SPG 1571

SPECIFICATION LIGHT SIGNALS

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### Document control

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<thead>
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<th>Version</th>
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<th>Summary of change</th>
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<td>1.0</td>
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<td>Replaced <em>SC 07 10 00 00 SP Light Signals</em></td>
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| 1.1     | 02-05-06   | Section 1.7.4. Tunnel signal aperture diameter was defined as 90mm.  
Section 4.1. Ladder cage detail update.  
New section 4.2.4. U-bolts to be Stainless Steel  
Section 6. Permissive to paint whole of rear of signal white, withdrawn.  
Section 7. Identification & notice plates revised.  
Section 8. Revision to location of phones associated with gantry signals.  
Section 9.1. Reference to cadmium removed.  
New section 9.3. Spacing of lights.  
Miniature Route Indicator Box designations included.  
Section 10.1.5. Left and Right running turnouts were shown reversed.  
Section 11. sub-selections split into outdoor and tunnel lights  
Section 11.1.1. Red Chromaticity changed from 632 – 660 nm to 630 – 650nm.  
Section 11.2.2. Pole mounted Subsidiary light output intensity limited to 50% of main.  
Section 11.3.1.1. Tunnel Tri & Bi-colour lights added.  
Section 11.3.2. Tunnel Turnout Repeaters added.  
Section 11.3.5. ‘Tunnel Fire Phone Light’ now ‘Emergency Light’. Colour changed.  
Section 11.3.6. Warning light wall mount angle re-defined.  
Section 13. Tunnel signal wiring diagrams included.  
Section 13.4.2. Mast wiring to be multi-core twisted cable.  
Section 13.5 updated for CBI requirements.  
Appendix A, updated. |
| 1.2     | 03-07-07   | Section 1.7. PPE definition. Removed reference to lanyards etc.  
Section 3.2. Fit background to outdoor warning light where necessary.  
Section 4. – Amendments to ladders and gantries.  
Section 5. Removed references to OH&S and safe working. Updated anchorage requirements.  
Section 9.3. Gantry light spacing 900mm normative, 750mm in extreme cases.  
Section 10.4. Added notice plate requirement to warning Light.  
Section 11.2.2. Added example of Low Speed light where light output intensity shall not be more than 60% of the main indication.  
Section 11.2.8. Charcoal Dusk Frost filter is the preferred filter for CO.  
Section 11.2.9, 11.2.10, 11.2.12. Display background shall be mat black. Front lens shall be convex.  
Section 13.5. Disk MOV to be 20mm dia. minimum.  
Figure 13-10. Removed terminal strip links. Re-assigned terminal numbers. |
| 1.3     | 19-01-09   | Ref documents list updated.  
Section 4.5 Signal gantries. Copied information in from SPG 0705.  
Section 8 Telephones revised.  
Section 9.1.1 labeling, updated.  
Updated Fig 14-12.  
Section 13.3 updated to include for bootlace ferrules and disconnect terminals.  
Section 11.3.4 updated for ‘A light, was 50m viewing requirement.  
Section 11.3.5 revised description of emergency phone light.  
Added gantry sketch 026 to Appendix.  
Minor formatting adjustments. |
<p>| | | |</p>
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<td>May 2010</td>
<td>Application of <em>TMA 400</em> format</td>
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<td>1.5</td>
<td>1 June 2010</td>
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1 General

1.1 Scope
This Specification defines the requirements for the manufacture of LED type railway light signals 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, “A” lights and “U” lights
- Guards indicators and buffer stop lamps.
- Light signals for use in tunnels.
- Tri & Bi-colour main signals.
- Tunnel Emergency Phone Light.
- Indicator Notice Boards.

1.2 Incandescent Lamps
As incandescent lamps have a relatively short life span and require higher levels of maintenance than LED lights, their use is not encouraged where an LED alternative is available. The requirements for incandescent signal lights has been removed from this document and is available on request.

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

1.4 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 two years from date of manufacture. This warranty shall cover but not be limited to such items as transformers, lamp-holders, relays, terminals, printed circuit boards and connections to components thereon, lampcases, backgrounds, hoods, posts, ladders and finishes. Consumable items such as lenses are not included in this requirement, but shall be warranted for compliance with this and any referenced specification and as being ‘fit for purpose’. LED modules may be considered consumable items and shall be warranted against defects in components or manufacturing and against more than 10 % loss of rated light output for at least five years from date of dispatch from supplier.

1.5 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 more than 50 years, except where otherwise stated in a contract.

With LED modules, based on present technology there is an expectation that the product will provide a minimum service life of 100,000 hours of lit time at 50°C without deterioration of LED light output level by more than 10%.

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 must be adhered to.

1.6 Referenced Documents

The following documents are referenced in this Specification:

- **Australian Standard AS1743**: Road Signs – Specifications.
- **Australian Standard AS1744**: Standard Alphabets for Road Signs – Metric Units.
- **Australian Standard AS9000 series**: Quality Assurance.
- **Australian Standard AS1874**: Aluminium Ingots & Castings.
- **Australian Standard AS1734**: Aluminium Sheet & Plate.
- **Australian Standard AS/NZS 4680**: Hot-dip galvanised (zinc) coatings on fabricated ferrous articles.
- **Australian Standard AS/NZS 4534**: Zinc & zinc/aluminium-alloy coatings on steel wire.
- **Australian Standard AS/NZS 4791**: Hot-dip galvanised (zinc) coatings on ferrous open sections.
- **Australian Standard AS/NZS 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/NZS2144**: Traffic Signal Lanterns
- **British Standard BS469**: Railway signal Lamps.
- **RailCorp Specification SPG 1010**: Cables for Railway Signalling Applications - Single Conductor Cables for Indoor Use.
- **RailCorp Specification SPG 1031**: General Requirements for Labelling of Signalling Equipment.
- **RailCorp Specification SPG 1042**: Signal Lamps.
- **RailCorp Specification SPG 1065**: Terminals.
- **RailCorp Specification SPG 1066**: Solderless Terminals – Cable Lugs for Signalling Applications.
- **RailCorp Specification SPG 1210**: Signs, Notice Plates and Instruction Plates.
1.7 Definitions

1.7.1 Signals / Indications

Main Signal main signal displaying one or more red, yellow, green or white indications.

Marker Light A small light fixed to a single light colour light signal post for the purpose of indicating the location of a signal in the event of the main signal light having failed. Off-set to the right on an automatic or distant signal and directly underneath the main signal on a controlled 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.

Shunt Signal Signals used for low speed movements from sidings to main lines, and vice versa, and within sidings, and from one running line to another and for shunt movements past a running signal.

Note: Usually but not necessarily, ground mounted, with two red and one yellow indications.

Ground Form Co-acting Signal A fixed signal co-acting with another signal and fixed on the same post or adjacent thereto, for the purpose of giving continuity of view to the train driver.
Note: 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 fixed on the approach side of a fixed signal in order to give earlier information to a driver of the aspect or position of the fixed signal to which it refers.

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 Repeater** A signal displaying two inclined white lights.

**Turnout Indicator** Also known as a running turnout. 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 Repeater** A Junction Repeater is displayed at the signal in rear of the signal at the junction, when that signal is cleared, to inform the driver which way the junction is set.

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 and/or 45° right.

**Route Indicator** An indicator working in conjunction with a signal indication. It is provided at the divergence of two or more lines, and indicates to the driver the route to be taken by the train.

The display is capable of displaying white letters or numerals which relate to a particular track or route. May be associated with a main signal or a subsidiary signal.

The following types are presently in common use:

- Miniature
- Large

**'A’- Light** An indication in the form of a letter ‘A’ mounted on a running signal which when displayed instructs the driver to treat the running signal as an automatic signal.

**'U’- Light** An indication in the form of a letter ‘U’ mounted on a running signal which when displayed instructs the driver to treat the running signal as unattended.

**'CO’- Light** Subsidiary signal fixed under the accept/home, home or home/starting signal for the route concerned and when showing a “proceed” indication authorises the driver to proceed under control into a section of line which may be obstructed at any point.

The indicator displays the white letters ‘CO’.

**Guards Indicator** A light blue (outdoor application) or blue (NSR underground airport line) light in a case inscribed “guard’s indicator” provided on the platform which, when illuminated, indicates to the guard of a train that the signal at the departure end of the platform is showing a proceed indication.

**Warning Light** Lights provided adjacent to running lines in order to provide warning of the approach of rail traffic.

For outdoor use the light consists of a circular white indication.

In tunnels and outdoors from North Sydney to Redfern, a yellow vertical bar is used.
Buffer Stop Light A single red light at terminating roads. Where the possibility of confusing the single red with other signals or a parallel running road exists, a white light is provided above the red light.

Tri Colour Signal A single unit 125mm or 200mm diameter signal light capable of displaying three different colour aspects from the one housing. The colours are red, yellow and green.

A bi-colour comprises a signal single unit 125mm or 200mm diameter signal light capable of displaying two different colour aspects from the one housing.

Tunnel Emergency Phone Light An indicator displaying a rectangular light blue light to display the location of an Emergency Phone.

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

1.7.2 Abbreviations Used in this Specification

AREMA 'American Railway Engineering and Maintenance of Way Association'.

CB 'Common battery'.

Cd 'Candela' SI Unit of Luminous Intensity. Equivalent to 1 lumen/steradian.

CIE 'Commission Internationale de l'Eclairage' (International Commission on Lighting).

LED 'Light Emitting Diode'.

MOV 'Metal Oxide Varistor'. Used for surge protection.

NSR 'New Southern Railway'.

PPE 'Personal Protection Equipment'.

1.7.3 Terminology

Approving Authority An authorised Signals Engineering representative of RailCorp.

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

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 The distance from which a colour and night vision normal person with 20/20 or corrected eyesight viewing a signal must be able to easily and correctly read the signal against a day time bright clear sky background and a night time black background, from within a cab.

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 Standard ESG 100.1 Signal Design Principles – Signals, for further details.

Dominant wavelength (λ) 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.

**LED turn-on Voltage** The voltage applied to the signal at which one or more individual LEDs first begin to glow.

**Lens** The component of the optical system which distributes the luminous flux from the light source into a preferred direction which may also filter the light to give a desired colour. The outer lens also provides a barrier from dust and moisture.

**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 a lamp unit such that the lamp 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. a lit signal is obscured or appears white or an indeterminate colour.

### 1.8 Environmental Conditions

**1.8.1 General**

Equipment shall conform to the requirements laid down in the RailCorp Specification SPG 1856 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 – zero to +70°C immediately surrounding the electronic modules.

Proof of compliance to SPG 1856 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.

**1.8.2 Wind Loading**

Signal posts, gantries, lamp cases, backgrounds, hoods and other associated signalling equipment and structures located outdoors shall be able to withstand without damage, wind loadings of up to 160km/hr:
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 6. 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. It is preferable that LED circuit boards/modules be removable through the rear of the lampcase. 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.

Lockable hinged doors shall be provided for access to terminations.

Provision shall be made for ventilation by means of a small breather in the signal case door.

Door shall be rearward opening and shall be provided with a hasp or similar device which can be secured by the standard padlock (shown on Drawing 071000 / 001). Doors which are 600mm nominal wide shall be fitted with door stays to allow the door to be fixed in the 90 degree position. Closed doors shall form an effective light proof, weather proof and dust proof seal with the lampcase.

Unused cable entry apertures to 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 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.

Where a number of single aspect lampcases are combined to form a multi-aspect lampcase, the joint between lampcases shall be effectively sealed and the individual doors on the lampcases shall be combined into a single door with single point securing.
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 light leakage between lampcases in an assembly or between aspects in any one lampcase.

2.2 Multiple Aspect Lampcases

Multiple aspect lampcases may be made up from any combination of single aspect, two aspect or three aspect lampcases to display up to four aspects.

The bottom lampcase or 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 or lampcase assembly. The terminals shall be mounted not less than 20mm above the bottom of the lampcase to avoid any moisture which may be present.

Where wiring passes between individual lampcases in the assembly or through partitions in a lampcase, it shall be protected by bushes, which shall also form a light seal between lampcases or sections of the lampcase.

2.3 Lampcases - Maximum Dimensions

Signal lampcases shall not exceed the following dimensions:

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

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 - Above ground

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 50 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 or changing lenses, 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.

2.5 Tunnel Light Brackets
Brackets for tunnel lights shall be manufactured from the same (or a compatible) material as the case. Case penetrations shall be fully sealed against water ingress.

Galvanised steel brackets or fasteners shall not be used in tunnels.
2.5.1 **Signal Light Brackets**

The mounting 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 with suitable stainless steel masonry anchors (not less than 16mm thread diameter) and if the bracket is manufactured from aluminium, it shall be insulated from the anchors with nylon bushes and washers.

2.5.2 **Staff Warning Light Brackets**

The staff warning lights shall be mounted against the tunnel wall with stand-off brackets which maintain the case body 25 - 50mm off the tunnel wall.

Fixing to tunnel walls shall be with suitable stainless steel masonry anchors (not less than 8mm thread diameter) and if the bracket is manufactured from aluminium, it shall be insulated from the anchors with nylon bushes and washers.

Outdoor staff warning light notice plate may be affixed to a stand-alone bracket.

2.5.3 **Emergency Phone Light Brackets**

The emergency phone lights shall be mounted against the tunnel wall with stand-off brackets which maintain the case body at least 20mm off the tunnel wall.

Fixing to tunnel walls shall be with suitable stainless steel masonry anchors (not less than 6mm thread diameter) and if the bracket is manufactured from aluminium, it shall be insulated from the anchors with nylon bushes and washers.

3 **Hoods and Backgrounds**

3.1 **Hoods**

All signal aspects (except tunnel signals) and all indicators shall be fitted with hoods. The hoods shall be made from aluminium alloy at least 1.6mm thick.

The minimum length and cover for hoods shall be:

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

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 shall 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 top, bottom or sides of the stencil arrangement.

### 3.2 Backgrounds

Where shown in Section 2, 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.

<table>
<thead>
<tr>
<th>Lampcase</th>
<th>Background Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Line Lampcase – Standard</td>
<td>600mm wide, projecting at least 200mm above the top aspect and 25mm below the</td>
</tr>
<tr>
<td>Background Refer note 1.</td>
<td>bottom aspect</td>
</tr>
<tr>
<td>Main Line Lampcase – Narrow</td>
<td>450mm wide.</td>
</tr>
<tr>
<td>Background Refer note 1.</td>
<td></td>
</tr>
<tr>
<td>Subsidiary Shunt, Low Speed, Close-</td>
<td>450mm diameter</td>
</tr>
<tr>
<td>up, Call-on – Standard Background</td>
<td></td>
</tr>
<tr>
<td>Refer note 2.</td>
<td></td>
</tr>
<tr>
<td>Subsidiary Shunt, Low Speed, Close-</td>
<td>375mm diameter</td>
</tr>
<tr>
<td>up, Call-on – Narrow Background</td>
<td></td>
</tr>
<tr>
<td>Repeater</td>
<td>As shown on drawing</td>
</tr>
</tbody>
</table>

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.

Note 2: Fit background to outdoor warning light where necessary.

### 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.

Ladders exceeding 6m shall be secured against unauthorised access and provided with fall protection.

A lockable ladder cage shall be provided where necessary and in accordance with the requirements of AS/NZS 1657. The ladder cage shall commence at 2.0 metres from the ground / landing pad. Alternatively, a 10mm minimum 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 in order to prevent use by unauthorised personnel. The ladder guard shall also be provided with an approved warning notice.

4.1.1 Signal Post Ladders

Signal post ladders up to 6m, shall comply with manufacturing drawings M01-159 and M01-160.

4.1.2 Gantry Ladders

Signal gantry access ladder/cage shall comply with Civil manufacturing drawing E1-451.

Signal cage ladder shall comply with Civil manufacturing drawing E1-452.

Refer to SPG 0706 for further details.

4.1.3 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.

Refer to manufacturing drawing M01-160 for details of gallery ring.

4.2 Signal Posts

Signal posts shall be manufactured from 125 nominal bore heavy (5.4mm wall thickness) steel tube (140mmOD) in accordance with drawing M01-144 with an integral base and terminal box equivalent to that detailed on drawing M01-307, unless specified otherwise. Equivalent approved designs may be accepted. 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 corners and edges ground or filed to remove any burrs.

Where cable conduits or cable glands are terminated onto the signal post they shall be threaded with a minimum of five threads.

Where design changes or modifications to the structure are required due to local conditions, approval must be sought from an approved design engineer and safety coordinator for risk assessment.
4.3 **Signal Post Foundations**

Foundations shall comply with the requirements in Specification SPG 0705 & SPG 0706.

4.4 **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 order.

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

Safe access shall be provided for the maintenance of any and all lampcases on the signal post. It shall 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.

It is generally not acceptable to require a lampcase to be accessed from a landing which is above the lampcase or to require a lampcase to be accessed from ground level where the lampcase is more than 1700 mm above ground level.

Access to the landing shall be provided by means of a fixed ladder. A safety chain / bar shall be provided at the top of the ladder fitted at handrail height to prevent 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 metres 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/NZS 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 above the landing shall be provided along both sides and across the front of the landing, generally in accordance with AS/NZS 1657.
Signal post landings shall be provided with guardrails / handrails of height 1.1m unless specified otherwise and shall conform to AS/NZS 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 shall be identified with high visibility hazard tape. Hazard tape shall be self adhesive black on white. Tape is not to be placed on rungs nor on any other surface which may be trodden on.

Unless local access conditions require a non standard design, signal post landings shall wherever possible, comply with manufacturing drawings M01-159 and M01-160 and in any case, the requirements of AS/NZS 1657 must always be met.

4.5 Signal Gantry

Where signal cages are cantilevered, the access to the cage from the walkway on the gantry shall be through a self closing gate which opens across the gantry walkway or through a removable (one side fixed) chain barrier. The gate or chain shall be painted gloss white.

If it is necessary for a cage to be immediately below the gantry with access through the gantry (this shall be considered a last resort solution), a suitable hinged trap door shall be provided in the gantry walkway. The trap door shall, if necessary, be counterweighted to limit the maximum force required to open it to 20 kg.

Suitable arrangements to secure the trapdoor in the open position shall be provided.

In the closed position the trap door shall provide a similar textured surface to the walkway and shall be level with the walkway. In the open position the trap door shall obstruct the walkway and shall open away from the normal approach direction. The underside of the trapdoor shall be painted white.

Both sides of the cage shall be covered with expanded aluminium mesh or similar as shall the back of the cage if this is not covered by sheet aluminium forming the background for the signal. The background shall be painted matt black. The mesh size shall not exceed 100 LWM x 50 SWM.

Where sheet aluminium is used on the back of the cage to form a signal background it shall be minimum 2 mm thick and be secured to the cage at 250mm maximum intervals.

Unless specified otherwise, gantry portal structures shall be constructed in accordance with the following:-

- For 300mm x 90mm double PSC structure steelwork, refer to Civil drawing E1-448.

  or

- 380mm x 100mm double PSC structure steelwork, refer to Civil drawing E1-437.

For larger/wider span structures, refer to Civil discipline.

Gantry walkway, gate and balustrade shall be constructed in accordance with Civil drawing E1-450.

Gantry signal cage shall be constructed in accordance with Civil drawing E1-452.
4.6 ‘U’ Bolts

‘U’-bolts shall be 316 Stainless Steel supplied with Stainless Steel nuts and washers. Anti-seize shall be applied to threads when installing, to prevent seizing of nuts.

5 Systems of Safe Access and Safe Working

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/NZS 1657.

Where these primary means of fall control cannot be fitted due to structure gauge or other space restrictions, limited fall arrest system/s may be specified in lieu or in addition.

All equipment shall be designed to allow for safe access and egress for installation and maintenance.

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/NZS 1891.4 : 2000, and must be designed by an approved engineer. Safe means of access and egress to/from an anchorage point in accordance with AS/NZS 1657 must be provided.

Anchorages for the connection of two persons shall be designed for a minimum force loading of 21kN and for the connection of one person shall be designed for a minimum force loading of 15kN.

Anchorage points and the associated structure/s to which they are fitted, should be inspected annually unless approved maintenance schedules advise otherwise.

5.1.1 Signal Posts

Where specified, signal posts may require the fitting of a suitable anchorage point such as an eye-bolt/s.

In the case of retrofit applications to existing signal posts, the supporting structure must be rated for 15kN however, the attachment point and brackets shall be designed for at least 21kN.

Refer to Drawings M01-161 and 162 for manufacturing detail of retro-fit anchorage point bracket.

5.1.2 Gantries

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.

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

Refer to Civil Drawing E1-452 and Signal Drawings M01-429 & 162 for manufacturing details of signal cage anchorage point.
5.2 **Gantry Cage Openings**

5.2.1 **Front of Cage**

Any opening in the front of a signal cage and in particular where tricolour signal lights are installed, such that the smaller of the two maximum dimensions of any opening (or diameter in the case of circular openings) exceeds 450 mm, shall be filled in. Where any opening (or diameter in the case of circular openings) exceeds 450 mm, the area of that opening shall not exceed 0.2 m².

Infill may be provided by means of appropriately spaced angle iron bars of minimum size 50mm x 50mm by 6mm, extending from one side of the vertical cage to the other.

Infill shall not interfere with the lampcase being able to be rotated.

Refer to example sketch 071000/026.

5.2.2 **Top of Cage**

A gravity operated self closing gate shall be provided at the opening in the balustrade above the signal cage. The gate shall take the form shown on Civil drawing E1-450. Alternative designs may be approved by the Chief Engineer Signals.

6 **Painting**

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

<table>
<thead>
<tr>
<th>Component</th>
<th>Location</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lampcases</td>
<td>Interior</td>
<td>Matt or semi-gloss black</td>
</tr>
<tr>
<td>Lampcases</td>
<td>Exterior</td>
<td>Matt or semi-gloss black</td>
</tr>
<tr>
<td>Fixtures etc</td>
<td>Inside lampcases</td>
<td>Matt or semi-gloss black</td>
</tr>
<tr>
<td>Bezels</td>
<td></td>
<td>Matt or semi-gloss black</td>
</tr>
<tr>
<td>Backgrounds</td>
<td>Front</td>
<td>Matt black</td>
</tr>
<tr>
<td>Backgrounds</td>
<td>Rear</td>
<td>Semi-gloss white</td>
</tr>
<tr>
<td>Hoods</td>
<td></td>
<td>Matt black</td>
</tr>
<tr>
<td>Posts, ladders,</td>
<td></td>
<td>No painting - galvanised finish to AS/NZS 4680, AS/NZS 4791 &amp; AS/NZS 4792 if steel. Anodised or natural finish if aluminium.</td>
</tr>
<tr>
<td>Brackets etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.**

Note 3: The rear of the background shall be painted white as specified above. The lamp case shall remain black.
7 Identification & Notice Plates

7.1 General

Identification and notice plates shall be according to Railcorp Equipment Specification SPG 1210 - Signs, Notice Plates and Instruction Plates, however, this specification shall take precedence.

All plates shall have rounded corners. Where the plate is shown as having square corners, a minimum radius of 5mm shall be applied.

Text shall comply with Australian Standards AS1743 and AS1744.

7.1.1 Identification Plates

A Signal identification plate shall be fitted to each signal.

Signal identification plates may take the forms shown on Drawing 071000 / 002 in Section 14 of this document. Characters shall be Series ‘D’ unless specifically approved otherwise by the Chief Engineer Signals.

The plate shall extend above and below the text by 25mm with a 50mm gap between rows of text.

Text material shall be retroreflective white Class 1.

Background material shall be black non-reflective.

Plates shall be attached to signals in the positions shown on RailCorp Drawings 071000 / 005 to 071000 / 025 in Section 14 of this document.

7.1.2 Notice Plates

Where required, driver’s notice or instruction plates shall be fitted to the signal post below the lowest aspect but above any signal telephone.

If there is insufficient space on the signal post to fit the notice plate, it shall be mounted on a separate 50NB galvanised steel post adjacent to the signal and in full view of the driver of any train standing at the signal.

8 Signal Telephones

Outdoor signal telephones shall be fitted to the posts of all Automatic signals except Distant signals unless otherwise specified in the particular specification.

For multi-track gantries, phones should be mounted on a post directly below the signal. Where no safe place exists, consideration should be given to phones being relocated to the gantry leg or adjacent, and the rationalisation of the number of phones. The consideration shall include operational impact assessment.

The phone shall be in a vandal resistant case, preferably without separate handcom, and securely attached to the signal post to prevent unauthorised removal or damage. Telephones shall be subject to type approval, and are required to be self identifying without any requirement for internal batteries.

The phone shall be mounted so that it is 1450 - 1600 mm above ground (or any platform) level at the base of the signal.
For information on phones refer to specification STM 0082 Analogue Two Wire Weatherproof Field telephones.

9 Assembly of Signals

9.1 General

Signals shall be assembled in the forms shown on Drawings 071000 / 005 to 071000 / 025 located at the rear of this document.

All bolts, nuts, washers etc used in assembly shall be galvanised or zinc 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. ‘U’ bolts and associated nuts and washers shall be to Section 4.6.

Assembly of both lampcase components and complete signals shall provide for ease of maintenance, i.e. lamp changing, lens replacement, relay replacement, adjustment of signal focus.

Anti-seize or thread sealant 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 must allow the metal-threads to be removed for maintenance activities without damage.

All wiring within lampcases and between lampcases and 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. Wiring shall be in accordance with the circuit diagrams shown herein.

Each multiple aspect lampcase or lampcase assembly 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. The required wiring diagrams are shown in Section 13 of this document.

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.
The wiring diagrams for double head and single head signal bases are shown in Section 13 of this document. These complete diagrams are to be used irrespective of the indications in use.

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

Labelling shall comply with the requirements of SPG 1031.

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

9.2 Alignment

Where a number of single unit lampcases are used to make up a two, three or four aspect lampcase, assembly shall be such that the light beams from each unit lampcase are parallel to one another in both the horizontal and vertical planes.

9.3 Spacing of lights

Red lights on signal posts shall be vertically spaced as follows. Drawings 071000 / 005 to 071000 / 025 are provided for guidance:

- Double Heads – 1,220 to 1,350mm.
- Single Head / Marker – 950 to 1,050mm.
- Red lights on gantry mounted signal heads are to be spaced 900mm.
- Tri-colour gantry mounted signal heads may be spaced at no closer than 750mm in extreme cases where there is a requirement to improve sighting due to visual obstruction from other infrastructure.
- Refer to Appendix sketch 071000/026 for details of gantry mounted light spacings.
- Tunnel Signal red lights - 600mm.
- Where a white light is required above a buffer stop red light, the white light shall be mounted between 700 and 900mm above the red light.

10 Forms of Signals and Indicators

10.1 Signals

Signals shall present the following appearance to train drivers.
10.1.1 Main Lampcase - 200mm diameter

[Diagram showing three and four light schemes with G, Y, R colors]

10.1.2 Marker Light - 127mm diameter

[Diagram showing R and Y lights with 'No Background' note]

10.1.3 Buffer Stop Light - 127mm diameter

[Diagram showing R and W lights with 'No Background' note]

10.1.4 Subsidiary - 127mm diameter

[Diagram showing Y and G lights with 'Background generally 450mm dia.' note]

10.1.5 Turnout Indicator - 127mm diameter

[Diagram showing R, Y, and W lights for right, left, and left or right with 'One route only illuminated at any one time. Only used in single light territory.' note]
10.1.6 Turnout Repeater – white aspect

10.1.7 "A", "CO" and "U" Lights - 200mm diameter

10.1.8 Vertical Shunt, Horizontal Shunt & Dwarf Signals - 127mm diameter

10.1.9 Repeater Signal - Main (90mm diameter Lens)

Four horizontal lights indicate parent signal at stop

Four vertical lights indicate parent signal at proceed

10.1.10 Repeat Signal - Low Speed or Shunt - 127mm diameter
10.2 **Route Indicators**

10.2.1 **Miniature - Route Indicators**

Refer to wiring tables in Section 14 for example of how to designate boxes when viewed from the front.

Other variations permitted as per Section 11.2.10.

10.2.2 **Large – Multi Lamp Route Indicator (MLRI)**

Also known as Main Line Route Indicator

Viewed from front.
Other variations permitted as per Section 11.2.11.

10.3 Tunnel Signal - 100mm diameter
10.3.1 Tri / Bi-colour Tunnel Signal

Example Tri/Bi-colour configurations

10.4 Warning Lights

Three aspect light shown. Each aspect 300 x 50mm

Front View
Outdoor Light – white
127mm diameter
Refer to Section 11.2.12
Note: where multi track, name plate to be inscribed with applicable line.

Front View
Tunnel Light – yellow
300mm x 50mm Rectangular
Refer to Section 11.4.2
10.5 Guards Indicators - 127mm diameter

Indicator: Light Blue

10.6 Tunnel Emergency Phone Light

10.7 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 whether incandescent or LED type, 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 'eight inch' design based on the AREMA incandescent light '8-3/8 inch' size outer lens.
- Subsidiary aspects shall be a nominal 'five inch' design based on the AREMA incandescent light '5-3/8 inch' size outer lens.
Main signal aspects used in tunnel systems shall be as close as practical to 100mm. The light aperture size may be achieved by fitting a 100mm diameter stencil/mask.

Low speed and shunt aspects used in tunnel systems shall be 45mm +/- 2mm. The light aperture size may be achieved by fitting a 45mm diameter stencil/mask.

Where secondary optics are not used to ensure an even dispersement 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.

11 LED Optic 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.

The LEDs shall be current limited and arranged such that a failure of any LED will result in no more than 25% loss of indication.

11.1 Common Performance & Design Criteria

11.1.1 Optical Requirements

The colours of LED signals and indications shall be as specified in Section 1.7 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/NZS 2144:2002 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 acceptable except where approved or specified by the approving authority; an example being where current LED technology cannot provide the desired colour. Coloured filters shall not be used except where required by the approving authority.

An even and equal distribution 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 shall 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 will be considered.

All LEDs used shall be in water clear packages.

The outer surface of the diffuser or cover shall be smooth, manufactured from polycarbonate and shall 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 L560’ 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 without the need for active dimming of lights.

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.

Signal sighting distances specified in this document are based on the requirements of RailCorp Standard ESG 100 Signal Design Principles, and are minimum nominal clear sighting distances. In practice, consideration must 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.

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

Each display within a lampcase shall be capable of being electrically isolated from every other display within the lampcase and signal. Eg: Whilst Multi-route LED indicators may utilise a common PCB for the mounting of components of all displays within a lampcase, the components and associated wiring for each display must be fully electrically isolated from each other. Common wires between different displays are not permitted, except where there is to be provision at the incoming terminal block where it shall be provided with provision for bussing the neutral/negative.

### Table 1 - Chromaticity Table definitions for LED Lights

<table>
<thead>
<tr>
<th>Colour</th>
<th>Chromaticity Boundary Definitions</th>
<th>LED Dominant Wavelength ((\lambda))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red (Wayside signals)</td>
<td>(y \leq 0.292) (y \geq 0.998-x)</td>
<td>630 - 650 nm</td>
</tr>
<tr>
<td>Refer to notes 1 &amp; 2 below.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red (Highway-Rail Crossings)</td>
<td>(y \leq 0.320) (y \geq 0.292) (y \geq 0.998-x)</td>
<td>615 - 630 nm</td>
</tr>
<tr>
<td>Refer to notes 2 &amp; 3 below.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>(y \leq 0.430) (y \geq 0.384) (y \geq 0.862 - 0.783x) (x \geq 0.554)</td>
<td>590 – 595 nm</td>
</tr>
<tr>
<td>Green</td>
<td>(y \geq 0.506 - 0.519x) (y \geq 0.150 + 1.068x) (y \leq 0.817-x)</td>
<td>500 – 510 nm</td>
</tr>
<tr>
<td>White</td>
<td>(x \geq 0.285) (x \leq 0.440) (y = 0.050 + 0.750x) (y = 0.150 + 0.640x)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Blue</td>
<td>(x \leq 0.179) (y \leq 0.209)</td>
<td>460 – 481 nm</td>
</tr>
</tbody>
</table>
Colour | Chromaticity Boundary Definitions | LED Dominant Wavelength (\(\lambda\))
--- | --- | ---
Light Blue (Guards Indicator) | \(y \leq 0.734x + 0.088\) | Not Applicable

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-AlGaAs and AS-AlGaAs 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.
Figure 1 - 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 above chart.
Figure 2 - Detail A - Yellow Chromaticity Boundary Envelope
Figure 3 - DETAIL B - Red Chromaticity Boundary Envelope
11.1.2 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.

11.2 Outdoor Signals and Indicators – Details

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.

11.2.1 Main Signals

The standard optic system for a main light shall be a circular array of not less than 110 LEDs evenly arrayed within a circle forming a nominal 200mm diameter indication. Pending approval from the approving authority, the number of LEDs may be reduced where secondary optics or alternative technology is used to provide an even disbursement of light across the face of the aperture.

The standard colours shall be as defined in the 'Chromaticity Table'.

The LEDs shall be current limited and arranged such that a failure of any LED will result in no more than 25% loss of indication.

The LEDs used in main aspects shall be such that, in combination with the diffuser or cover, all signal indications shall be clearly readable in all light conditions at the following sighting distances:

- Standard signal: 500 metres minimum.
- Long Range Signal: 1000 metres minimum.

This implies a luminous distribution rate in excess of 6500 cd/m².

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°.

11.2.2 Tri / Bi-colour

The Tri-colour signal is a single unit signal light capable of displaying three different colour aspects from the one housing.

The Bi-colour signal is a single unit signal light capable of displaying two different colour aspects from the one housing.

The colours for a Tri or Bi Colour signal shall be as defined in the 'Chromaticity Table'.

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 RailCorp Specification SPG 1600 - Electrical & Electronic Components (Ratings & Construction Requirements) for minimum requirements.

Terminal strips within lampcases shall have provision for bussing 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.

Requirements of ‘Main Signals’ apply.

11.2.3 Subsidiary and Shunt Indications 127mm diameter

The standard optic system for this light shall be a circular array not normally less than 75 LEDs forming a nominal 127mm diameter indication. Where a subsidiary such as a ‘Low Speed’ or shunt light is post mounted in conjunction with mainline indications, the light output intensity shall not be more than 60% of the main indication.

A slightly reduced array diameter may be permitted subject to approval by the approving authority.

Colours shall be as defined in the ‘Chromaticity Table’.

Subsidiary and Shunt Indications shall be clearly readable in the train cabin environment for a minimum clear sighting distance of 150 metres in all light conditions.

11.2.4 Guards Indicators

The standard optic system for this light shall be a light blue circular array of not less than 80 LEDs forming a nominal 127mm diameter indication. 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, 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. The colour shall be as defined in the ‘Chromaticity Table’.

This homogeneous dispersal 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 must be correctly hooded so that the indicator can be clearly seen from below and from a wide viewing angle.

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

Light output intensity of the Guards Indicator shall range between 40 and 50cd. The Guard’s Indicator light shall be clearly readable at a clear sighting distance of the full length of the platform at all times in all light conditions.

Note that the white / lunar white guard’s indicator has been superseded by the 'light blue’ indicator.
11.2.5 Turnout Repeaters

The standard optic system for this light shall be a white rectangular band 625mm long by 80mm thick, made up of no less than 195 white LEDs arranged in no less than 4 rows. LEDs shall be 15° or 20° angle type. The LEDs shall be arranged such that open circuit failure of any LED will result in no more than 25% loss of indication and short circuit failure of any LED will result in the loss of only that LED. The LEDs shall be covered by a tinted anti-glare polycarbonate cover.

The rectangular band shall be inclined at 45 degrees either to the left or to the right indicating the direction of turnout. Where there are diverging routes to the left and to the right, both rectangular bands may be incorporated into the one unit. The two rectangular bands shall be electrically isolated from each other.

To reduce misinterpretation of indications and maximise contrast, the display shall present a uniform black or dark grey antiglare face to the observer when the display 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 Section 11.4.1 for details of approved products.

Display background shall be matt black.

Turnout Repeaters when illuminated, shall be clearly readable and identifiable in the train cabin environment for a minimum clear sighting distance of 400 metres in all light conditions.

11.2.6 Signal Repeaters (White light type)

The standard optic system for this light shall consist of:-

- Four individual 90mm diameter white lights mounted vertically (indicating next signal shows ‘proceed’) and,
- Four individual 90mm diameter white lights mounted horizontally (indicating next signal shows ‘stop’).

Where individual lights are used they shall be 90mm diameter, each shall contain a minimum of 36 white LEDs with the LEDs arranged such that open circuit failure of any LED will result in no more than 25% loss of indication and short circuit failure of any LED will result in the loss of only that LED.

A common printed circuit board may be used for the four “proceed” aspects and similarly for the four “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.

LEDs shall be 15° or 20° angle type.

The LEDs shall be covered by a tinted anti-glare polycarbonate cover.

To reduce misinterpretation of indications and maximise contrast, the display shall present a uniform black or dark grey antiglare face to the observer when the display 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 Section 11.4.1 for details of approved products.

Display background shall be matt black.

Aspects when illuminated, shall be clearly readable and identifiable in the train cabin environment for a minimum clear sighting distance of 200 metres in all light conditions.
11.2.7 **Ground Form Indicator (Colour light type)**

As for subsidiary and shunt indications detailed in this Specification.

11.2.8 **‘A’ Lights & 'U' Lights**

The letter ‘A’ and the letter 'U' shall be 150mm in height and fit within the standard nominal 200mm diameter lens aperture.

The letter shall be illuminated with white LEDs and may be formed with a double row of LEDs or alternatively, a broad array of LEDs combined with an appropriate stencil cut-out.

To reduce misinterpretation of indications and maximise contrast, the signal shall present a uniform black or dark grey face to the observer when the light is not lit.

This black or dark grey presentation may be achieved by the use of the “Charcoal Dusk Frost” filter or other approved dark lens material placed in front of the LEDs. Refer to Section 11.4.2 for details of the “Charcoal Dusk Frost” filter.

Letter font style to be submitted for approval.

LEDs shall be 15° or 20° angle type.

The letter, when illuminated, shall be clearly legible in the train cabin environment for a minimum clear sighting distance of 20 metres in bright daylight conditions.

11.2.9 **'CO' Lights**

The letters shall be 140mm in height and fit within the standard nominal 200mm diameter lens aperture.

The letters shall be illuminated with white LEDs and may be formed with a double row of LEDs or alternatively, a broad array of LEDs combined with an appropriate stencil cut-out.

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 the “Charcoal Dusk Frost” filter or other approved dark lens material placed in front of the LEDs. Refer to Section 11.4.2 for details of the “Charcoal Dusk Frost” filter.

Letter font style shall be submitted for approval.

LEDs shall be 15° or 20° angle type.

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

11.2.10 **Route Indicators – small / miniature type**

Route indicators may comprise of one or more display boxes. A display box is a nominal 200mm wide by 200mm high. Refer to section 2.3 for display box dimensions and Section 10.2.1 for examples.

Each display shall be electrically isolated from all others. Local switching within the signal shall not be permitted.

A box may be capable of displaying one fixed display or multiple different displays.
A box shall display no more than two alphanumeric characters side by side though one character per box is preferred.

The minimum height of characters shall be 125mm but may be reduced slightly pending approval by the approving authority and providing that the minimum sighting distance is maintained. Where 2 characters are displayed side by side, the characters shall be spaced appropriately so that they do not blend together at the required viewing distance specified further below.

Character font style shall be submitted for approval.

Characters shall be white and may be formed by:

- one or two rows of individual white LEDs, or
- where a box of the route indicator is required to exhibit only a fixed display, an array of white LEDs combined with an appropriate stencil cut-out, is permitted or
- 7x7 or 9x9 LED light source arrays.

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

- LEDs shall be 15° or 20° angle type.

To reduce misinterpretation of indications and maximise contrast, the display shall present a uniform black or dark grey antiglare face to the observer when the display 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 Section Error! Reference source not found. for details of approved products.

Display background shall be matt black.

The character/s shall be clearly legible in the train cabin environment for a minimum clear sighting distance of 50 metres. Characters shall be legible in all ambient light conditions without the need for active dimming.

Front lens shall be convex to minimise reflections misleading indications.

11.2.11 Route Indicators - main / large type

Large route indicators (MLRI) shall consist of multiple LED light sources which are capable of displaying a number of different alphanumeric white characters, one at a time.

Each display shall be electrically isolated from all others. Local switching within the signal shall not be permitted.

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

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

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

To reduce misinterpretation of indications and maximise contrast, the display shall present a uniform black or dark grey antiglare face to the observer when the display 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 Section 11.4.1 for details of approved products. The lens shall be convex and sloped downward to minimise reflection.

Display background shall be matt black.
The route indicator when illuminated, shall be legible in the train cabin environment for a minimum reading distance of 200 metres. Characters shall be legible in all ambient light conditions without the need for active dimming. For high speed lines, longer sighting distances may be required.

11.2.12 Warning Lights (Staff)
The standard optic system for this light shall be a white circular array of not less than 75 LEDs forming a nominal 127mm diameter indication. White circular warning lights shall be used in outdoor applications.

Warning lights shall be designed such that when illuminated, they are visible for a minimum distance of 150 metres in all ambient light conditions.

Backgrounds may be required where the visibility of the warning light is compromised by other light sources.

11.2.13 Indicator Notice Boards
The standard optic system for this notice board shall consist of characters no less than 140mm in height. Each character shall be formed with a string of individual white LEDs.

LEDs shall be 15° or 20° white and shall be covered by a diffused cover so that the array is not readily visible when the lamp is not illuminated.

The notice board shall not exceed 600mm x 600mm in size unless otherwise approved by the Chief Engineer Signals.

To reduce misinterpretation of indications and maximise contrast, the display shall present a uniform black or dark grey antiglare face to the observer when the display 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 Section 11.4.1 for details of approved products.

Display background shall be matt black.

The lens shall be convex and sloped downward to minimise reflection.

The notice board when illuminated, shall be clearly legible in the train cabin environment for a minimum clear sighting distance of 100 metres in all ambient light conditions without the need for active dimming.

Other design options will be considered on application to the Chief Engineer Signals.

11.3 Tunnel Signals - Details

11.3.1 Tunnel Main Signals
The light in tunnel signals shall consist of not less than 36 LEDs evenly arrayed within a circle forming a nominal 100mm diameter indication. The "low speed" or "shunt" aspect shall have an equivalent density of LEDs. This may be achieved by mounting a stencil with a 45mm diameter aperture in front of a 100mm diameter aspect.

The standard colours shall be as defined in the 'Chromaticity Table'.

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.
The diffuser or 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 in the train cabin environment 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 require the fitting of hoods and or increased intensity levels.

11.3.1.1 Tunnel Tri / Bi-colour

The Tri-colour signal is a single unit signal light capable of displaying three different colour aspects from the one housing.

The Bi-colour signal is a single unit signal light capable of displaying two different colour aspects from the one housing.

The colours for a Tri or Bi Colour signal shall be as defined in the 'Chromaticity Table'.

Active and neutral connections shall be electrically isolated for 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 RailCorp Specification SPG 1600 - Electrical & Electronic Components (Ratings & Construction Requirements) for minimum requirements.

Terminal strips within lampcases shall have provision for bussing 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.

Requirements of ‘Tunnel Main Signals’ apply.

11.3.2 Tunnel Turnout Repeaters

The standard optic system for this light shall be a white inclined rectangular band of LED’s making up a matrix of minimum size 136mm long by 20mm wide, and located behind a tinted lens aperture, made up of no less than 60 white LEDs.

LEDs shall be 15° to 25° angle type.

To reduce misinterpretation of indications and maximise contrast, the display shall present a uniform black or dark grey antiglare face to the observer when the display 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 Section 11.4.1 or details of approved products.

Display background shall be matt black.

The rectangular band shall be inclined at 45 degrees indicating the direction of turnout.

Where combined left and right turnout indication is required, this may be achieved by installing two separate lampcases mounted one above the other.

Each display shall be electrically isolated from all others. Local switching within the signal shall not be permitted.

Turnout Repeaters when illuminated, shall be clearly readable and identifiable in the train cabin environment for a minimum clear sighting distance of 100 metres in the ambient light level found in the typical underground tunnel.
11.3.3 Tunnel Route Indicators

Tunnel route indicators may be capable of displaying one fixed display or multiple different displays.

Each character displayed shall be electrically isolated from all others. Local switching within the signal shall not be permitted.

No more than one alphanumeric character shall be displayed within the nominal 100mm diameter display aperture at any one time.

The height of the character shall fill the 100mm diameter aperture.

Character font style shall be submitted for approval.

Characters shall be white and may be formed by one row of individual white LEDs or where it is required to exhibit only a fixed display, an array of white LEDs combined with an appropriate stencil cut-out, is permitted.

LEDs shall be 15° or 20° angle type.

To reduce misinterpretation of indications and maximise contrast, the display shall present a uniform black or dark grey antiglare face to the observer when the display 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 Section 11.4.1 for details of approved products.

Display background shall be matt black.

The character/s shall be clearly legible in the train cabin environment for a minimum clear sighting distance of 50 metres in the ambient light level found in the typical underground tunnel.

11.3.4 Tunnel ‘A’ Lights

The letter ‘A’ shall be illuminated with white LEDs and may be formed with either a double row of LEDs or alternatively, a broad array of LEDs combined with an appropriate stencil cut-out.

When fitted to tunnel signals the height of the letter ‘A’ shall fill the 100mm diameter aperture.

To reduce misinterpretation of indications and maximise contrast, the signal shall present a uniform dark grey face to the observer when the letter is not lit. This dark grey presentation may be achieved by the use of a smoky grey “Shinkolite” filter or other approved lens material placed in front of the LEDs.

Display background shall be matt black.

Letter font style shall be submitted for approval.

LEDs shall be 15° or 20° angle type.

The letter, when illuminated, shall be clearly legible in the train cabin environment for a minimum clear sighting distance of 20 metres.

Note that the blue LED ‘A’ light has been superseded by the white LED ‘A’ light.
11.3.5 **Tunnel Emergency Phone Light**

The purpose of the Emergency Phone Light, is to indicate the location of an Emergency Telephone at the refuge.

The standard optic system for this light shall have a 75x50mm vertically mounted rectangular array of not less than 28 LEDs of 20° or 30° angle type, mounted behind a light blue lens, displaying a ‘light blue’ indication.

The ‘light blue’ colour shall be as defined in the ‘Chromaticity Table’. Where LEDs are not available in the specified ‘light blue’ colour, the desired ‘light blue’ colour shall be achieved by a mix of white and blue LEDs evenly arranged in a chequer board pattern so as to achieve an even homogeneous dispersal of colour.

The Tunnel Emergency Phone Light shall have two LED arrays, 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.

The light unit shall incorporate an internal 12 Volt sealed lead-acid gel battery and integral 240 Vac charger. Sealing shall be to IP64 or better. The light 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 telephone rings. The telephone interface shall comply with all applicable telephone system standards.

The clear sighting distance shall be 100 metres in the ambient light level found in the typical underground station.

Refer to Specification SPG 1572 Emergency Telephone Location Lights for Underground Railway, for further details.

11.3.6 **Tunnel Warning Lights – Yellow**

The standard optic system for this light shall be a yellow rectangular band 300mm high by 50mm wide, consisting of a minimum matrix of 120 yellow 30 degree LEDs arranged in a reasonable number of columns.

The LEDs shall be arranged in a minimum of four separate series current limited strings. LED colour shall be yellow. There are three styles of these rectangular lights, comprising:-

- One LED matrix board. Matrix board mounted perpendicular to the tunnel wall.
- Two LED matrix boards. One matrix board facing in either direction along the tunnel angled 5 to 10 degrees away from the tunnel wall.
- Three LED matrix boards. One matrix board facing in either direction along the tunnel angled 5 to 10 degrees away from the tunnel wall and with one board facing directly away from the wall.
The yellow colour shall be as defined in the ‘Chromaticity Table’.

Warning lights shall be designed such that when illuminated, they are visible for a minimum distance of 150 metres in all light conditions. A minimum of one light shall be visible from any point on track.

Further details available on request.

11.4 Phantom Reducer – Approved Products

11.4.1 Anti Phantom Filter

“Shinkolite L560” is a high quality neutral grey tinted Polymethyl Methacrylate Acrylic (Perspex) with no red-brown colour content and a light attenuation of ~80% 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.

Hshinhwa HH560 is an acceptable alternative to Shinkolite L560.

11.4.2 Charcoal Dusk Frost Filter

“Charcoal Dusk Frost” is a high quality neutral grey translucant (frosted) Polymethyl Methacrylate Acrylic (Perspex) with no red-brown colour content and a light attenuation of ~90% in 3mm thick sheet. This product severely attenuates light transmission and is therefore limited in its application to short range indicators such as the ‘CO’ light.

12 Electrical – General

12.1 Transformers

Signal Lighting transformers where fitted shall be rated for continuous operation in an environment with temperatures to 70 degrees C and relative humidity to 95%.

Transformers shall be rated at a minimum of:-

- 30VA for a single LED aspect.
- 85VA for special LED displays.

The above rating requirements are based on mains frequency transformers typically for use with incandescent lights, and do not apply to PCB mounted or high frequency transformers. Magnetising current shall be between 30 and 60mA RMS when measured at 110Vac on the primary side with no load.

Construction of the transformers shall be generally in accordance with the requirements of RailCorp Specification SPG 1133. Shape and size was specified to make them interchangeable.
12.2 **Resistors**

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

Resistors shall be packaged and mounted to tolerate vibration at the levels laid down in the RailCorp Specification SPG 1856.

Where resistors are required to be mounted within the lampcase, the supplier shall supply the lampcases with the resistors mounted and wired to a suitable terminal strip.

Where a heat sink is required to attain the manufacturer's heat dissipation level, it is permissible to affix the resistor to the body of the lampcase. Heat transfer paste shall be provided to ensure good thermal contact.

Where the resistors are to be soldered to wires, wires shall be twisted together and high melting point (HMP >230°C) lead free solder shall be used. The exposed solder joint shall be covered with a sleeve of suitable heat-shrink product.

12.3 **Termination**

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

Terminals and termination of cables and wiring shall comply with RailCorp Specifications SPG 0707, SPG 1065 and SPG 1066.

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

In-line wire connectors and crimps shall not be used.

Wiring to tunnel screw clamp type terminals shall be terminated with approved pre-insulated insulation grip (double grip) crimp pin lugs of the type specified in SPG 1066. Where two wires are fitted into one tunnel terminal, blade lugs shall be used.

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

Terminals shall provide access for testing with a multimeter and or insulation tester.

Insulation resistance, terminal to terminal, or terminal to earth or mounting rail shall be greater than 100 M Ohm when tested at 500 Volts.

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.

12.3.1 **Lampcase Terminals**

Approved tunnel screw clamp or spring cage clamp terminals shall be used within the lampcase.

Spring cage terminals shall be front entry. When terminating into spring cage type terminals, bootlace ferrules shall be used.

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

12.3.2 Signal Base
Tunnel screw clamp type approved terminals shall be used within the signal base.

12.4 Wiring Specifications

12.4.1 Wiring within Lampcases
Wiring used within lampcases, i.e. between terminals and transformer or transformer and LED board, or terminals and resistor 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/NZS 5000, Electric cables - Polymeric insulated - For working voltages up to and including 0.6/1 kV. The insulation shall be at least V90 rating.

Where this wiring passes either through or within 5 mm of metal surfaces it shall be protected with a PVC or similar sleeve at least 0.5 mm thick or with an insulating bush.

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. Approved in-line plug/sockets between the signal head terminal strip and the LED module may be permitted providing there is no possibility of mixing up the plugs and sockets.

12.4.2 Wiring Between Lampcase(s) and Base
Multi-core twisted pair sheathed cables shall be used between lampcases and base. Cable construction shall consist of plain annealed copper conductors not less than 7/0.50mm (1.5mm²), V90 PVC insulated twisted pairs numbered and colour coded black and white. Cable cores shall be encased in a black PVC sheath not less than 1.2 mm thick.

Olex Instrolex ® Instrumentation cable (previously known as Dekoron) complies with the above specification.

If overall shielded cable is used, shielding and drain wire shall be cut back on both ends flush with the end of the sheath.

Black heat-shrink shall be applied to both ends of the cut cable sheath.

12.5 Electrical Requirements for LED Modules
Wherever applicable, the components used shall comply with the latest requirements of RailCorp Specification SPG 1600 Electrical and Electronic Components (Ratings & Construction Requirements).

Each aspect of a LED signal shall be electrically isolated from all other aspects as well as the lampcase ground for a voltage rating of 250Vrms. Creepage distances, and component ratings shall comply with RailCorp Specification SPG 1600 Electrical and Electronic Components (Ratings & Construction Requirements). Compliance will be tested by inspection and a test to confirm isolation is greater than 100 Meg Ohms when measured at 500V using an approved megger. Purpose designed link bars shall be fitted on the incoming terminal strips within the lampcase where neutral wires are to be connected together.
LED modules shall either meet RailCorp Specification SPG 0712 Lightning and Surge Protection Requirements or external surge protection shall be provided within the signal head to meet the requirements. MOV’s shall be fitted to the terminal strip within the lampcase irrespective of whether surge protection is provided within an LED module. MOV’s shall be of disk type, minimum 20mm diameter with a preferred 70 Joule rating. Where the LED module is provided for retrofit application, the MOV shall be packed with the lamp.

Either the type of LED used and/or the forward current in the LEDs may be varied as required to achieve this result. However, the drive current for each LED shall not exceed the value recommended by the LED manufacturer for achieving the device expected minimum service life of at least 100,000 hours at 50°C.

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

12.5.1 Alternating Current fed LED Light Design

- LED aspects shall operate from an AC supply voltage range of 96 to 132 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 section will not be permitted.
- LED lights 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 40 Volts AC (higher turn-on voltages are preferred).
- AC LED lights 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.

Refer to Appendix A for details of testing for capacitive coupling.

If necessary, an approved design four terminal bleed resistor arrangement may be fitted within the signal head for individual lights to allow a particular LED light to be fed longer distances. These resistor arrangements are to be designed to minimise failure modes which remove a resistor from circuit and leave the LED functioning. The design shall consist of a number of resistors in parallel, so that an open circuit on one resistor does not unduly affect the overall performance of the device. This arrangement shall not be used to match load current of like aspects.

The four terminal resistor arrangement is not permitted for use with Tri-Colour lights.
Note that the distance limitation values are designed for relay controlled signal applications only, as SSI TFMs will shut down with residual voltages around 10 volts on lights, when they are off.

12.5.1.1 Current Proving for SSI Signal Modules

Current proving for SSI Signal Modules requires:

- The current wave shape to be symmetrical around zero.
- There shall be only two transitions though 0.6 Volts positive or negative when measured across a resistor in series with the LED module with the resistor sized to drop 0.8 Volts RMS.
- The time for each half cycle exceeding 0.6 Volts positive or negative when measured across a resistor in series with the LED module with the resistor sized to drop 0.8 volts RMS shall be greater than 6mS.
- The current drawn shall be stable when measured over a 5 minute period. The minimum, and maximum voltage measured across a series resistor (set for 0.8 V rms) over the 5 minute period shall be within 5% of the average voltage measured.

The current drawn shall not contain transient or intermittent noise when measured over a 15 minute period. The voltage measured across a series resistor (set for 0.8 V rms) over a 15 minute period with a Scopemeter (CRO) set to trigger at 0.1 volt higher than the observed peak voltage shall not trigger.

12.5.2 Direct Current fed LED Light Design

12.5.2.1 General

DC LED modules shall operate from a supply Voltage range of 9 to 16 Volts DC and shall operate within this range without significant variation in luminous intensity. Voltage range for level crossing lights shall be at least 8 to 18 Volts DC.

Protection shall be provided such that no LED will illuminate at a supply voltage of less than 4 Volts DC and 5 Volts AC RMS.
12.5.2.2 Microlok II Computer Based Interlocking Systems

- The current drawn shall be a steady DC current after 100mS with no transients measurable with an Oscilloscope set for a timebase of 1uS per division.
- Switchmode power supplies in particular, need to be designed with suitable front end filtering to ensure that the current drawn is steady DC.
- The LED module shall be suitable such that while in the non-energised state, when pulsed ON with a 60us electrical pulse, no light output shall be visible to the naked eye in a darkened environment. Observers to be colour and night vision normal with 20/20 or corrected eyesight.
- Conversely, the LED module shall be suitable such that while in the energised state, when turned OFF for 60us, the OFF pulse will not be visible to the naked eye in a darkened environment. Observers to be colour and night vision normal with 20/20 or corrected eyesight.
- LED modules directly driven by CBI lamp output shall draw a current within the range of 1.3 Amperes to 2.8 Amperes with a preference for minimal current within this range.

Whilst not the preferred solution; current range adjustment may be achieved by fitting suitably rated load resistors within the signal light head of the type specified in Section 12.2 of this Specification. Where an external resistor solution is required, and where practical, the resistor is to be permanently connected at the LED module such that it is not easily removable independently of the LED module.

Where the resistor cannot be directly connected across the LED module, the arrangement shown below may be permissible. Designs which do not require a resistor external to the LED module for current range compliance, will be the preferred solution.

13 Wiring Diagrams

Wiring diagrams for internal lampcase wiring and base to lampcase wiring are shown in this Section.

The wiring diagrams for the signal base allocate a unique terminal number for each aspect and indication which can be displayed on the signal.

When assembling a particular signal, only those numbered terminals which are required by the aspects in use on that signal need be fitted to the base. The fitted terminals are to be numbered according to the numbering scheme shown on the following pages.
Eg: For a single head signal with marker light and shunt as shown on Drawing 071000 / 007 herein; the following terminals would be installed in the signal base, and numbered as such:

- 1 to 8,
- 29 & 30.
Signal Base Terminal Allocation 5 and 6 light, 120Vac or 12Vdc outdoor LED Signals.

Refer to standard circuit for detail.

<table>
<thead>
<tr>
<th>Terminal Number</th>
<th>Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Green positive</td>
</tr>
<tr>
<td>2</td>
<td>Green negative</td>
</tr>
<tr>
<td>3</td>
<td>Yellow positive</td>
</tr>
<tr>
<td>4</td>
<td>Yellow negative</td>
</tr>
<tr>
<td>5</td>
<td>Red positive</td>
</tr>
<tr>
<td>6</td>
<td>Red negative</td>
</tr>
<tr>
<td>7</td>
<td>Lower Green positive</td>
</tr>
<tr>
<td>8</td>
<td>Lower Green negative</td>
</tr>
<tr>
<td>9</td>
<td>Lower Yellow positive</td>
</tr>
<tr>
<td>10</td>
<td>Lower Yellow negative</td>
</tr>
<tr>
<td>11</td>
<td>Lower Red positive</td>
</tr>
<tr>
<td>12</td>
<td>Lower Red negative</td>
</tr>
<tr>
<td>13</td>
<td>Low Speed positive</td>
</tr>
<tr>
<td>14</td>
<td>Low Speed negative</td>
</tr>
<tr>
<td>15</td>
<td>“A” Light positive</td>
</tr>
<tr>
<td>16</td>
<td>“A” Light negative</td>
</tr>
<tr>
<td>17</td>
<td>Subsidiary shunt positive</td>
</tr>
<tr>
<td>18</td>
<td>Subsidiary shunt negative</td>
</tr>
<tr>
<td>19</td>
<td>Eg: 4 box Route Indicator. Top left box (front view 1) positive</td>
</tr>
<tr>
<td>20</td>
<td>Eg: 4 box Route Indicator. Top left box (front view 1) negative</td>
</tr>
<tr>
<td>21</td>
<td>Eg: 4 box Route Indicator. Top right box (front view 2) positive</td>
</tr>
<tr>
<td>22</td>
<td>Eg: 4 box Route Indicator. Top right box (front view 2) negative</td>
</tr>
<tr>
<td>23</td>
<td>Eg: 4 box Route Indicator. Bottom left box (front view 3) positive</td>
</tr>
<tr>
<td>24</td>
<td>Eg: 4 box Route Indicator. Bottom left box (front view 3) negative</td>
</tr>
<tr>
<td>25</td>
<td>Eg: 4 box Route Indicator. Bottom right box (front view 4) positive</td>
</tr>
<tr>
<td>26</td>
<td>Eg: 4 box Route Indicator. Bottom right box (front view 4) negative</td>
</tr>
<tr>
<td>27</td>
<td>Main Line Route Indicator No. 1 route positive</td>
</tr>
<tr>
<td>28</td>
<td>Main Line Route Indicator No. 1 route negative</td>
</tr>
<tr>
<td>29</td>
<td>Main Line Route Indicator No. 2 route positive</td>
</tr>
<tr>
<td>30</td>
<td>Main Line Route Indicator No. 2 route negative</td>
</tr>
<tr>
<td>31</td>
<td>Main Line Route Indicator No. 3 route positive</td>
</tr>
<tr>
<td>32</td>
<td>Main Line Route Indicator No. 3 route negative</td>
</tr>
<tr>
<td>33</td>
<td>Turnout or Signal Repeater left or vertical positive</td>
</tr>
<tr>
<td>34</td>
<td>Turnout or Signal Repeater left or vertical negative</td>
</tr>
<tr>
<td>35</td>
<td>Turnout or Signal Repeater right or horizontal pos.</td>
</tr>
<tr>
<td>36</td>
<td>Turnout or Signal Repeater right or horizontal neg.</td>
</tr>
<tr>
<td>37</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td></td>
</tr>
</tbody>
</table>
Signal base terminal numbers assigned, are to be used whether all terminals fitted or not. Train Stop terminals to continue at number 43.

**Figure 4 - Figure 14-1 - Double Head Signals – LED**

**Wiring Signal Gase to Lampcases**

120 Volt 50hz or 12 Volt DC signal lighting supply using twisted pair tail cable.
Signal Base Terminal Allocation Single Head, 120Vac or 12Vdc LED Signals.

Refer to standard circuit for detail.

<table>
<thead>
<tr>
<th>Terminal Number</th>
<th>Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Green positive</td>
</tr>
<tr>
<td>2</td>
<td>Green negative</td>
</tr>
<tr>
<td>3</td>
<td>Yellow positive</td>
</tr>
<tr>
<td>4</td>
<td>Yellow negative</td>
</tr>
<tr>
<td>5</td>
<td>Red positive</td>
</tr>
<tr>
<td>6</td>
<td>Red negative</td>
</tr>
<tr>
<td>7</td>
<td>Marker Light positive</td>
</tr>
<tr>
<td>8</td>
<td>Marker Light negative</td>
</tr>
<tr>
<td>9</td>
<td>Turnout Unit top LH lamp positive</td>
</tr>
<tr>
<td>10</td>
<td>Turnout Unit top LH lamp negative</td>
</tr>
<tr>
<td>11</td>
<td>Turnout Unit middle lamp positive</td>
</tr>
<tr>
<td>12</td>
<td>Turnout Unit middle lamp negative</td>
</tr>
<tr>
<td>13</td>
<td>Turnout Unit bottom RH lamp positive</td>
</tr>
<tr>
<td>14</td>
<td>Turnout Unit bottom RH lamp negative</td>
</tr>
<tr>
<td>15</td>
<td>Turnout Unit top RH lamp positive</td>
</tr>
<tr>
<td>16</td>
<td>Turnout Unit top RH lamp negative</td>
</tr>
<tr>
<td>17</td>
<td>Turnout Unit bottom LH lamp positive</td>
</tr>
<tr>
<td>18</td>
<td>Turnout Unit bottom LH lamp negative</td>
</tr>
<tr>
<td>19</td>
<td>Low Speed positive</td>
</tr>
<tr>
<td>20</td>
<td>Low Speed negative</td>
</tr>
<tr>
<td>21</td>
<td>Eg: 4 box Route Indicator. Top left box (front view 1) positive</td>
</tr>
<tr>
<td>22</td>
<td>Eg: 4 box Route Indicator. Top left box (front view 1) negative</td>
</tr>
<tr>
<td>23</td>
<td>Eg: 4 box Route Indicator. Top right box (front view 2) positive</td>
</tr>
<tr>
<td>24</td>
<td>Eg: 4 box Route Indicator. Top right box (front view 2) negative</td>
</tr>
<tr>
<td>25</td>
<td>Eg: 4 box Route Indicator. Bottom left box (front view 3) positive</td>
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<tr>
<td>26</td>
<td>Eg: 4 box Route Indicator. Bottom left box (front view 3) negative</td>
</tr>
<tr>
<td>27</td>
<td>Eg: 4 box Route Indicator. Bottom right box (front view 4) positive</td>
</tr>
<tr>
<td>28</td>
<td>Eg: 4 box Route Indicator. Bottom right box (front view 4) negative</td>
</tr>
<tr>
<td>29</td>
<td>Subsidiary shunt positive</td>
</tr>
<tr>
<td>30</td>
<td>Subsidiary shunt negative</td>
</tr>
<tr>
<td>31</td>
<td>“A” Light positive</td>
</tr>
<tr>
<td>32</td>
<td>“A” Light negative</td>
</tr>
<tr>
<td>33</td>
<td>MLRI / Turnout Repeater terminals as required</td>
</tr>
<tr>
<td>34</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td></td>
</tr>
</tbody>
</table>
Signal base terminal numbers assigned, are to be used whether all terminals fitted or not. Train Stop terminals to continue at number 43.

**Figure 5 - Figure 14-2**

**Single Head Signals – LED**

**Wiring Signal Base to Lampcases**

120 Volt 50hz or 12 Volt DC signal lighting supply using twisted pair tail cable.
Turnout Repeater – LED Lamps

120 Volt 50hz or 12 Volt DC signal lighting supply.
For single repeater, use terminals 1 and 2.

Mainline Signal Repeater – LED Lamps

120 Volt 50hz or 12 Volt DC signal lighting supply.
Figure 8 - Figure 14-5
Low Speed Repeater/Shunt Repeater – LED Lamps
Internal Circuit

120 Volt 50Hz or 12 Volt DC signal lighting supply.

Figure 9 - Figure 14-6
Main Line Lampcase – LED Lamps
Internal Circuit Single Head Signals and Double Head Signals - Upper Lampcase.

120 Volt 50Hz or 12 Volt DC signal lighting supply.
Figure 10 - Figure 14-7
Main Line Lampcase – LED Lamps
Internal Circuit Double Head Signals – Lower Lampcase

120 Volt 50hz or 12 Volt DC signal lighting supply.

Figure 11 - Figure 14-8
Turnout Unit Lampcase – LED Lamps
Internal Circuit

120 Volt 50hz or 12 Volt DC signal lighting supply.
**Figure 12 - Figure 14-9**  
Marker Light and Subsidiary Signals – LED Lamps  
Internal Circuit

120 Volt 50hz or 12 Volt DC signal lighting supply.

**Figure 13 – Figure 14-10**  
Position Light Shunt Signal (Vertical or Horizontal) – LED Lamps  
Internal Circuit

120 Volt 50hz or 12 Volt DC signal lighting supply
Figure 14 - Figure 14-11
Indicator Dwarf Signal – LED Lamps
Internal Circuit

120 Volt 50hz or 12 Volt DC signal lighting supply.
Note: Signal base terminal numbers to be used whether all terminals fitted or not.

Figure 15 - Figure 14-12
Outdoor Single / Double Head Signals – LED
Wiring Signal Base to Tri-colour Lampcases

120 Volt 50hz signal lighting supply.
Tunnel Signal Junction Box Terminal Allocation - LED Signals.

Refer to standard circuits for detail.

<table>
<thead>
<tr>
<th>Terminal Number</th>
<th>Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Green positive</td>
</tr>
<tr>
<td>2</td>
<td>Green negative</td>
</tr>
<tr>
<td>3</td>
<td>Yellow positive</td>
</tr>
<tr>
<td>4</td>
<td>Yellow negative</td>
</tr>
<tr>
<td>5</td>
<td>Red positive</td>
</tr>
<tr>
<td>6</td>
<td>Red negative</td>
</tr>
<tr>
<td>7</td>
<td>Lower Yellow positive</td>
</tr>
<tr>
<td>8</td>
<td>Lower Yellow negative</td>
</tr>
<tr>
<td>9</td>
<td>Lower Red positive</td>
</tr>
<tr>
<td>10</td>
<td>Lower Red negative</td>
</tr>
<tr>
<td>11</td>
<td>Lower Green positive</td>
</tr>
<tr>
<td>12</td>
<td>Lower Green negative</td>
</tr>
<tr>
<td>13</td>
<td>Low Speed positive</td>
</tr>
<tr>
<td>14</td>
<td>Low Speed negative</td>
</tr>
<tr>
<td>15</td>
<td>“A” Light positive</td>
</tr>
<tr>
<td>16</td>
<td>“A” Light negative</td>
</tr>
<tr>
<td>17</td>
<td>Subsidiary shunt or “CO” positive</td>
</tr>
<tr>
<td>18</td>
<td>Subsidiary shunt or “CO” negative</td>
</tr>
<tr>
<td>19</td>
<td>Turnout Repeater left or vertical positive</td>
</tr>
<tr>
<td>20</td>
<td>Turnout Repeater left or vertical negative</td>
</tr>
<tr>
<td>21</td>
<td>Turnout Repeater right or horizontal positive</td>
</tr>
<tr>
<td>22</td>
<td>Turnout Repeater right or horizontal negative</td>
</tr>
<tr>
<td>23</td>
<td>Main Line Route Indicator No. 1 route positive</td>
</tr>
<tr>
<td>24</td>
<td>Main Line Route Indicator No. 1 route negative</td>
</tr>
<tr>
<td>25</td>
<td>Main Line Route Indicator No. 2 route positive</td>
</tr>
<tr>
<td>26</td>
<td>Main Line Route Indicator No. 2 route negative</td>
</tr>
</tbody>
</table>
Tunnel Signal terminal numbers assigned, are to be used whether all terminals or lights fitted or not.

Vertical position of aspects shown above does not necessarily reflect actual required physical position of aspects.

**Figure 16 - Figure 14-13**
Tunnel Signals – LED
Internal Circuit - Lampcase

120 Volt 50hz signal lighting supply
Double Head Signal - six aspect with subsidiary indications. Terminals for subsidiary indications as per Figure 17

Double Head Signal - six aspect with subsidiary indications. Terminals for subsidiary indications as per Figure 17

Tunnel Signal terminal numbers assigned, are to be used whether all terminals or lights fitted or not.

Figure 17 - Figure 14-14
Tunnel Signals – LED
Internal Circuit – Lampcase

120 Volt 50Hz signal lighting supply
### 14 Drawings

Contents:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>071000 / 001</td>
<td>Standard Padlock</td>
</tr>
<tr>
<td>071000 / 002</td>
<td>Signal Identification Plates</td>
</tr>
<tr>
<td>071000 / 005</td>
<td>Controlled Signal - Single Aspect</td>
</tr>
<tr>
<td>071000 / 006</td>
<td>Automatic Signal - Single Aspect</td>
</tr>
<tr>
<td>071000 / 007</td>
<td>Controlled Signal - Single Aspect with Subsidiary</td>
</tr>
<tr>
<td>071000 / 008</td>
<td>Single Head Controlled Signal with Subsidiary</td>
</tr>
<tr>
<td>071000 / 009</td>
<td>Single Head Controlled Signal with Subsidiary Indications</td>
</tr>
<tr>
<td>071000 / 010</td>
<td>Single Head Controlled Signal with Turnout</td>
</tr>
<tr>
<td>071000 / 011</td>
<td>Single Head Signal with “A” Light</td>
</tr>
<tr>
<td>071000 / 012</td>
<td>Single Head Controlled Signal with Turnout and Subsidiary Indication</td>
</tr>
<tr>
<td>071000 / 013</td>
<td>Single Head Controlled Signal with Route Indicator and Turnout</td>
</tr>
<tr>
<td>071000 / 014</td>
<td>Single Head Controlled Signal with Subsidiary and “A” Light</td>
</tr>
<tr>
<td>071000 / 015</td>
<td>Double Head Signal 5 – Light Controlled and Automatic</td>
</tr>
<tr>
<td>071000 / 016</td>
<td>Double Head Signal with Low Speed</td>
</tr>
<tr>
<td>071000 / 017</td>
<td>Double Head Signal with Subsidiary Indication</td>
</tr>
<tr>
<td>071000 / 018</td>
<td>Double Head Signal with Subsidiary and “A” Light</td>
</tr>
<tr>
<td>071000 / 019</td>
<td>Double Head Signal – 6 Light</td>
</tr>
<tr>
<td>071000 / 020</td>
<td>Double Head Signal – 6 Light with Subsidiary Indications</td>
</tr>
<tr>
<td>071000 / 021</td>
<td>Double Head Signal – 6 Light with Route Indicator</td>
</tr>
<tr>
<td>071000 / 022</td>
<td>Double Head Signal – 5 Light with Junction Repeater</td>
</tr>
<tr>
<td>071000 / 023</td>
<td>Controlled Signal - Single Aspect with Low Speed Repeater</td>
</tr>
<tr>
<td>071000 / 024</td>
<td>Single Head Controlled Mainline Indicator with Turnout</td>
</tr>
<tr>
<td>071000 / 025</td>
<td>Controlled Mainline Indicator - Single Head</td>
</tr>
<tr>
<td>071000 / 026</td>
<td>Gantry mounted lights</td>
</tr>
</tbody>
</table>
Figure 18

STANDARD PADLOCK

Drg No 071000/001
Figure 19
Figure 20

* NOTE

Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

RECOMMENDED MAST 3000MM LONG. REFER TO DRG M01-144.

Note:
3500, 4000 or 4500 mast may be used where required for sighting.
Figure 21

* NOTE

Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

AUTOMATIC SIGNAL – SINGLE ASPECT

Drg No 071000/005
Figure 22

* NOTE
Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

CONTROLLED SIGNAL – SINGLE ASPECT WITH SUBSIDIARY
Figure 23

Minimum recommended mast 3500mm long with two box route indicator. 4000mm long with four box route indicator. Refer to drg M01-144.

Note:
4000 or 4500 mast may be used where required for sighting.

* NOTE
Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

Single Head Controlled Signal with Subsidiary
Figure 24

* NOTE
Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

Recommended mast 4500mm long. Refer to drg M01-144.

Note:
5000 mast may be used where required for sighting.

Single Head Controlled Signal with Subsidiary Indications

Drawing No 071000 / 009
* NOTE
Signal base may be between 300mm below and 150mm above rail level — this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

SINGLE HEAD CONTROLLED SIGNAL WITH TURNOUT
Figure 26

**NOTE**

Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

*SINGLE HEAD SIGNAL WITH "A" LIGHT*
Figure 27

* NOTE
Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

SINGLE HEAD CONTROLLED SIGNAL WITH TURNOUT AND SUBSIDIARY INDICATION

**Recommended mast 4500mm long. Refer to drg M01-144.**

Note: 5000 mast may be used where required for sighting.
Marker Light

Recommended mast 4500mm long. Refer to drg M01-144.

Note:
5000 mast may be used where required for sighting.

* NOTE
Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

SINGLE HEAD CONTROLLED SIGNAL WITH ROUTE INDICATOR AND TURNOUT

Drawing No 071000 / 013

Figure 28
*NOTE*

Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

SINGLE HEAD CONTROLLED SIGNAL WITH SUBSIDIARY AND "A" LIGHT

**Figure 29**
Figure 30

DOUBLE HEAD SIGNAL 5—LIGHT CONTROLLED AND AUTOMATIC

* NOTE
Signal base may be between 300mm below and 150mm above rail level — this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.
**NOTE**

Signal base may be between 300mm below and 150mm above rail level — this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

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**DOUBLE HEAD SIGNAL WITH LOW SPEED**

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*Figure 31*
**Figure 32**

* NOTE

Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

**DOUBLE HEAD SIGNAL WITH SUBSIDIARY INDICATION**
* NOTE
Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

DOUBLE HEAD SIGNAL WITH SUBSIDIARY AND "A" LIGHT

Figure 33
* NOTE

Signal base may be between 300mm below and 150mm above rail level — this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

Recommended mast 3500mm long. Refer to drg M01-144.

Note:
4000 or 4500 mast may be used where required for sighting.

DOUBLE HEAD SIGNALS — 6 LIGHT

Figure 34
* NOTE  
Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

DOUBLE HEAD SIGNAL – 6 LIGHT WITH SUBSIDIARY INDICATIONS

Figure 35
*R NOTE
Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

Recommended mast 4500mm long. Refer to drg M01-144.

Note:
5000 mast may be used where required for sighting.

DOUBLE HEAD SIGNAL – 6 LIGHT WITH ROUTE INDICATOR

Drawing No 071000 / 021

Figure 36
* NOTE
Signal base may be between 300mm below and 150mm above rail level — this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

DOUBLE HEAD SIGNAL — 5 LIGHT WITH JUNCTION REPEATER

Figure 37
* NOTE

Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

CONTROLLED SIGNAL – SINGLE ASPECT WITH LOW SPEED REPEATER

Figure 38
Recommended mast 3500mm long. Refer to drg M01-144.

Note:
4000 or 4500 mast may be used where required for sighting.

*NOTE
Signal base may be between 300mm below and 150mm above rail level — this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

SINGLE HEAD CONTROLLED MAINLINE INDICATOR WITH TURNOUT

Figure 39
* NOTE
Signal base may be between 300mm below and 150mm above rail level – this dimension will vary accordingly. Where the base is 200mm or more below rail level the next size post should be used.

CONTROLLED MAINLINE INDICATOR – SINGLE HEAD

Figure 40
Figure 41
Appendix A

Results of tests are to be submitted in the form of a signed off certificate on company letterhead. The certificate is to include test results in tabular form and include details of procedures, test equipment used and their calibration status.

Thermal Tests

Each LED product shall be mounted in its intended signal head and soak tested whilst continuously illuminated for the following conditions:-

- Operation at lower temperature limit, dry.
- Operation at upper temperature limit, dry.

Acceptance criteria for operating in the above conditions is a normal LED display with no flickering and no failed LEDs or any other anomalous behaviour.

Low temperature Test

LED product to be mounted within signal head, illuminated at nominal supply voltage and cooled to zero +/-2°C for 12 hours continuous.

High temperature Test

All signals and indications shall be rated for 100% duty and all components shall be capable of operating in ambient temperatures to 70°C with relative humidity to 95%.

LED product to be mounted within signal head, illuminated at nominal supply voltage and heated at 70 +/-2°C heat for 12 hours continuous.

Diaclectric Tests

Each LED product is to be insulation tested at the incoming power terminals for the following conditions:-

- Common mode,
- Active to signal case,
- Neutral to signal case.

Acceptance criteria, >100M Ohms when measured at 1,000 Vdc.

Capacitive Coupling Tests

Testing for Capacitive Coupling: Relay Interlocking

False illumination of LED signals due to capacitive coupling is dependent on the voltage coupled in the cable and the input impedance of the LED light.

Lights are required to be tested and a conformance statement as to maximum safe operating distance based on the capacitive values listed below is to be provided as part of the required documentation to be submitted when lights are assessed for type approval.

In testing the distance limitations of LED lights related to capacitive coupling in cables for conformance to this Specification; capacitive coupling may be simulated by using various values of 240Vac mains rated capacitors in series with the LED light being tested, documenting what happens in terms of light being emitted.

RailCorp commonly used signal cables are multi-core control and Dekoron (brand name) type twisted pair. The following fixed distance capacitance values were determined using...
single cut multi-core cables and are to be used when assessing and testing LED lights for compliance:-

- 235nF = 0.75km
- 313nF = 1km
- 470nF = 1.5km
- 627nF = 2km

The required nominal test voltage is 115Vac.

Example 1: If for example a value of 0.23uF is reached just prior to some individual LEDs beginning to glow, then the maximum cable distance permitted would be less than the minimum 750m distance value. Thus the light would not conform to the minimum requirements.

Example 2: If for example a value of 0.28uF is reached just prior to some individual LEDs beginning to glow, then the maximum cable distance permitted would be the 750m distance value. Thus the light would conform to the minimum requirements.

Submissions for Type Approval of LED Modules & Signals

Type Approval Submissions must be accompanied by the following minimum base data, and submitted in a A4 size 4 ring binder as a complete report package:-

- Suppliers point by point statements of compliance or otherwise, to each applicable section of this Specification.
- Manufacturer/supplier details of overall LED module assembly.
- Part/model number and revision if applicable.
- Detailed description (including LED array aperture dimensions) and intended application for product.
- Photograph/s or sketch of product where appropriate.
- Photometric Report providing details of light output intensity (in Candela) vs Voltage (in 10V steps for AC and 2V steps for DC) vs Current in tabular and graphical form. Note that the LED turn-on voltage point must be identified. Ambient test temperature to be recorded and reported. Light output level at various viewing angles of aspect at nominal supply voltage.
- LED chromaticity coordinates to CIE 1931 as well as effective overall measured dominant wavelength (where applicable) as measured when mounted within the applicable lampcase. Ambient test temperature to be recorded and reported.
- Rated operating voltage limits and LED turn on voltage.
- Nominal rated viewing range for observers in cab conditions, in all ambient light conditions.
- Surge protection conformance details.
- Dielectric insulation details. Refer Appendix A.
- Environmental conformance details. Refer Appendix A.
- Number of LEDs, type of LEDs and information on the design details of the electrical arrays/groupings and percentage of light lost on various LED failure modes.
- Cabling distance limit rating results for AC LED light. Refer to Section 12.5 & Appendix A (Testing for Capacitive Coupling).
- Warranty details including replacement turn-around time.
- Product overall MTBF details.
- Overall service life expectancy of a complete signal head (excluding consumable items).
- A projected LED degradation and illumination on-time in hours figure.
- Materials used for body, front lens and other relevant parts.
- Quality assurance standard under which the product was manufactured.
- Maintenance and mounting detail instruction sheet if applicable.
• Purchase order delivery turnaround times.
• Manufacturers recommended method/s for lamp proving.
• Lampcase door label drawing.

Some LED units such as Tri- or Bi-colours may require additional information to be submitted, including but not limited to:-

• Failure Mode Effect Analysis down to component level,
• Hazard Analysis,
• Factory Inspection and Test Plan,
• Quality Audit Report.

Once a product is type approved for use on RailCorp Infrastructure, Specifications are not to change without prior written approval from the approving authority otherwise approval may be withdrawn. If in the opinion of the approving authority the product has been changed significantly, the authority may withdraw the existing type approval, or request a representative new production sample (one off) of the approved LED colour light product to be tested and a compliance report provided by the vendor, highlighting any changes from the original specification.