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1.3	Aug 26	4.2	Clarification on tilt mast requirements.

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1 General

1.1 Purpose

This Specification describes the general design and construction requirements for lineside signals, indicators and other devices that give a visual indication to train drivers and train crew.

1.2 Scope

This specification defines the requirements for the manufacture of trackside railway signals, indicators and other devices that give rail traffic crew a visual indication that utilise Light Emitted Diode (LED) technology, including but not limited to:

- Main line signals, both single and double aspect types.
- Dwarf signals, both horizontal and vertical types.
- Subsidiary signals.
- Route indicators.
- Turnout indicators.
- Turnout Repeaters.
- Signal Repeaters.
- Marker lights, warning lights, “CO” lights, and “A” lights.
- Guards indicators and buffer stop lamps.
- Light signals for use in tunnels.
- Tri-colour main signals.
- Tunnel Fire Safety Phone Light.
- Indicator Notice Boards.
- Main Line Indicators (MLI), MLI repeaters and Electric Point Indicators (EPI) in Train Order Working (TOW) areas
- Light Indicators

1.3 Incandescent Lamps

As incandescent lamps have a relatively short life span and require higher levels of maintenance than LED equivalents, they shall not be utilised where an LED alternative is available.

1.4 Quality Assurance

Railway signal manufacturers and/or assemblers are expected to hold Quality Assurance Certification to AS/NZS ISO 9000:2015.

1.5 Warranty

All signals and associated parts, supplied to this specification or any Appendix thereto, shall be warranted against defect in manufacture and/or assembly for a period of at least 5 years for LED modules and 2 years for the rest of the components from date of manufacture.

1.6 Service Life

Signals and all related components shall be manufactured and assembled to maximise reliability, availability and maintainability and shall be designed, manufactured and assembled to provide a minimum service life of at least 25 years given normal consumable item replacement.

All structural components shall be designed for an operating life of 100 years, except where otherwise stated in a contract.

The photometric requirements within this standard apply to new signals. In service the performance will deteriorate therefore, to ensure that the signal continues to perform at a satisfactory level, specified maintenance programs in accordance with manufacturers' stated maintenance regimes or industry standard levels shall be adhered to.

1.7 Referenced Documents

The following documents are referenced in this specification:

Australian Standard AS9000 series	- Quality Assurance
Australian Standard AS 1874	- Aluminium Ingots & Castings.
Australian Standard AS1734	- Aluminium Sheet & Plate.
Australian Standard AS 4534	- Hot-dip galvanised (zinc) coatings on fabricated ferrous articles.
Australian Standard AS 4534	- Zinc & zinc/aluminium-alloy coatings on steel wire.
Australian Standard AS 4791	- Hot-dip galvanised (zinc) coatings on ferrous open sections.
Australian Standard AS 4792	- Hot-dip galvanised (zinc) coatings on ferrous hollow sections.
Australian Standard AS 1657	- Fixed Platforms & Ladders.
Australian Standard AS1906 Pt 1	- Retro-reflective Materials.
Australian Standard AS1865	- Aluminium Alloy Bar & Strip.
Australian Standard AS1554.1	- Welding - Steel.
Australian Standard AS1665	- Welding - Aluminium.
Australian Standard AS 5000	- App & Test - Electric Cables.
Australian Standard AS 2144	- Traffic Signal Lanterns.
Australian Standard AS/1891.4	- Industrial Fall Arrest Systems & Devices.
AS1170.2	- Structural Design Actions – Wind Loading
British Standard BS469	- Railway signal Lamps.
AREMA Signal Manual Part 7.1.10	- Colours for Signal Lenses
AS7721	- Lineside Signals, Indicators and Signal Signage
ARTC Specification SPS 23	- Single Phase Air Cooled, Isolating Transformer for Signalling Applications.
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ARTC Specification SPS 12	- Signal Lamps.

ARTC Specification SPS 02	- Environmental Conditions.
ARTC Specification SPS 05	-Electrical & Electronic Components (Ratings & Construction Requirements).
ARTC Specification SDS 01	- Signal Design Principles, Signals.
ARTC Specification ESC-09-02	- Lightning and Surge Protection Requirements'.
ARTC Standard ETS-07-00	- Clearances (formerly Section 7)
Standard S4 (SA/WA)	- Signals – Work on Asset
ARTC Rule books	- NSW Rules, TA20 (Vic) and CoP (SA/WA)

1.8 Definitions

1.8.1 Signals / Indications

Main Signal:

A signal utilising a LED module between 200-220mm that is capable of displaying one or more red, yellow, green or white indications.

Marker Light:

A signal with a red or in the case of 'distant' signals, a yellow indication mounted on the same post, or in the same cage, as the associated main signal.

Subsidiary Signal:

A signal with indications mounted on the same post, or in the same cage, as the associated main signal displaying green or yellow, generally utilising a LED module 140mm nominal diameter.

Shunt Signal:

A signal, usually but not necessarily, ground mounted, with two red and one yellow indications.

Ground Form Indicator Signal:

For the purposes of this specification, a signal using the same lampcase as a vertical shunt signal but with one or more red, yellow and green indications.

Repeater Signal:

A signal displaying four vertical white lights for a “parent signal at proceed” indication and four horizontal white lights for a “parent signal at stop” indication.

Low Speed or Shunt Repeat:

A signal displaying two inclined white lights.

Turnout Unit – CTC or RVD Safeworking:

A signal mounted on the same post as, or in the same cage as, a main signal, containing a marker light and one or two bands of yellow lights consisting of three indications. The bands may be inclined 45° left, 45° right or 45° left and right.

Turnout Unit – Train Order Working:

An indicator mounted on the same post as, or in the same cage as, a main line indicator, containing one band of white lights consisting of three indications. The bands may be inclined 45° left, 45° right or 45° left and right.

Turnout Repeater:

Also known as a junction repeater. A signal, generally mounted on the same post as, or in the same cage as a main signal, or stand-alone containing one or more bands of white lights. The bands may be inclined 45° left, 45° right or a combination of 45 left and right.

Route Indicator:

An indicator capable of displaying white letters or numerals which relate to a particular track or route. Used in association with a signal to indicate to the driver the route set. May be associated with a main signal or a subsidiary signal.

The following types are presently in common use:

- Miniature

- Large or Theatre

A'-Lights and 'U'-Lights:

An indicator displaying a white letter 'A' or an indicator displaying a white letter 'U'. An 'A' Light is used to designate 'Automatic'.

A 'U' Light is used to designate 'Unattended'.

CO'-light:

An indicator displaying the white letters 'CO' used as a subsidiary signal for Call-On moves.

Guards Indicator:

An indicator displaying a lunar white light (blue) indication located on a station platform.

Warning Light:

A circular white indication for outdoor use.

Buffer Stop Light:

A red indication or a white indication over a red indication where the buffer stop indicator is adjacent to a running line.

Tri-colour Signal:

A single aspect mainline size housing displaying a red or yellow or green indication.

Indicator Notice Boards:

A large board indicator displaying an instruction to the train driver.

Note: For more information on types of signals and indicators, please refer to applicable network rules.

1.8.2 Abbreviations used in this Specification

AREMA	American Railway Engineering and Maintenance of way Association
cd	Candela' SI Unit of Luminous Intensity. Equivalent to 1 lumen/steradian
CIE	Commission Internationale de l'Eclairage
LED	Light Emitting Diode
MOV	Metal Oxide Varistor - used for surge protection

PPE	Personal Protection Equipment - typically, taking the form of a body harness and lanyard to enable attachment of a person to the structure being accessed
PVC	Polyvinyl Chloride - plastic

1.8.3 Terminology

Approving Authority

The ARTC Signal Engineer/Manager or their delegated representative.

Bright daylight

This implies a clear sky background luminance (lux) in excess of 50,000 cd/m².

Chromaticity Coordinates

Two numbers which fix the position of a point on a colour diagram in order to numerically and graphically represent the colour of a light source.

Clear sighting distance

A colour and night vision normal person viewing a signal shallbe able to easily and correctly read the signal against a day time bright clear sky background and a night time black background, in cab conditions, with 20/20 or corrected eyesight.

The terms 'clear visibility', 'clearly visible' or 'clearly legible' used within this document are defined as a reasonable person being able to unambiguously interpret a signal/indication at the minimum sighting distance under normal expected ambient conditions for the intended application.

Refer to Signal Design Principles document titled 'Signals', with a reference number of SDS 01, for further details.

Dominant wavelength

Dominant wavelength is derived from the CIE Chromaticity Diagram and defines colour in terms of a single wavelength in nanometres (nm). It is that single wavelength of light that has the same perceived colour as the LED radiated spectrum. Dominant wavelength is not necessarily the peak wavelength.

Highway-Rail Crossing Red

The preferred colour of red light suitable for viewing by members of the public at railway / road level crossings. Refer to chromaticity definition in section 11.1.1.1.

LED turn-on Voltage

The voltage applied to a LED module where one or more individual LEDs first either begin to glow or turn on.

Luminous Intensity

The concentration of luminous flux emitted in a specified direction. Unit: Candela (cd)

Luminance

The luminous intensity of an area of the surface divided by that area. Unit: Candela per square meter (cd/m²).

Phantom signal

An external or internal source of light reflecting from the optical surface of an aspect such that the aspect could be mistaken for an 'illuminated' state. I.E. an 'extinguished' signal appears 'illuminated'.

Shinkolite

A brand name neutral grey tinted acrylic with no red-brown colour content (#560). This definition is not unique and is provided for guidance.

Veiling reflection

The reflection of incident light from an aspect such that the aspect appears white or de-saturated in colour. I.E. an 'ON' signal is obscured or appears white or an indeterminate colour.

1.8.4 LED Light Source & Signal Case External Aperture Sizes

It is desirable that brands of colour light LED modules be interchangeable across a broad range of signal head designs and that signal aperture diameters remain consistent when viewed by train drivers.

Whilst the actual signal face light aperture diameter (allowing for a reasonable tolerance) of an LED signal has little to do with perception from a distance; because the light is perceived as extending wider than the source aperture diameter; the proportions between main, subsidiary and other standard aspect sizes shall remain consistent.

A design which in the opinion of the approving authority deviates significantly from the accepted 'nominal' diameter, may be rejected.

The following signal case nominal light aperture diameters shall apply for LED signals:

- Main signal aspects shall be a nominal 200mm design based on the AREMA Standard.
- Circular subsidiary aspects shall be a nominal 125mm design based on the AREMA Standard.
- For 90mm diameter aspects, typically used in tunnel systems, the actual diameter of the light source aperture, shall be as close as practical to 90mm and in any case, the tolerance shall not exceed +/- 2mm. The light aperture size may be achieved by fitting a 90mm diameter stencil.
- For 45mm diameter aspects used in tunnel systems such as a low speed or shunt, the actual diameter of the aperture, shall be as close as practical to 45mm and in any case, the tolerance not to exceed +/- 2mm. The light aperture size may be achieved by fitting a 45mm diameter stencil.

Where secondary optics are not used to ensure an even disbursement of light across the signal face light aperture; the diameter of an LED array light source behind the aperture shall be as close as practical to the nominal diameter of the aperture.

1.9 Environmental Conditions

1.9.1 General

Equipment shall conform to the requirements laid down in the ARTC Specification SPS 02 - Environmental Conditions.

All signals and indicators shall be rated for 100% duty and all components therein shall be capable of operating, when continuously illuminated, in ambient temperatures to 50°C in the shade with relative humidity to 95% and exposure to full sunlight.

The operating temperature range of LED signals and associated equipment shall be – 10 to +70°C immediately surrounding the electronic modules.

Proof of compliance to SPS 02 is required in the form of a formal test report carried out by an independently accredited laboratory however, a waiver may be issued on request where it can be shown that the design is based on:

- proven, good engineering design principles or alternatively,
- an existing currently approved and acceptable product which has been in service successfully for an extended period of time.

1.9.2 Wind Loading

Signal posts, gantries, lamp cases, backgrounds, hoods and other associated signalling equipment and structures located outdoors shall be designed to withstand the maximum wind loading as set out in AS/NZS 1170.2.

2 Lampcases

2.1 Construction

Materials used in the lampcase assembly shall be mutually compatible under the operating and environmental conditions experienced in normal service.

The preferred materials for lampcases shall either be a medium strength, high corrosion resistant cast aluminium alloy to AS 1874 or a medium strength, high corrosion resistant aluminium alloy sheet to AS1734. Alternative materials may be used if guarantees of similar service life, robustness and resistance to vandalism, when compared to the aluminium, can be provided. Painting shall be in accordance with section 5. Hinges shall use corrosion free materials such as stainless steel. Where stainless steel threads are in direct contact with aluminium, an appropriate insulation product shall be applied to reduce galvanic action.

Lampcases shall be of sufficient size to accommodate the components required to be fitted therein, and to provide reasonable access to maintain or change components with the minimum disturbance to other components.

LED circuit boards/modules shall be separately removable from the lampcase either from the rear or the front of the lampcase, preferably from the rear. Designs where non-captive screws are used requiring access from both the front and the back at the same time, will not be accepted.

All lampcases including tunnel signals shall be to the greatest possible extent weatherproof, insect proof and dustproof so as to operate in accordance with the rates of deterioration and maintenance program assumed in the design. Notwithstanding, provision shall be made for ventilation by means of a small breather in the signal case door.

Doors shall be rearward opening and shall be provided with a hasp or similar device which can be secured by the standard padlock. Closed doors shall form an effective light proof, weather proof and dust proof seal of the lampcase.

Unused cable entry apertures shall be sealed with a screwed plug or bolted plate of similar material to the case.

Screw penetration of the signal case for the mounting of components etc within the case, shall be minimised, except where it can be shown that to do so is unavoidable. Any penetrations are to be compression gasket sealed or where applicable, combined with a neutral cure sealant. Bolt or cable penetrations made against horizontal surfaces shall be fully sealed against water ingress using flexible compression gaskets, 'O' rings, sealant or a combination of the above.

Where cable conduits or cable glands are to terminate onto curved surfaces such as signal masts, a flat section of steel shall be fully welded onto the pipe to provide a flat sealable surface. Where the inside of a pipe or enclosure cannot be easily accessed to fit a conduit terminator/cable-gland nut, the wall of the pipe or enclosure shall be threaded with a minimum of six threads.

It is not acceptable to join a number of single aspect lampcases to form a multi-aspect lampcase.

The lampcase and ancillary equipment shall be free from sharp corners and projections which could cause injury to personnel during normal installation and maintenance procedures.

There shall be no possibility of light leakage into any lampcase by way of the access door or any ventilators or between aspects in any one lampcase.

2.2 Multiple Aspect Lampcases

Multiple aspect lampcases shall be either a single aspect, two aspect, three aspect or four aspect lampcases.

The bottom section of the lowest lampcase shall contain sufficient terminals of the type specified herein to enable termination of the cable or wiring from the signal base to all aspects within the multiple aspect lampcase. The terminals shall be mounted not less than 20mm above the bottom of the lampcase to avoid any moisture which may be present.

Wiring from the terminals to the aspects needs to be protected

2.3 Lampcases - Maximum Dimensions

Signal lampcases shall not exceed the following dimensions.

Lampcase Type	Width	Height
Main Lampcase	300mm	N.A.
Subsidiary shunt, low-speed, call-on	300mm	300mm
Turnout Unit	600mm	-
Turnout Repeater	600mm	-
Signal Repeater (white lights)	650mm	-
Horizontal Shunt Signal	355mm	400mm
Vertical Shunt Signal	195mm	550mm
Small Route Indicator	355mm	200mm
Large Route Indicator	600mm	600mm
Warning Light, Guards Indicator, Buffer Stop Lamp	300mm	300mm
Tunnel signal - 2-light case	195mm	425mm
Tunnel signal - 4-light case	195mm	800mm

Note 1: These dimensions do not include backgrounds.

Note 2: Slight variances to the above dimensions may be permitted, on application to the approving authority.

2.4 Lampcase Brackets

The brackets securing the lampcase to the signal post shall preferably be manufactured from hot dip galvanised mild steel. Other materials will be considered, provided it can be clearly demonstrated that the material has a service life exceeding 100 years and that it is capable of carrying the abnormal loads which may occur (such as a maintainer using the bracket as a step or support).

Brackets shall be arranged and attached to the signal post so that one person can carry out adjustment for signal aligning (focusing). Where it is necessary to rotate front of post brackets on the post to align the lampcase, a support ring shall be provided to support the bracket during the alignment process.

Where it is necessary to rotate the lampcase for maintenance purposes, such as cleaning, the support ring shall take the form of a locating ring such that the lampcase can be returned to its

correct alignment after maintenance. The lampcase bracket and ring shall be provided with a locating pin to clearly define the correct position.

The locating ring shall be provided on all main, turnout and junction indicator lampcases mounted in gantry cages and shall be provided for the lower main lampcases of double aspect post mounted signals

2.4.1 Top of Post Brackets

Where a lampcase is to be mounted onto the top of the post, the bracket shall consist of a socket which fits over the post and is secured to it by U-bolt, clamp or hardened point set or grub screws or other approved means. The bracket shall provide vertical tilt adjustment for the lampcase between 8 degrees downward and 2 degrees upward. Adjustment shall be infinitely variable by screw thread.

Provision shall be made for wiring from the signal post to pass through the top of the socket into the base of the signal lampcase. The wiring entry shall form a rain and insect proof seal in both lampcase and socket but shall permit the wiring or cable to rotate freely within the socket.

Note: Main Line Route Indicators, Turnout Repeaters and other like sized lampcases shall wherever possible, be mounted directly onto the post. It is no longer acceptable to mount a MLRI directly on the top of another lampcase, except in a retro-fit situation where there is no other reasonable option.

2.4.2 Front of Post Brackets

Where a main lampcase or turnout unit is to be mounted in front of the post, the bracket shall accept the same socket used to fix the lampcase to the top of the post. The bracket shall be able to rotate on the post so that the lampcase can be mounted directly in front of the post or offset by up to 200mm to the right (when facing the signal). The bracket shall provide sufficient clearance from the post to permit lampcase doors to be fully opened.

Brackets for subsidiary signals (other than turnout units) shall provide for the lampcase to be mounted directly in front of the post or 200mm to the left or right of the post. The bracket shall provide at least 5 degrees of vertical adjustment and ±10 degrees of horizontal adjustment in addition to being able to rotate around the post.

2.4.3 Tunnel Signal Brackets

Brackets for tunnel signals shall be manufactured from the same (or a compatible) material as the signal lampcases. Case penetrations shall be fully sealed against water ingress.

The bracket shall be placed between the upper and lower lampcases and shall provide for a minimum of ± 5 degrees of lampcase rotation in the horizontal plane. The bracket shall be designed to hold the lampcases 25 - 30mm off the tunnel wall.

Fixing to tunnel walls shall be in accordance with the requirements of the ARTC track and civil standards.

3 Hoods and Backgrounds

3.1 Hoods

All signal and indicator aspects shall be fitted with hoods – with the exception being tunnel signals that do not require hoods. The hoods may be made from aluminium alloy at least 1.6mm thick.

The minimum length and cover for hoods shall be:

Indication	Length mm	Cover
Main Line 200mm nominal dia. Refer notes 1 & 2.	375	>225°
Subsidiary 127 or 140 dia. And Repeater (each indication)	200	>225°
Route Indicator - Small. 125mm	300	Top and both sides – also divider between indications
Route Indicator - Large. 400mm	500	Top and both sides
Turnout Repeater	500	Top and both sides
CO', and 'A' lights. Refer note 5.	375	>225°
Repeater	500	Top and both sides
Guards Indicator. Refer note 3.	200	>225°
Warning Light (outdoor circular) Refer note 3.	200	>225°

Note 1: Minor variations to hood dimensions may be permitted, on application to the approving authority.

Note 2: Where main line signals are placed on a gantry, a one piece hood, covering all indications in the lampcase and 375mm long at the top tapering to 300mm long at the bottom may be used in place of individual hoods on each indication.

Note 3: Fit hood where necessary.

Note 4: Reducing plates shall not be affixed to hoods.

Note 5: Where there is no reasonable alternative, stencils may be secured to the hood, incorporating at least four points of attachment. The design shall be such that there will be no light spillage from the sides of the stencil arrangement.

3.2 Backgrounds

Where shown in Section 3, Form of Signals, lampcases shall be fitted with a background of the size specified herein. The background may be made from aluminium 5052 H36 or H38 or similar minimum 1.6mm thick.

Lampcase	Background Size
Main Line Lampcase – Standard Background Refer note 1.	600mm wide, projecting at least 200mm above the top aspect and 25mm below the bottom aspect
Main Line Lampcase – Narrow Background	450mm wide.
Subsidiary Shunt, Low	450mm diameter

Speed, Close-up, Call-on – Standard Background		
Subsidiary	Shunt, Low	375mm diameter
Speed, Close-up, Call-on – Narrow Background		

Note 1: Where a signal is mounted in a gantry cage, the individual lampcase backgrounds may be replaced by a single full length background fitted to the rear of the cage, provided that this background is effective for all of the approach view of the signal.

4 Signal Structures

The completed equipment shall be hot dip galvanised in accordance with AS 1397, AS/NZS 4791 & AS/NZS 4792 with a galvanised coating weight of 450g/sq metre.

Steel cables to be coated to AS/NZS 4534.

4.1 Ladders

Signal ladders shall comply with AS/NZS 1657 “Fixed Platforms, Walkways, Stairways and Ladders” in respect to minimum size of stile and rung, spacing of rungs and minimum width of ladder. Ladders shall be set at 70 to 75 degrees. Ladders and associated brackets and bolts shall be hot dip galvanised as detailed above.

A concrete landing pad for ladders used on signal posts shall be 600 x 900 x 200mm minimum, with F72 mesh. Where more than one ladder is fitted to a signal post, a single concrete pad shall be formed and poured linking all ladders, wherever possible.

A ladder cage shall be provided where a person could fall from a ladder more than 6.0m however, a 10mm diameter steel fixed static line may take the place of the cage, where specified. Where a static line is fitted, a lockable guard shall be fitted over the first 2.5m of the ladder, to prevent use by unauthorised personnel. The ladder guard shall also be provided with an approved warning notice.

4.2 Signal Posts

Signal posts shall be manufactured from 125 nominal bore heavy (5.4mm wall thickness) steel tube with an integral base and terminal. The completed post and associated fittings shall be hot dip galvanised as above.

All cable or wiring entry/exit holes in the signal post shall have sharp corners and edges ground or filed to remove any burrs.

Where cable conduits or cable glands are terminated onto the signal post, a flat section of steel shall be fully welded onto the pipe and threaded with a minimum of five threads, to provide a flat sealable surface. Where welding on site is required, weld and affected area by weld shall be thoroughly cleaned and cold galvanised.

Where design changes or modifications to the structure are required due to local conditions, approval shall be sought from an accredited structural engineer.

Tilt signal masts are preferred for the new installations. Alternative signal mast arrangements may be adopted where supported by a risk assessment, in consultation with the Signal Maintenance Engineer and agreed by the business unit Signalling Engineering Manager. Tilt signal masts and associated cabling shall be installed in accordance with manufacturer’s instructions.

Movement of tilt signal mast shall be manageable by one person safely and shall not infringe the structure outline of ETS-07-00 – Clearances. The tilt signal mast shall have a means of being secured and locked in the upright position to prevent unauthorised operation.

If practicable, the Project may consider, based on a risk assessment and in consultation with Operations and the Signal Maintenance Engineer, implementing measures to ensure that the signal in the rear (where appropriate) displays the most restrictive aspect when the tilt mast signal is folded down.

A tilt signal mast shall not be positioned such that its movement would potentially cause damage to other trackside equipment, cable routes or any part of the tilt mast. Movement of the tilt mast shall not restrict safe access to trackside equipment and safe recess located in the rail corridor.

The design shall incorporate a flat service area around tilt masts to allow room for maintenance workers to safely lower and raise the tilt masts from a position of safety. A tilt mast in the lowered position should be landed on a flat working service area on which maintenance workers can safely carry out maintenance works on the signal heads. When the tilt signal mast is being lowered for maintenance purposes, maintenance staff shall ensure that the rear signal is displaying the stop aspect for the entire duration when the signal is not in its normal (vertical) position.

4.2.1 Signal Post Foundations

Foundations may be pre-cast or cast-in-situ type.

Foundations shall be in accordance with an approved engineering design from a structural engineer/manufacturer or supplier and shall be of sufficient size to support the signal mast, cater for incidental loading from maintenance personnel. As built engineering drawings and certifications shall be provided to ARTC.

4.2.2 Signal Post Landings

Unless specified otherwise, landings shall be provided on, but provision is not limited to, the following situations:

- All double light 5, 6 and 7 aspect signals.
- Double light signals with main line route indicators for access to the route indicator, the upper lampcase and for access to the lower lampcase.
- Single light signals with turnout units for access to the turnout unit.
- Single light signals with subsidiary signals for access to the subsidiary signal, any route indicator and the marker light.
- Single light signals with main line route indicators for access to the route indicator, main line lampcase and for access to marker light and/or other subsidiary signal.
- As otherwise specified in any particular specification or signal sighting form.

Landing and platform designs which require a person to step out into unsupported free space and around a ladder to gain access are no longer permitted.

Safe access shall be provided for the maintenance of any and all lampcases on the signal post. It should not be necessary for maintenance staff to stand anywhere other than on the ladder within the ladder gallery ring (where fitted) or on a landing platform, to maintain any lampcase equipment.

Access to the landing shall be provided by means of a fixed ladder. A safety self closing gate/bar shall be provided at the top of the ladder fitted at handrail height to reduce the risk of a person stepping back and falling from a landing.

Where access is required to low or intermediate height signal cases, access may be provided by a landing, a ladder or neither, pending the work height and outcome of a risk analysis.

Where a person needs to work underneath a landing, ladder or other part of a structure, there shall be sufficient space to stand upright and work comfortably and in any case, there should be a minimum of 2 meters between the floor of the lower work area and the underside of any upper structure.

Where space restrictions do not permit a landing to be used, other means of approved safe access shall be provided.

All landings and handrails shall be designed for the live loadings specified in AS 1657 for fixed platforms and handrails.

Landings shall be at least 600mm wide between handrails and a minimum of 750mm long.

Ladder stiles shall extend up to the handrail. The handrail shall extend along both sides and across the front of the landing. A toe rail projecting at least 100mm above the landing shall be provided along both sides and across the front of the landing, generally in accordance with AS 1657.

Signal post landings shall be provided with guardrails / handrails of height 1.1 m unless specified otherwise and conforming to AS 1657.

Steel landings, handrails and associated brackets and bolts shall be hot dip galvanised as detailed above.

Landings and ancillary equipment shall be free from sharp corners and projections which could cause injury to personnel during normal installation and maintenance procedures.

Where there is a clearance issue with a risk of a person striking their head on the structure above, this should be identified with high visibility hazard tape. Hazard tape should be self adhesive black on white. Tape is not to be placed on rungs nor on any other surface which may be trodden on.

4.2.3 Ladder Gallery Rings

Where landings are not provided at the top of the ladder, ladder gallery rings shall be fitted unless the gallery ring would be at a height of less than two metres. The gallery rings shall be made from minimum 50 x 6 mild steel hot dip galvanised as detailed above and shall be at 90 degrees to the signal post and of 600 mm diameter unless otherwise specified. The gallery rings shall be braced from the ladder on both sides to prevent movement.

Gallery rings are not to be used for attaching PPE.

5 Systems of Safe Access and Safe Working

Working at heights can present a fall hazard to personnel. The primary means of fall control when accessing and working on signal posts and gantry structures will be by means of cages and handrails conforming to AS 1657.

Where these primary means of fall control cannot be fitted due to structure gauge or other space restrictions, PPE in the form of limited fall arrest system/s may be specified in lieu. In some cases, limited fall arrest PPE systems may be specified in addition to primary fall protection equipment for reasons such as rescue and recovery or where the risk of injury is considered high enough to warrant their use.

In general, the design of safety systems shall comply to the latest requirements of the appropriate Australian Standards, the Work Health and Safety Legislation and ARTC Safety Standards.

5.1 Fall Restraint Anchorage Points

Where rescue and or fall protection systems requiring a person to wear a body harness and lanyard are specified at a signal post or gantry structure, suitably rated anchorage points will be required to be incorporated into that structure. Anchor points, their locations and the structure to which they are attached shall conform to the requirements of AS 1891.4. Safe means of access to an anchorage point in accordance with AS 1657 shall be provided.

Anchorages for the connection of two persons shall be designed for a minimum force loading of 21 kN.

Anchorages for the connection of one person shall be designed for a minimum force loading of 15kN.

5.1.1 Signal Posts

Anchorage points and associated fixing structure shall generally conform to the 21 kN force loading. In the case of retrofit applications to existing signal posts, the structure may be rated for 15kN however, the attachment point itself shall be rated for 21 kN.

5.1.2 Gantries

Anchorages and associated fixing structure shall conform to the 21 kN force loading as a minimum.

Where specified, signal cages may require the fitting of a suitable anchorage point such as an eye-bolt or davit above the cage. Anchorage points are typically required to be positioned above the signal cage at a suitable height to assist in the rescue/recovery of persons and to enable the connection of a PPE lanyard.

6 Painting

The paint finishes and colours for lampcases and other signal components shall be:

Component	Location	Finish
Lampcases	Interior	Matt or semi-gloss black
Lampcases	Exterior	Matt or semi-gloss black
Fixtures etc	Inside lampcases	Matt or semi-gloss black
Bezels		Matt or semi-gloss black
Backgrounds	Front	Matt black
Backgrounds	Rear	Matt black
Hoods	Entire surface	Matt black
Posts, ladders, Brackets etc.		No painting - galvanised finish to AS 4680, AS 4791 & AS 4792 if steel. Anodised or natural finish if aluminium.

Note 1: Powder coating, enamels or vinyl co-polymer finishes may be used. The finishes, primers and undercoats are to be applied strictly in accordance with the recommendations published by the finish coat manufacturer.

Note 2: The interior surface of hoods and the front of backgrounds shall be finished matt black so as to minimise reflections of the illuminated signal; semi-gloss or gloss finish is not acceptable.

7 Signs, Notice Boards and Instruction Plates

Refer to ESA-07-01.

8 Signal Telephones

Signal telephones are not required to be fitted to any fixed signal or indicator in the ARTC network.

9 Assembly of Signals

9.1 General

All bolts, U-bolts, nuts, washers etc used in assembly shall be galvanised, zinc plated or cadmium chromate plated steel or stainless steel. Brass bolts, screws etc shall not be used in contact with any aluminium component and aluminium bolts may only be used in non load bearing applications.

Assembly of both lampcase components and complete signals shall provide for ease of maintenance, i.e. LED module changing, adjustment of signal focus.

Anti-seize compound shall be applied to metal-threads which are external to the lampcase and which are likely to be disturbed during maintenance activities during the expected service life of the signal. Thread sealant shall be applied to metal-threads where they penetrate a signal casing. The product shall allow the metal-threads to be removed for maintenance activities without damage.

All wiring within lampcases and between lampcases and the signal base shall be double insulated from metal. All openings for wiring in posts and lampcases shall have rounded edges. In addition any cable or wiring entry opening through metal less than 2 mm thick shall be fitted with an insulating bush..

Each multiple aspect lampcase and each turnout unit shall have a circuit diagram of the internal wiring of the lampcase on photo anodised aluminium or equivalent fixed permanently to the inside of the door.

Each signal post shall have a circuit diagram of the wiring between base and lampcases on photo anodised aluminium or equivalent permanently fixed to the inside of the base door.

9.1.1 Marking

Each lampcase shall have a circuit diagram of the wiring between the incoming terminal strip and the equipment contained therein on photo anodised aluminium or equivalent permanently fixed to the inside of the lampcase door. The label within the lampcase shall include but is not limited to the following details:

- Manufacturer / Supplier,
- Model / Catalogue number,
- Brief description of product,
- Rated nominal operating voltage,
- Batch code/Serial number,
- Simple wiring diagram,
- Date of manufacture and or expiry date.

LED modules shall be clearly and permanently marked as to colour when deenergised with any additional markings necessary for the correct selection of replacement parts.

Note: It is recommended that items be marked in accordance with AS ISO9000 to facilitate product identification and traceability as required for the application of the quality management system based on the provisions of the standard.

10 Optic Systems

10.1 LED Optical Systems

LED indications are the preferred optical system for all colour-light signals.

This section describes the requirements in terms of general appearance, form, viewability distance, colour and operating voltage.

10.1.1 Common Performance & Design Criteria

10.1.1.1 Optical Requirements

The colours of LED signals and indications shall be as specified in section 1.6 of this specification and as defined in the Chromaticity Table.

To determine compliance with this standard; colours and luminous intensity shall be tested according to acceptable recognised standards such as those specified in AS 2144 and by laboratories which are independently accredited as having competence to carry out the type of measurements involved. The colour of the light emitted from each signal aspect defined in terms of its chromaticity coordinates, shall fall within the area of the CIE 1931 chromaticity diagram boundary envelope as defined within this document.

Colour shall be achieved by careful selection of LED. Mixing of different coloured LEDs to achieve the specified result is not preferred. Coloured filters shall not be used.

An even and equal disbursement of light intensity across the entire face of the signal aperture is required, and is to be achieved by a minimum number of evenly dispersed LEDs as specified for each light, on the following pages of this document. The centre to centre distance between any two adjacent LEDs should not be greater than twice the LED lens diameter unless approved otherwise. The use of a diffuser or secondary optics which provide a uniform display shall not be used.

All LEDs used shall be in water clear packages.

The outer surface of the diffuser or cover shall be clear, smooth, manufactured from poly-carbonate and should incorporate features to reduce reflection, phantoms and veiling.

Stencil type and route indicators shall be designed and constructed to minimise distortion, i.e. a sharp clear image without fuzzy edges is required to maximise legibility. The light source shall be covered by a smooth polycarbonate or high impact resistance acrylic cover such that the form of the digit is not readily visible when the indicator is not illuminated. Tinted material such as Shinkolite may be used to reduce the chance of phantoms, providing that the specified minimum readability distance is not compromised. The non illuminated area of the indicator/stencil shall be black or dark grey, to maximise contrast and minimise reflection. White backgrounds shall not be used. Light intensity shall be suitable for both daylight and night time viewing at the rated distance.

The outer face of the printed circuit board shall be matt black in tone.

When standing in front of an outdoor signal, the luminous intensity of that signal is not to be so high so as to cause the driver excessive glare therefore, to limit glare luminous intensity shall not exceed 750 candela from any single aspect, unless approved otherwise. Tunnel lights intensities shall be sufficient to provide clear visibility, without dazzling or otherwise interfering with the vision of train drivers in a tunnel.

Where more than one signal aspect and indication (main and subsidiary) are combined and simultaneously displayed on a signal, the brightness levels of displayed lights shall be such that the brighter aspect or indication shall not make the other unreadable when observed from the normal viewing distance of the subsidiary aspect or indication.

Signal sighting distances specified in this document are minimum nominal clear sighting distances. In practice, consideration shall be given to the proposed location and purpose for which a signal / indicator is intended, to determine the optimum luminous intensity level of the LED signal. Signal luminous intensities are to provide an easily seen signal at the nominated viewing distance with background sky luminance of at least 50,000 cd/m² as well as at night.

Turnouts when illuminated, shall be clearly readable and identifiable for a minimum clear sighting distance of 400 meters in all light conditions.

Arrangement of LED array should be in such a way that with 25% loss of indication, signal aspect is still recognisable at given sighting distance. LED signal should have arrangement to detect and indicate the failure of the LED arrays after which signal aspect cannot be recognised for the given sighting distance.

LED modules should have improved self-diagnostic e.g. raising an alarm/warning in the event of cluster of LEDs failing or with an internal contact to directly interface with the interlocking.

Where lamp proving is required, LED modules to replacement of incandescent signal should be chosen such a way that it requires minimal changes to the signal design.

LED aspects shall be suitable for flashing with no visible flicker or noticeable start-up delay at turn-on.

Chromaticity Table definitions for LED Lights.

Colour	Chromaticity Boundary Definitions	LED Dominant Wavelength (λ)
Red	y ≤ 0.292	–630-650 nm
(Wayside signals)	y ≥ 0.998-x	
Refer to notes 1 & 2 below.		
Red		–630-650 nm
(Highway-Rail Crossings)	y ≥ 0.292	
Refer to notes 2 & 3 below.	y ≥ 0.998-x	
Yellow	y ≤ 0.430	590 – 595 nm
	y ≥ 0.384	
	y ≥ 0.862 - 0.783x	
	x ≥ 0.554	
Green	y ≥ 0.506 – 0.519x	500 – 510 nm
	y ≥ 0.150 + 1.068x	
	y ≤ 0.817-x	
White	x ≥ 0.285	Not Applicable
	x ≤ 0.440	
	y = 0.050 + 0.750x	
	y = 0.150 + 0.640x	
Blue	x ≤ 0.179	460 – 481 nm
	y ≤ 0.209	
	y ≤ 0.734x + 0.088	

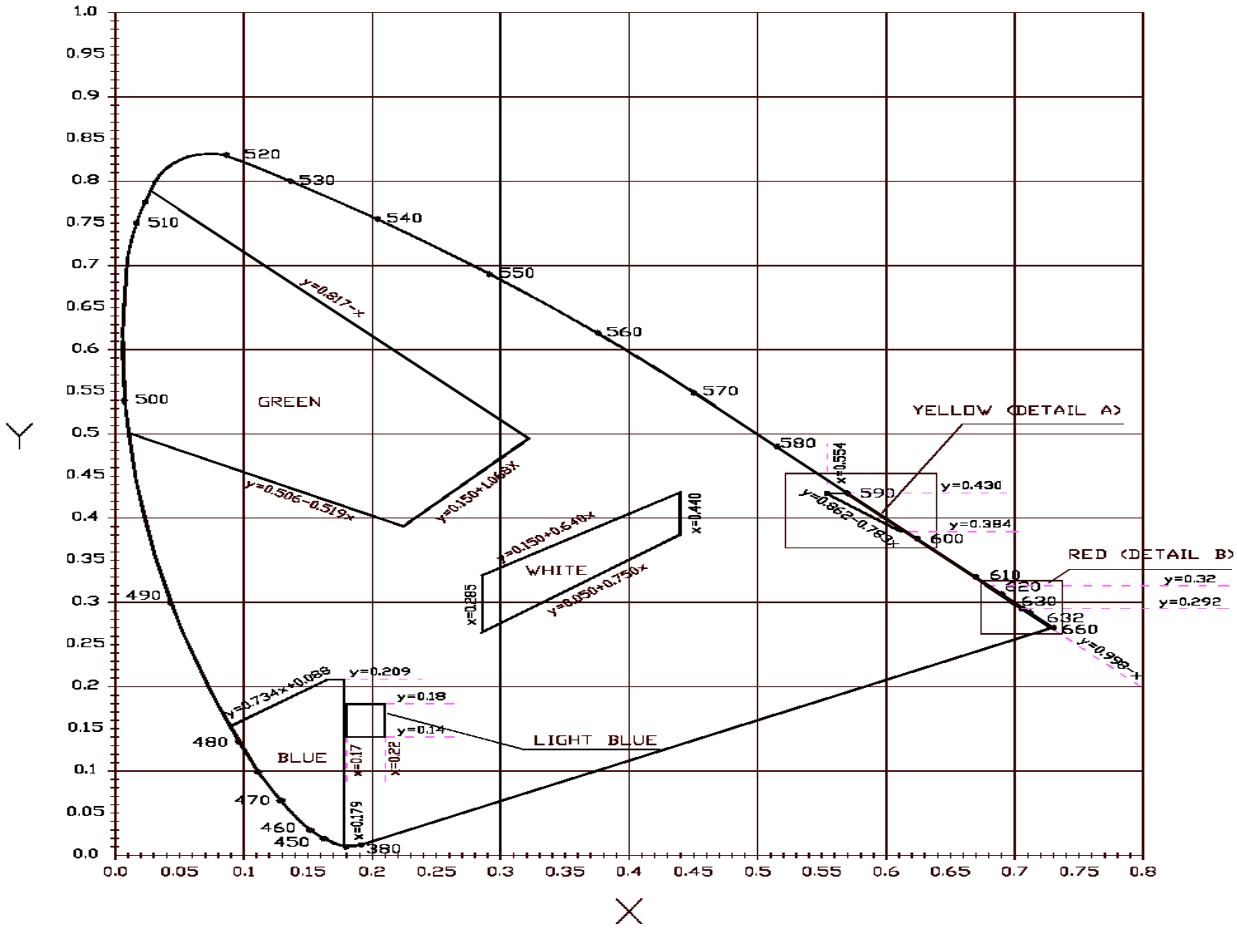
Light Blue	x ≥ 0.17	Not Applicable
(Guards Indicator)	x ≤ 0.22	
(Lunar white)	y ≥ 0.14	
	y ≤ 0.18	

Notes:

1. The chromaticity definitions for reds, yellow, green and blue above, have been adopted directly from AREMA 2001 Signals Manual Part 7.1.10. Note that the red for wayside applications is acceptable at 630nm wavelength and it is this limit shown on the chromaticity diagram below.
2. LEDs of the type TS-AIGaAs and AS-AIGaAs shall not be supplied due to their relative susceptibility to moisture.
3. With reference to LED chromaticity for highway-rail level crossing warning lights: Consideration has been given herein to the recommended benefits of designing signals such that the resultant dominant wavelength is towards the shorter rather than the longer end of the allowable red range as this may increase the probability of detection of a signal by colour anomalous individuals with reduced sensitivity to long wavelengths.

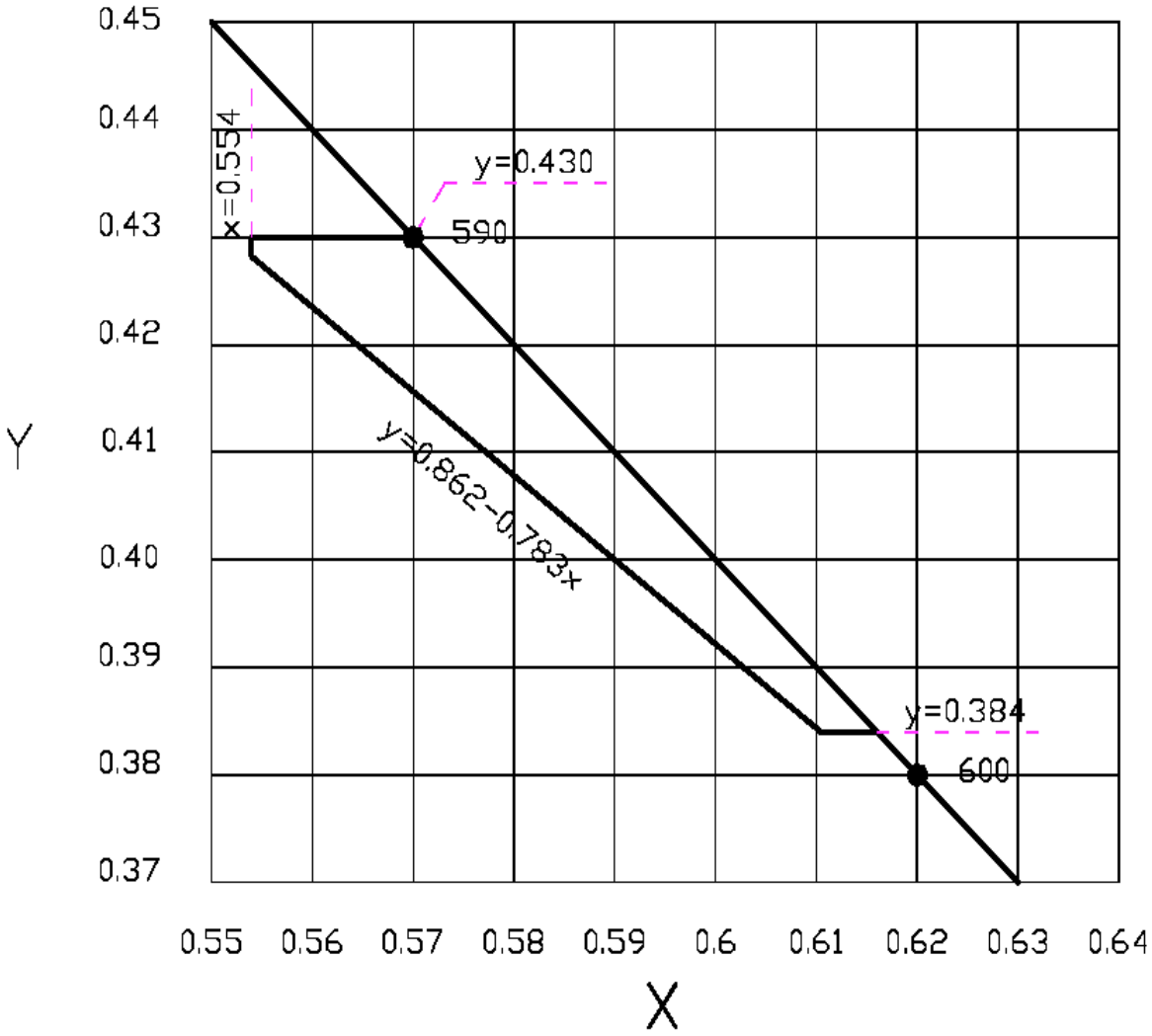
Chromaticity Diagram according to 1931 C.I.E. Coordinate System, for LED Lights.

Chromaticity boundary envelopes are according to the definitions of signal colours in the following chart.



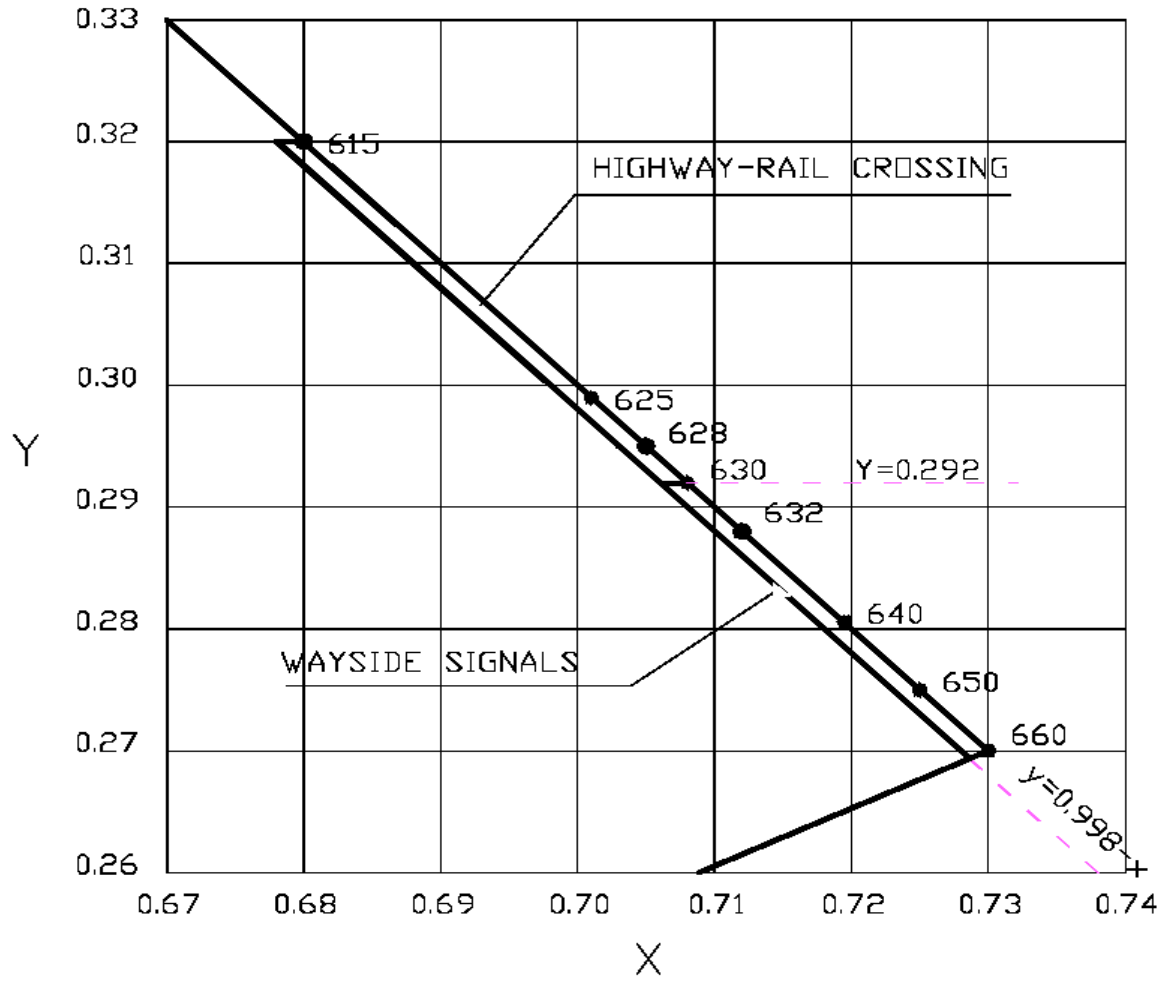
DETAIL A

Yellow Chromaticity Boundary Envelope



DETAIL B

Red Chromaticity Boundary Envelope



10.1.2 Reliability & Spares

Where all of the LEDs in any one aspect, or any one indication, are powered from a single source on the printed circuit board, the components used in that source shall have a level of reliability equivalent to the LEDs where practical.

LED module test certificates are to be retained / stored by the manufacturer / supplier for a period of not less than seven years. Copies of certificates are to be made available when requested.

All user replaceable parts are to be available from the manufacturer / supplier for the life of the product and are to carry distinct, indelible identification details to ensure that correct replacement parts can be ordered.

10.1.3 Signals and Indicators - Details

10.1.3.1 Main Indication

The standard optic system for a main light shall be a circular array of LEDs of sufficient number to achieve the required luminous output.

The LEDs used in main aspects shall be such that all signal indications shall be clearly readable in all light conditions at the following sighting distances:

- Short range signal – 150m minimum
- Medium signal: 500 metres minimum.
- Intermediate Signal: 1000 metres minimum.
- Long range signal: 1500 meters minimum.

In addition, the standard signal shall provide not less than 33% of maximum intensity at an offset angle of ±10° and not less than 10% of maximum intensity at an offset angle of ±20°.

10.1.3.2 Tunnel Signals

The 127 mm nominal diameter light in tunnel signals shall consist of a circular array of LEDs of sufficient number to achieve the required luminous output. The “low speed” or "shunt" aspect shall utilise the same LED module and can have a stencil with a 45mm diameter aperture in front of a 127mm diameter aspect to achieve the small aspect.

The clear cover shall be of a type and be located at a distance in front of the LED array which will ensure that:

- Tunnel signals shall be clearly readable at a clear sighting distance of 300 metres; in the ambient light level found in the typical underground tunnel. Lights mounted at tunnel portals may necessitate the fitting of hoods and or increased intensity levels.
- Clear visibility of indication at a viewing angle of 35° either side of the zero axis in the ambient light level found in the typical underground station is required.

10.1.3.3 Subsidiary and Shunt Indications 127 / 140mm diameter

The standard optic system for this light shall be a circular array of LEDs of sufficient number to achieve the required luminous output forming a nominal 127mm diameter indication.

The LEDs used in Subsidiary and Shunt Indications shall be such that, in combination with the diffuser or cover, shall be clearly readable for a minimum clear sighting distance of 150 meters in all light conditions.

10.1.3.4 Guards Indicators

The 127mm diameter indication shall consist of a circular array of LEDs of sufficient number to achieve the required luminous output. LEDs shall be 20° or 30° angle type. Fifteen degree angle LEDs may be used together with a suitable optical diffuser, on approval by the approving authority.

Where LEDs are not available in the specified 'light blue' colour (Lunar White), the desired 'light blue' colour may be achieved by a mix of white and blue LEDs evenly arranged in a nominal mix so as to achieve an even homogeneous dispersal of colour.

This homogeneous disbursement of light may be achieved by the use of an approved diffuser lens.

All guards Indicators shall be fitted with an approved sign advising 'Guards Indicator'. All indicators which are outdoors with any possibility of sunlight on them shall be correctly hooded so that the indicator can be clearly seen from below and from a wide viewing angle.

Guards Indicators shall be sighted and agreed to as part of the signal sighting surveys and agreed signoffs. Signoff by a guards representative is required to ensure that the indicator is in the best position.

Intensity to range between 40 and 50cd. The guards indication shall be clearly readable at a clear sighting distance of 150 meters at all times in all light conditions.

Note that the lunar white / white guards indicator has been superseded by the 'light blue' indicator.

10.1.3.5 Turnout Repeaters

Turnout repeaters shall have a rectangular band of white LEDs arranged such that sufficient luminous output is achieved. The LEDs shall be covered by a clear antiglare polycarbonate cover. Diffusion is not required.

10.1.3.6 Signal Repeaters (White light Type)

Where individual LED light units / modules are used they shall be 90mm diameter, of sufficient number to achieve the required luminous output,

A common printed circuit board may be used for the four aspects – both “proceed” and “stop”. In this case, the four aspects may be achieved by fitting a stencil with four by 90mm diameter cut-outs in front of an array of white LEDs.

Aspects when illuminated, shall be clearly readable and identifiable for a minimum clear sighting distance of 200 meters in all light conditions.

10.1.3.7 Ground Form Indicator (Colour Light Type)

As for subsidiary and shunt indications detailed in this specification.

10.1.3.8 ‘A’ Lights

The letter ‘A’ shall be 150mm in height.

When fitted to tunnel signals the letter ‘A’ shall be 100mm in height. The letter shall be formed with LEDs.

Alternatively, a broad array of LEDs combined with an appropriate stencil cut-out, is permitted.

Letter font style to be submitted for approval.

The letter, when illuminated, shall be clearly legible for a minimum clear sighting distance of 50 meters in bright daylight conditions and 100 meters in tunnel conditions.

10.1.3.9

The letters shall be 140mm in height and shall be formed with white LEDs.

Alternatively, a broad array of white LEDs combined with an appropriate stencil cutout, is permitted. To reduce misinterpretation of indications and maximise contrast, the signal shall present a uniform black or dark grey face to the observer when the ‘CO’ is not lit. This black or dark grey presentation may be achieved by the use of a smoky grey Shinkolite or other approved dark lens material placed in front of the LEDs. Refer to clause 11.1.5 for details of approved Shinkolite product.

Letter font style to be submitted for approval.

The Call On indicator when illuminated, shall be clearly legible for a minimum clear sighting distance of 20 meters in all light conditions.

10.1.3.10 Route Indicators – small / miniature type

Miniature route indicators shall consist of multiple LED light sources which are capable of displaying one or two digits.

Where a bay of the route indicator is required to exhibit only a fixed display, an array of LEDs combined with an appropriate stencil cut-out, is permitted.

Miniature multi-lamp route indicators will be considered and shall consist of 7x7 or 9x9 LED light source arrays.

The minimum height of digits shall be 125mm but may be reduced slightly pending approval by the approving authority and providing that the minimum sighting distance is maintained. Where a

double digit display is required, the digits shall be spaced appropriately so that they do not blend together at the specified viewing distance. Digit font style to be submitted for approval.

LEDs shall be white.

The digits shall be clearly legible for a minimum clear sighting distance of 50 meters. Digits shall be legible both during bright daylight conditions as well as night conditions without the need for dimming.

10.1.3.11 Route Indicators - main / large type

Large route indicators shall consist of multiple LED light sources which are capable of displaying a number of different alphanumeric characters, one at a time. Digits may be formed using individual LEDs or clusters of LEDs.

Displays may be of the matrix type using 7x7 or 9x9 pixel arrays, or a string of individual LED lights may be used to form the shape of each character.

The display digits shall not be readily visible when not illuminated.

The minimum character size shall be 400mm in height and preferably larger.

The large medium range route indicator when illuminated, shall be legible for a minimum reading distance of 200 meters. Digits shall be legible both during bright daylight conditions as well as night conditions. For high speed lines, longer sighting distances may be required.

10.1.3.12 Tri-colour main signals

Tri-colour signals comprise three different colour lights in a nominal 200mm diameter single head housing.

The standard system and colours for a main tri-colour signal shall be as defined in section 1.6 of this specification, the 'Chromaticity Table' further above and as defined for 'main indications'.

Active and neutral connections shall be electrically isolated from each colour aspect in the same signal light module and from all other aspects in the same signal head. Each aspect within a signal light module shall have fully independent and electrically isolated power supplies. Refer to ARTC Specification SPS 05 - Electrical & Electronic Components (Ratings & Construction Requirements) for minimum requirements.

Terminal strips within lampcases shall have provision for busing together the neutral connections using proprietary bus bars. However, the bus bar/s with screws etc shall not be fitted but rather, supplied loose within a plastic bag firmly attached to the light assembly.

Best visibility minimum clear sighting distances are as per 'main indications'.

10.1.3.13 Point Indicator – White Arrow

White arrow shall be formed with white LEDs.

Alternatively, a broad array of white LEDs combined with an appropriate stencil cutout, is permitted.

Nominal diameter should be 125mm and have a sufficient number of LED to achieve the required luminous output.

The white arrow when illuminated, shall be clearly legible for a minimum clear sighting distance of 20 meters in all light conditions.

10.1.3.14 Warning Lights

Warning lights when illuminated, shall be visible for a minimum clear sighting distance of 150 meters in all light conditions. Where used in tunnels, the intensity may need to be reduced to minimise glare.

White round warning lights are normally used in all applications.

Round warning lights shall be a nominal 127mm diameter and have a sufficient number of LEDs to achieve the required luminous output.

10.1.3.15 Tunnel Fire Safety Phone Light

An indicator displaying a nominal 127mm diameter blue indication.

Tunnel Fire Safety Phone Light, shall be rectangular and have a 75x50mm array of LEDs.

The rectangular light shall comprise of two LED matrices, one facing in either direction, angled slightly away from the tunnel wall. The illumination produced by the light shall be visible from any angle within a tunnel. Light unit to incorporate internal 12 Volt sealed lead-acid gel battery and integral 240 Vac charger. Sealing shall be to IP64 or better. The unit shall incorporate a flash facility to flash the light with a rate of 45 to 90 flashes per minute with a 50% duty cycle, when the handset of the associated telephone is not on the hook. The telephone interface shall comply with all applicable telephone system standards.

The clear sighting distance shall be 300 metres in the ambient light level found in the typical underground station.

Detailed construction specification available on request.

10.1.3.16 Indicator Notice Boards

The large notice board shall not exceed 600mm x 600mm in size. The letters shall be 140mm minimum height and shall be formed with LEDs.

LEDs shall be white and shall be covered by a diffused cover so that the array is not readily visible when the lamp is not illuminated.

The large notice board when illuminated, shall be clearly legible for a minimum clear sighting distance of 100 meters in all light conditions.

Other options will be considered

10.1.3.17 Phantom Reducer

“Shinkolite 560” is a high quality neutral grey tinted Polymethyl Methacrylate Acrylic with no red-brown colour content and a light transmittance of 31 % in 3mm thick sheet.

Supplier and product information is available on request. The product is stock coded with three disk sizes.

Since every disk will not necessarily carry a product label, random sample colour testing of each batch of product received shall be carried out. The minimum acceptable test shall sample 10% or 5%, whichever is greater of each batch received. The results of the tests shall be documented and form part of the quality inspection documentation forwarded with lampcases or lens units when these are delivered.

11 Electrical - General

11.1 Resistors

Resistors shall operate at 50% or less of their maximum power dissipation at 70°C.

Resistors shall be wire wound type typically packaged in an alloy heatsink housing.

Resistors shall be mounted to tolerate vibration at the levels laid down in the ARTC Standard Specification SPS 02.

Where resistors are required to be mounted within the lampcase, the supplier shall supply the lampcases with the resistors mounted to the lampcase with heat transfer paste to ensure good thermal contact for heat-sinking purposes and wired to a suitable terminal strip.

Where the resistors are to be soldered to wires, wires shall be twisted together and high temperature solder shall be used. The exposed solder joint shall be covered with a sleeve of suitable heat-shrink product.

11.2 Termination

Lampcases and signal bases shall be provided with an approved terminal block.

Cables and wires shall be terminated with the appropriate type of crimp lug or bootlace ferrule to suit the style of terminal block.

Sufficient terminals should be provided in the signal base to allow for the termination of all cable cores from the equipment room including spares.

The terminal shall be able to accept wire sizes of between 0.5 and 2.5mm square, as a minimum.

Where two wires are fitted into one terminal position, blade lugs shall be used.

In-line connections or crimps shall not be used.

Insulation displacement types of terminals in either lampcase or base shall not be used under any circumstances.

Terminals shall provide access for testing with a multimeter and or megger meter.

The terminals within a lampcase shall allow for the fitting of MOVs or other approved devices for surge protection, whether the devices are required at the terminals or not.

Surge protection shall be provided for LED signals, either on the LED module or preferably on an approved terminal block within the same enclosure, and shall conform to the ARTC Standard ESC-09-02 'Lightning and Surge Protection Requirements'.

Where surge protection is not integral to an LED light module, i.e. not provided on the LED circuit board, protection shall be provided by the vendor and fitted on the abovementioned terminals.

Provision shall be made for fixed labelling of each terminal.

Terminals shall be marked according to the terminal numbers shown on the standard circuits herein. Terminals for DC circuits shall be marked with the polarity in addition to the terminal numbers.

11.3 Wiring Specifications

11.3.1 Wiring within Lampcases

Wiring used within lampcases may be single insulated and shall be at least 7 strand copper, not less than 0.87 sq mm in area and shall be insulated in accordance with the requirements of AS 5000, "Electric cables - Polymeric insulated - For working voltages up to and including 0.6/1 kV". The insulation shall be at least V - 90 quality.

Wiring layout shall be neat and allow for easy clear access. There shall be no joints or intermediate connections between LED module and signal head terminal strip or between resistors and signal head terminal strip.

11.3.2 Wiring Between Lampcase and Base

Wiring between lampcases and the signal base shall comply with the requirements of ESA-11-01.

11.4 Electrical Requirements for LED Modules

Wherever applicable, the components used shall comply with the latest requirements of SPS05 Ratings & Construction Requirements.

Each individual signal aspect of a LED signal shall be electrically isolated from all other aspects as well as the lampcase ground and conform with the requirements of ESM-11-01.

A LED module shall have an expected minimum service life of at least 100,000 hours at 50°C.

MOVs of minimum 50 Joule rating shall be supplied fitted to the terminal strip within the lampcase irrespective of whether surge protection is provided within an LED module. Where the LED module is provided for retrofit application, the MOV shall be packed with the LED module.

Current draw of main indications within the same head shall be matched to within 10%.

11.4.1 Alternating Current fed LED Light Design

- LED aspects shall operate from an AC supply voltage range of 100 to 130 Volts 50Hz (120 Volts 50Hz nominal supply) and shall operate within this range without significant variation in luminous intensity.
- All 200mm mainline aspects shall draw not less than 100mA and not more than 300mA at 120VAC RMS. Resistors external to the LED module for the purpose of compliance with the above clause will not be permitted.
- LED modules shall be designed to minimise the effects of coupled voltages causing unwanted aspects to be illuminated. Protection against coupled voltages in long supply cables shall be provided such that no LED will illuminate at a supply voltage of less than 40VAC (higher turn-on voltages are preferred).
- AC LED modules shall be suitable for operation with tail cables of up to 750 metres in length as a minimum, without being illuminated due to capacitive coupling in cables. The maximum capacitive coupling in a 750m length of cable can be simulated using a 235nF mains rated capacitor. Twisted pair cables shall be used to eliminate so far as possible the effects of capacitive coupling in tail cables.

11.4.2 Direct Current fed LED Light Design

11.4.2.1 General

DC fed LED modules shall operate within the ranges stated below without significant variation in luminous intensity.

- a nominal 12VDC supply. The voltage range of 9VDC to 16VDC.
- a nominal 24VDC supply. The voltage range of 18VDC to 30VDC.
- a level crossing supply. The voltage range of 8VDC to 18VDC.

Protection shall be provided such that no LED will illuminate at a supply voltage of less than 4VDC and 5VAC RMS.