system only in short underpasses and where vehicle clearance envelopes dictate that the luminaires must be mounted between super "T" beams, e.g. Devlin Street, King Georges Road Underpass.



Transport
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QA SPECIFICATION R158

ROAD TUNNEL AND UNDERPASS LIGHTING

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VERSION FOR: DATE:

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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW R158 Edition 1 Revision 3.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Any project specific changes are indicated in the following manner:

- (a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. ***Additional Text***.
- (b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. ~~Deleted Text~~.

TfNSW QA SPECIFICATION R158

ROAD TUNNEL AND UNDERPASS LIGHTING

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for the design, supply, installation, connection, testing, commissioning and maintenance within the warranty period of a lighting scheme for tunnels and underpasses.

Your scope of work includes the following:

- (a) complete photometric design;
- (b) supply, installation and connection of all luminaires;
- (c) supply and installation of all auxiliaries;
- (d) supply, installation and connection of light level control cabling and light sensor.

Provide all necessary notices to the local Energy Authority, pay all necessary fees and charges, and arrange for all inspections and tests by their personnel.

This Specification does not cover the requirements of the approach road lighting.

1.2 STRUCTURE OF THE SPECIFICATION

This Specification includes a series of annexures that detail additional requirements.

1.2.1 Project Specific Requirements

Project specific details of work are shown in Annexure R158/A.

1.2.2 Measurement and Payment

The method of measurement and payment and the acceptance of materials and work must comply with Annexure R158/B.

A Provisional Sum Item is included in the Schedule of Rates for the provision of spare part consumables which would reasonably be expected to ensure the continued operation of the lighting services for a two (2) year period after the Date of Completion.

1.2.3 Schedules of HOLD POINTS, WITNESS POINTS and Identified Records

The schedules in Annexure R158/C list the **HOLD POINTS** and **WITNESS POINTS** that must be observed. Refer to Specification TfNSW Q for the definitions of **HOLD POINTS** and **WITNESS POINTS**.

The records listed in Annexure R158/C are **Identified Records** for the purposes of TfNSW Q Annexure Q/E.

1.2.4 Referenced Documents

Inform yourself and comply with all current Legislation, Codes, Regulations, Standards and Directives issued by the governing regulatory bodies.

Unless specified otherwise or is specifically supplied by the Principal, the applicable issue of a referenced document, including any standards and codes, is the issue current at the date one week before the closing date for tenders, or if no issue is current at that date, the most recent issue.

Standards, specifications and codes used in this Specification are referred to in abbreviated form (e.g. AS 1023). For convenience, the full titles are given in Annexure R158/M.

1.3 DEFINITIONS

In addition to the definitions and meanings given in AS/NZS 60598, the following terms used in this document have the meanings stated below.

“Luminaire”: An apparatus, which distributes light transmitted from one or more lamps. It comprises the complete assembly including lamps, housing and all the parts necessary for supporting, fixing and protecting the lamps and where necessary circuit auxiliaries together with the means for connecting them to the electrical power supply.

“Lamps”: A replaceable light producing element of the luminaire. A luminaire may comprise one or more lamps.

1.4 ENVIRONMENT

All electrical equipment supplied must be suitable for withstanding the tunnel environment. They must be fire resistant, non-flammable, low smoke and halogen free.

Clean the tunnel by washing with high pressure hoses. The light fittings must be sealed and be able to withstand such washing.

All equipment must be rated for 0 to 40°C ambient and test certificates will be required for a 40°C rating.

Protect the electrical installation against damage from the operation of fire protection systems, by spillage, by cleaning, or from any form of water ingress or mechanical damage.

Take care of the electrical installation to ensure that no cable, conduit, switchboard, panel or luminaire are located within the trafficable section of the tunnel, including roll of a vehicle impacting with the side barrier. Calculation of a suitable clearance for varying speed zones and pavement crossfalls is given in Section 6 of the Road Design Guide and this clearance is known as “working width”.

2 MATERIALS

2.1 EQUIPMENT ENCLOSURES

All equipment enclosures must have IP 65 Degree of Protection in accordance with AS 60529, unless stated otherwise.

The PE Cell and Photometer must have IP 54 Degree of Protection in accordance with AS 60529.

HOLD POINT

Process Held:	Supply of equipment enclosures.
Submission Details:	Degree of Protection test certificates.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

2.2 IDENTIFICATION OF EQUIPMENT SAFETY RISKS

Use colours for equipment and components in accordance with AS 1318.

Identify all hazards and risks associated with the equipment or installations, and supply and fit the necessary safety signs in accordance with AS 1216 and AS 1319.

2.3 EQUIPMENT AND MATERIALS APPROVALS

Submit for review and acceptance by the Principal complete data of all the equipment which are proposed for use in the works, prior to their supply and/or installation. In the submission, list the manufacturer, model number and all other information necessary for the Principal to identify the items and determine their acceptance or otherwise. The cost of providing any samples required will be at your own expense.

Include in the list the materials which are specified in the Contract Documents with manufacturer's name, model or trade name, as well as the materials proposed by you.

HOLD POINT

Process Held:	Approval of equipment and materials prior to supply and/or installation
Submission Details:	Equipment and materials data sheets
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point

2.4 EQUIPMENT AND MATERIALS SUPPLIED BY PRINCIPAL

Collect any equipment and materials provided by the Principal from the storage depot stated in Annexure R158/A.

Where applicable, unpack and uncrate the equipment immediately after taking delivery. Check the contents against the packing list accompanying the equipment and report any discrepancy or damage to the Principal.

From the date of receipt of the supplied equipment from the Principal until the Date of Completion, you are wholly responsible for the safe keeping of this equipment. Make good any loss or damage incurred during this period to this supplied equipment, to the Principal's satisfaction, at your own expense.

3 DESIGN REQUIREMENTS

3.1 DESIGN CRITERIA

Design the tunnel lighting scheme in accordance with the requirements of AS/NZS 1158.5 “Lighting for roads and public spaces - Part 5: Tunnels and underpasses”.

The following criteria are applicable:

- (a) Design speed of 60 km per hr;
- (b) Road surface characteristic is R3 Q₀ 0.7;
- (c) Maintenance factor value of 0.8;
- (d) Traffic volume is “high” (vehicles per hour is $\geq 1,000$);
- (e) Operating temperature range is 0 to 40 degrees Celsius.

Determine the tunnel wall surface characteristics when carrying out the lighting design.

3.2 TUNNEL ACCESS ZONE

Prepare tunnel access zone luminance values in accordance with AS/NZS 1158.5 Appendix H – Determination of the access zone luminance L_{20} .

The lighting system must be symmetrical in accordance with AS/NZS 1158.5. Do not use counterbeam or pro-beam lighting systems.

Determine design values for threshold zone luminance, interior zones in tunnels and night lighting on a prorata basis in accordance with AS/NZS 1158.5 Tables 3.1 and 3.2.

Select switching stages in accordance with AS/NZS 1158.5 Appendix G. However, select a second level of switching at between 70% to 80% of the maximum daylight value to equate with mid-winter solar illuminance levels.

At all switching stages, the lighting design must comply with the luminance reduction values in AS/NZS 1158.5 Clauses 3.3.2 and 3.3.3 and Fig 3.2 and any stepped values must not fall below the continuous curve in Fig 3.2.

Where the tunnel length permits an exit zone, design the last 60 m for 50cd/m² maintained luminance.

In long underpasses or tunnels where the driving time, at design speed, equals or exceeds 20 seconds, interior light and night time lighting must be a continuous end-to-end system of tubular fluorescent lamps in which the maximum spacing between light emitting sections, i.e. clear cover glasses, refractors or reflectors must not exceed 300 mm (20 seconds @ 60 km per hr = 333 m and @ 80 km per hr = 444 m).

Where night time lighting is achieved by switching out one lamp in twin lamp fluorescent luminaires, provide an alternate night duty cycle for each lamp to balance operating times.

Where tunnels, underpasses or ramps have a carriageway width greater than 5.5 m, locate the luminaires such that it is possible to carry out maintenance work on the luminaires without closing the whole carriageway.

For tunnels and long underpasses where speed restrictions apply at portals, install signposts showing the reduction in speed limits at a distance prior to the portal at least equal to the stopping distance.

Where this is not possible, base the lighting design for the tunnel on the posted speed for the road prior to the portal and thereafter comply with the luminance reduction requirements of AS/NZS 1158.5 Fig 3.2.

4 DESIGN COMPLIANCE

Prepare calculations for the lighting using a computer software programme specifically for tunnel lighting design.

Prior to commencing work on site, submit a report, with summary and supporting computer calculations, of the lighting design to demonstrate design compliance. The report must contain details of the following:

- (i) Access zone luminance calculations;
- (ii) Threshold zones and transition zones, interior and exit and night time lighting maintained luminance values, overall and longitudinal uniformity for the road surface. Also, luminance values and overall uniformity for walls up to a height of 2 m for each zone and switching level;
- (iii) Luminance reduction curve for all switching stages from entry to exit complying with AS/NZS 1158.5 Fig 3.2;
- (iv) Glare calculations for maximum 15% threshold increment in accordance with AS/NZS 1158.5 Clause 3.3.7 for each zone and switching stage;
- (v) Evaluation of flicker requirement;
- (vi) Photometric data for proposed luminaires in NAIES format, from a photometric laboratory with NATA registration.

Submit all such documents in both hard copy (two copies) and electronic format.

Where a tunnel or underpass lighting design has been prepared from preliminary drawings or sketches of portals, review the design after the portal construction stage, in accordance with AS/NZS 1158.5 Appendix H – Determination of the access zone luminance L_{20} , and, where necessary, revise the lighting design to comply with requirements.

HOLD POINT

Process Held:	Submission of tunnel lighting design information
Submission Details:	Lighting design calculations
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point

5 TUNNEL LUMINAIRES

5.1 GENERAL

Use only the following two types of lamps in tunnel lighting:

- (a) tubular fluorescent 58W/1500 mm
- (b) twin arc high pressure sodium (SON) 150W/250W/400W

Twin arc tube high pressure sodium lamps must have minimum output as shown in Table R158.1.

Table R158.1 - Minimum Output of Twin Arc Tube High Pressure Sodium Lamps

Wattage (W)	Output (lumen)
150	16,700
250	31,000
400	53,000

If 150W, 250W and 400W twin arc high pressure sodium lamps are used, mark the size of the lamp permanently and clearly on the front or visible side of the luminaire.

5.2 SPARE PARTS

Supply all luminaires as required in the tunnel lighting scheme together with the spare parts for each type, as shown in Table R158.2.

Table R158.2 – Spare Parts Required

Description	Quantity Required
Luminaires	10 of each type
Gear tray assembly	20 of each type
Frame assemblies	20 of each type

Package the parts individually in cartons to prevent damage and ingress of water or dirt. Label the cartons to indicate the contents and provide a description of the goods, supplier's name and address and the part numbers of the respective goods.

Deliver and store the spare parts at the location nominated in Annexure R158/A.

5.3 CONSTRUCTION

All luminaire housing must have a minimum design life of 20 years and must incorporate the following features:

- (a) The body of the luminaire must be constructed from half hard sheet or extruded aluminium ALMGSI 0.5 or similar, and have a minimum wall thickness of 1.8 mm. All welding must be carried out using the argon arc process and all welds must be continuous, free from pits and slag, and clean and smooth after completion, as overzealous dressing can lead to loss of IP integrity and weaken the welds;

- (b) The complete housing, including the glass surrounds, must be anodised to AS 1231 or chromated and powder coated to AS 3715. Alternatively, luminaire bodies may be constructed of stainless steel, minimum grade 304, formed for torsional rigidity and of minimum thickness of 0.7 mm;
- (c) The front glass assembly must include tempered plate glass of 5 mm minimum thickness, preferably fitted to an aluminium surround and the whole must be hinged and clamped to the luminaire body using foam silicone rubber or EPDM gaskets which ensure a dust and water jet-proof seal. The clamping method must be capable of adjustment to eliminate any loss of gasket resilience during the life of the luminaire. All gaskets must be securely held in position after the cover is removed and must be able to be readily renewed with the luminaire in situ. The front glass assembly must be removable without the use of tools;
- (d) All luminaires must be dustproof and waterproof to IP 65 and capable of withstanding water pressure jet cleaning without any leakage whatsoever;
- (e) Access to the lamp, control gear and wiring chambers must be achieved by opening of glass cover without the use of tools. The cover must be effectively supported and must remain intact during and after removal. All external clamps, hinges, etc, must be of stainless steel, minimum grade 304, or similar corrosion resistant material. Plugs and sockets must be designed to withstand lamp ignition voltages and to prevent inadvertent cross wiring;
- (f) The electrical and photometric components of the luminaire must be mounted on or as removable assemblies with plug-in electrical connections to facilitate removal and maintenance. Assemblies must be removable without the use of special tools. Gear trays must be retained by safety cords;
- (g) The luminaires must be supplied complete with lamps, anti-vibration lamp holders, control gear and power factor correction condensers to 0.9pf minimum and must be completely wired ready for erection and connection to the external wiring. All luminaire wiring must be low smoke halogen free;
- (h) All sub-components including lamps must be selected from locally available high volume usage stock, with each component having a minimum of two equivalent units available from two or more suppliers;
- (i) Reflectors must be of super purity pre-anodised aluminium of minimum thickness 0.5 mm. The construction rigidity and fixing of these must be such that, with normal careful handling, they cannot be distorted during removal, replacement or cleaning and must be fully interchangeable with equivalent luminaires;
- (j) The luminaires and removal assemblies must be manufactured to close tolerances in all dimensions so that correct contact pressures are maintained on fluorescent lamps and twin arc high pressure sodium lamps;
- (k) The luminaire bodies and any reversible photometric components must be clearly and permanently marked to prevent incorrect mounting (photometrically) in the tunnel or incorrect re-assembly during installation and routine maintenance;
- (l) Cable entry to each luminaire must be made using cable glands to maintain the IP 65 rating of the fitting;
- (m) The luminaires to be supplied must comply with AS/NZS 60598.1 for a reference ambient temperature of 40 degrees Celsius. Provide a Certificate of Suitability from the Office of Energy to demonstrate compliance;

- (n) Essential safety requirements in Australia require a full test to AS/NZS 60598 and more arduous thermal endurance testing than AS 3137;
- (o) Luminaires must be such that they can be serviced without the use of special tools.

HOLD POINT

Process Held: Supply and/or installation of luminaires.

Submission Details: Certificate of Suitability.

Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

5.4 FLUORESCENT LUMINAIRES

Fluorescent luminaires must comply with the following:

- (a) Lamp holders must be of polycarbonate ceramic construction or a “non-deteriorating plastic” material with positive lamp rotation and contact;
- (b) Fluorescent lamp ballasts must be of fully electronic high frequency type to AS 60928 and AS 60929. They must have an operating frequency above 30 kHz;
- (c) The luminaires must be well earthed to ensure optimum radio interference suppression.

5.5 HIGH PRESSURE SODIUM LUMINAIRES

High pressure sodium luminaires must, in addition to the requirements of fluorescent luminaires specified above, comply with the following:

- (a) The HPS lamp starting circuit must employ an electronic super-imposed pulse ignitor. The ignitor must have a time out facility to detect lamp failure and must be a passive component when not required for starting. Ignitors must be selected based on the criteria of proven performance, reliability of operation and quality design **and must provide full lamp re-ignition within 60 to 180 seconds of mains restoration after a power interruption;**
- (b) Lamp holders must be of ceramic construction and easily replaceable without the need to remove or adjust other components.

5.6 REMOTE CONTROL GEAR

Luminaires must be of the integrated type, with the control gear housed within the fitting.

If remotely mounted control gear is proposed, submit full details in the tender.

5.7 ALTERNATIVE FITTINGS

Where the proposed fitting departs from the requirements detailed in this Specification, clearly outline such departures and indicate the suitability of the alternative for the application. Acceptance of such departures by the Principal must be in writing.

6 TUNNEL LUMINAIRE INSTALLATION

6.1 GENERAL

Install all the electrical equipment, including any minor and incidental work which may not be specifically mentioned in this Specification, necessary for the efficient and effective functionality of the tunnel lighting scheme.

Install all equipment strictly in accordance with the manufacturers' and/or designers' instructions. Take particular care in the installation of withdrawable equipment to ensure the satisfactory operation of the equipment and the interchangeability of moving parts. Demonstrate these features to the satisfaction of the Principal.

Supply all necessary mounting brackets, clamps, plates, stands, etc. All steelwork must be hot-dipped galvanized unless otherwise specified.

6.2 CABLE IDENTIFICATION

Label all new cables near the cable origin and destination terminations. The labels must be permanent straight cut type (minimum 5 mm black legend on yellow background). Hand written labels are unacceptable and legends must be either pre-printed or generated from a hand-held label printer.

The marker holders or method of attachment to the cable must be permanent and must provide protection to the label. The marker holders must be securely attached to the cable and not be an adhesive type attachment.

Submit details of the cable identification system to the Principal for approval prior to use.

6.3 LUMINAIRES

Do not use counterbeam or pro-beam lighting systems.

Mount the luminaires in accordance with the manufacturer's recommended method of installation. Do not use alternative methods of mounting unless authorised by the Principal.

The alignment of the luminaire must be parallel to the grade of the road.

Fit the specified lamp into the luminaire.

All luminaires must be suitable for mounting on Unistrut type P1000 channel or similar corrosion resistant "C" channel, which must be fixed to the tunnel ceiling or cable ladder.

The body of each luminaire must incorporate a clamping flange running the full length of the body. Supply with each luminaire four mounting clamps which can engage with the luminaire clamping flange and the "C" channel so that, after initial erection, the luminaires can be moved longitudinally and laterally for fine adjustment and be finally clamped in position when the adjustment is completed.

Fix mounting brackets, conduits or any equipment to the tunnel walls and ceiling by an anti-vibration securing method and the method must be approved by the Principal prior to installation.

Prior to the commencement of installation, provide to the Principal a Structural Engineer's Report certifying that the method of attachment of luminaires and cable ladders is suitable under the

anticipated dynamic and static loads and that it does not affect the structural integrity of the tunnel structure.

Direct overhead luminaires must have a minimum clearance of 4.6 m from the top of the roadway.

After erection, number all luminaires by means of a permanent stick-on label, preferably WBW traffolyte labels. These labels must be affixed adjacent to, but separate from, the luminaries. Clearly identify the luminaries by the relevant number on the circuit diagram.

Supply each luminaire in individual cartons, which must be sufficiently robust to prevent any damage to the luminaire during shipment and storage.

HOLD POINT

Process Held: Supply and/or installation of luminaire and cable ladder support attachment in the tunnel

Submission Details: Structural Engineer's Report

Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point

6.4 LAMPS

Supply with the luminaires full complement of lamps **plus 10% spares** for each type. Supply lamps in multi lamp cartons.

Deliver and store the spare parts at the location nominated in Annexure R158/A.

All lamps must be suitable for operation from the 240 volts 50Hz mains supply.

Fluorescent lamps must be of the triphosphor type and suitable for electronic control gear operation, which must provide a rapid and flicker free start. The colour of the fluorescent lamps must satisfy approximately the following parameters on the CIE Chromaticity Chart: X = 0.4, Y = 0.4.

All lamps must be of a type readily available in Australia.

For all types of lamps offered, submit their initial lumen output after 100 hours and 2500 hours burning and curves showing lumen depreciation and mortality rates over their anticipated life.

HOLD POINT

Process Held: Supply and/or installation of lamps

Submission Details: Lamp performance data

Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point

6.5 TUNNEL EMERGENCY LIGHTING

Employ an uninterruptible power supply (UPS) to energise sufficient system luminaires.

In case of emergency, the emergency luminaires will form part of Stage 1, being the normal night time level throughout the tunnel. These luminaires must always be powered by the UPS.

In the event of failure of the UPS and while the service mains supply is available, provide mains supply to emergency tunnel and egress luminaires by a bypass switch, which must be automatically activated.

In the event of failure of the UPS and the service mains supply having been interrupted, provide emergency egress light signs with emergency 90 minutes back supply.

The average illuminance level of emergency lighting must be at least 10 lx, with 2 lx being the minimum level at any location within the tunnel.

6.6 IDENTIFICATION OF CONTENTS OF PIPES, CONDUITS AND DUCTS

Identify all pipes, conduits and ducts in accordance with the requirements of AS 1345 and AS/NZS 3000.

7 LIGHTING PHOTOMETER CONTROL SYSTEM FOR TUNNELS

Switching control for tunnel lighting must be from the PCMS system or a dedicated lighting control unit. A luminance photometer mounted at the stopping distance from each portal will monitor the 20 degree conical field and provide a 4 to 20 milliamp signal to the lighting controller which in turn provides the switching control for each switching stage appropriate to varying levels of daylight. Mount each photometer on a 4.5 m galvanized column with pan/tilt adjustment.

The control function of the photometer must be compatible with the Lighting Control Unit.

Mount the photometer in an IP 65 rated weatherproof stainless steel housing with stainless steel fittings.

The photometer must be maintenance free and protected from lightning damage.

8 INSPECTION AND TESTING

8.1 GENERAL

Submit to the Principal an Inspection and Test Plan (ITP), which details the process controls and acceptance criteria for the lighting scheme and its components.

8.2 INSPECTION DURING MANUFACTURE

Materials and equipment covered by this Specification are subject to inspection by the Principal at any time during its construction at the manufacturer's premises, or those of a nominated sub-contractor. No materials or equipment can be shipped until you have received notification in writing that the inspection requirements have been satisfied.

8.3 TESTING AT MANUFACTURER'S PREMISES

Test all equipment at the manufacturer's premises prior to shipment in accordance with the requirements of the appropriate Australian Standards and/or this Specification.

The Principal may witness these tests and you must give seven (7) days notice of the intention to carry out the tests.

Provide four (4) copies of the test reports within fourteen (14) days of the completion of the tests.

8.4 PRODUCTION TESTS

Irrespective of any successful identical installation or previous testing, fully test each completed luminaire before shipment to the Site. The Principal may witness some of the testing.

As part of the production test, operate each luminaire for a minimum of eight (8) hours, or additional time as considered necessary, in order to minimise early component mortality when installed.

WITNESS POINT

Process Witnessed: Inspection of materials, equipment testing and production testing

Submission Details: Notification of intention to carry out testing, seven (7) days in advance, with details of ITPs and production testing schedules

9 COMMISSIONING

Take measurements of lighting performance to verify that the actual lighting levels applied to the road surface are in accordance with those stated in the submitted design.

Where the road surface is already worn by more than 12 months traffic use, carry out luminance measurement using an instrument with a measuring field of maximum 2' x 20'. For road surfaces which are newly laid, illuminance measurement is acceptable.

Demonstration of compliance must include:

- (i) Measurement of road surface and walls using a measurement grid corresponding to the design calculation grid;
- (ii) Measurement of sufficient grids to demonstrate that all zones, walls and switching levels on each carriageway achieve design values and uniformity.

The Principal may agree to limit the number of measuring grids where zones and switching levels are repeated by symmetry.

Other single "benchmark" measurements may be requested during this measurement process for maintenance reference purposes to determine the cleaning cycle for installation.

Submit a commissioning report providing:

- (a) Equivalent luminance and illuminance calculations for each zone measured;

- (b) Details of correction factors applied in accordance with AS/NZS 3827.2;
- (c) A copy of valid certificate of calibration for all instruments used.

All work must be subject to inspection by the Energy Supply Authority to determine its acceptability. Provide to the Principal evidence of a satisfactory inspection by the Energy Supply Authority on completion of commissioning and testing. A satisfactory inspection by the Energy Supply Authority is not considered to be full compliance with the Contract. All work is also subject to inspection by the Principal to assess its compliance with the Contract.

Each defect noted by the Energy Supply Authority or the Principal during the inspections and tests will constitute a nonconformity under the Contract.

HOLD POINT

Process Held: Acceptance of tunnel lighting scheme.

Submission Details: Commissioning report.

Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

10 SPARE PARTS

Prepare a list of recommended spare parts for two (2) years normal operation for the tunnel lighting scheme provided under this Contract.

The list must contain the part number, current price and normal delivery of each part recommended for stocking. The Principal may elect to purchase any of the items listed under the standard terms of this Contract regarding extra equipment. The list must be provided not later than one (1) month after award of the Contract so that spare parts may be manufactured at the same time as the main bulk of the light fittings.

ANNEXURE R158/A – PROJECT SPECIFIC REQUIREMENTS

NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure R158/A)

Where “Yes / No” options are shown below, delete whichever is not applicable.

Complete the table below by inserting the address of the storage depot, if applicable.

Clause	Description	Requirement
2.4	Equipment and materials supplied by Principal	Yes / No
2.4	If requirement for above is “Yes”, storage depot is located at:	
5.2	Spare parts to be stored at:	

ANNEXURE R158/B – MEASUREMENT AND PAYMENT

Payment will be made for all costs associated with completing the work detailed in this Specification in accordance with the following Pay Items.

Where no specific pay items are provided for a particular item of work, the costs associated with that item of work are deemed to be included in the rates and prices generally for the Work Under the Contract.

Pay Item R158P1 – Design of tunnel lighting scheme and supply of luminaires

This is a Lump Sum item.

The lump sum must include the detailed design of the tunnel lighting system and the supply and delivery to Site of all luminaires, including the 10% spare lamps of each type supplied in multi lamp cartons.

Pay item R158P2 – Installation, testing and commissioning of tunnel lighting system

This is a Lump Sum item.

The lump sum must include the installation, testing and commissioning of the tunnel lighting system.

Progress payments must be made on a prorata basis of work done under this item, having due regard to the duration of the Contract.

Pay item R158P3 – Spare parts

This is a Provisional Sum item.

This item covers the supply and delivery of spare parts for two (2) years normal operation for the tunnel and underpass lighting scheme provided under the Contract, excluding 10% spare lamps.

Payment will be made for the costs incurred for the supply and delivery of the spare parts plus the provisional sum margin added in accordance with Clause 55.4 of the GC21 “General Conditions of Contract”.

ANNEXURE R158/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.3.

C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS

Clause	Type	Description
2.1	Hold	Test certificates for degree of protection for equipment enclosures
2.3	Hold	Equipment and materials approvals
4	Hold	Design compliance
5.3	Hold	Luminaires certificate of suitability
6.3	Hold	Structural Engineer's Report
6.4	Hold	Lamp performance data
8.4	Witness	ITPs and production testing schedules
9	Hold	Commissioning report

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW Q Annexure Q/E.

Clause	Description of Identified Record
2.1	IP test certificates
2.3	Equipment and materials information
4	Design calculations
5.3	Luminaires certificate of suitability
6.3	Structural Engineer's report and certification
6.4	Lamp performance data
9	Commissioning report

ANNEXURES R158/D TO R158/L – (NOT USED)

ANNEXURE R158/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.4.

TfNSW Specifications

TfNSW Q Quality Management System

Other TfNSW Documents

GC21 General Conditions of Contract

Australian Standards

AS/NZS 1158.5 Lighting for roads and public spaces – Tunnels and underpasses
AS 1216 Class labels for dangerous goods
AS 1231 Aluminium and aluminium alloys – Anodic oxidation coatings
AS 1318 SAA Industrial safety colour codes
AS 1319 Safety signs for the occupational environment
AS 1345 Identification of the contents of pipes, conduits and ducts
AS/NZS 3000 Electrical installations
AS 3137 Approval and test specification – Luminaires (lighting fittings)
AS 3715 Metal finishing – Thermoset powder coating for architectural application of
aluminium and aluminium alloys
AS/NZS 3827.2 Lighting system performance – Accuracies and tolerances – Compliance
requirements
AS 60529 Degrees of protection provided by enclosures (IP Code)
AS/NZS 60598 Luminaires
AS 60928 Auxiliaries for lamps – A.C. supplied electronic ballasts for tubular fluorescent
lamps – General and safety requirements
AS 60929 A.C. supplied electronic ballasts for tubular fluorescent lamps – Performance
requirements

Other Reference Codes

Local Energy Supply Authority

TfNSW Road Design Guide