

**Tunnel Lighting Controller**

**Software Requirements Specification**

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Approved by:

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# Version History

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| --- | --- | --- |
| Version | Revised by | Description |
| 1.0 | Jane Wilson | Original |
| 2.0 | Jane Wilson | Correction of typo errors |
| 3.0 | Jane Wilson | Addition of lamp siren & sign handling |
| 4.2 | Jane Wilson | Significant updates made for functional safety compliance |
| 5.0 | Jane Wilson | Changes made for updated requirement volume |

# Introduction

* 1. **Purpose**

The purpose of this document is to provide a complete description of software level requirements for a tunnel lighting system application. As defined in BS5489-2:2003, the levels of the lighting inside a road tunnel needs to be varied depending on the brightness of the prevailing conditions on entry to and exit from that tunnel, to ensure that drives have good visibility into the tunnel as far as their safe stopping distance.

* 1. **Scope**

**The scope of this document is intended to be at the software level to describe the expected behaviour, constraints, and performance parameters of the Tunnel Lighting System software**

# Referenced Documents

1. IP66 specifications

# Requirements

## Human machine interface (HMI)

HLR\_0010: Starting display software

Upon execution of the Tunnel lighting system software, the software shall read the Tunnel.ini file and query the user for an input. Configuration files will provide the appropriate data for the example configuration of the system, as described in the document Tunnel Lighting Control System Overview.

Links: SYS\_0020

HLR\_0020: Input option photometer nominal range

The software shall allow a real number value in the range 4-20 mAmps to be input for photometer input

Links: SYS\_0010, SYS\_0040

HLR\_0030: Input options photometer input out of bounds

The software shall handle out of bound range inputs

Links: SYS\_0010, SYS\_0040

HLR\_0040: Input options exit

The software shall allow the user to exit the application

Links: SYS\_0010

HLR\_0050: Input options days since cleaning nominal

The software shall allow the user to set the number of days since cleaning

Links: SYS\_0010

HLR\_0070: Input options power failure

The software shall allow the user to invoke all power states

Links: SYS\_0010, SYS\_0060

HLR\_0090: Display total cell demand

In the nominal power state, after entering a nominal range photometer input or nominal days since cleaning, the software shall display Total Cell demand and lumens per meter

Links: SYS\_0050

HLR\_0100: Display Lumens

In the nominal power state, after entering a nominal range photometer input or nominal days since cleaning, the software shall display lumens for each lamp, its power setting, and the lamp ID

Links: SYS\_0010

## Cleanliness factor

HLR\_0110: Cleanliness Factor

A percentage cleanliness factor shall be calculated depending on time elapsed since cleaning. 0% shall represent totally obscurity of the luminaires through the buildup of grime; 100% shall represent complete cleanliness. The rate of grime accumulation has been calculated by Waveworks Research Labs, their figures indicate a reduction to 50% over a period of 182 days

Links: SYS\_0030, SYS\_0050

HLR\_0115: Cleanliness efficiency factor

A cleanliness efficiency factor shall be applied on a range from 1 (immediately after cleaning) to 0 (when dirt blanks out all luminaire output)

Links: SYS\_0030, SYS\_0050

## Output power and demand calculation

## Zone constraints and calculation

HLR\_0120: Tunnel Lighting Output Demand Calculation

Lighting demand parameters for the tunnel shall be calculated and allocated to each zone

Links: SYS\_0030

HLR\_0125: Adjust Powered Lighting

Given the photometer input lighting shall be calculated across all zones

Links: SYS\_0030

HLR\_0130: Zone Lighting Formulae

A set of lighting demand straight line formulae shall be calculated to form a contiguous set for all zones

Links: SYS\_0030

HLR\_0140: Zone Lighting Output Demand Calculation

A lighting demand straight line formula shall be calculated for each individual zone

Links: SYS\_0030

## Lamp constraints and calculation

HLR\_0150: Set Lighting Output Demand Calculation

Lighting demand shall be calculated for each luminaire set

Links: SYS\_0030

HLR\_0160: Lamp Selection

For a particular set, lamps required for inclusion in satisfying current demand levels shall be selected, with efficiency a contributory factor

Links: SYS\_0030

HLR\_0170: Lamp Lighting Output Demand Calculation

Lighting demand shall be calculated for each individual lamp

Links: SYS\_0030

HLR\_0180: Tunnel Lighting Output Handling

Commands shall be sent to all lamps to achieve appropriate output overall

Links: SYS\_0030, SYS\_0130

HLR\_0190: Lamp Output Handling

Commands shall be sent to each individual lamp to ensure that appropriate output is achieved in each case

Links: SYS\_0030

## Configuration

HLR\_0200: Tunnel Lighting Configuration

Configuration facilities shall be provided to facilitate the automatic calculation of the number of lamps which may be positioned in a particular tunnel ceiling area

Links: SYS\_0020, SYS\_0130

## Exit Sign

HLR\_0210: Exit sign battery drain

The system shall provide data to summarize emergency battery drain imposed by each individual siren & exit sign, and by all such provision in the system as a whole

Links: SYS\_0080

## Luminary

HLR\_0215: Luminary configuration

Luminaries shall be grouped in sets of one, two, or three depending on where they lie in the tunnel. Lamps within a set can be used in any combination to assist in the optimisation process, which means that the control system need have no concept of the discrete luminaires themselves, only of the sets to which they belong. Luminary grouping will be described in the configuration file

Links: SYS\_0020

## Failures

HLR\_0220: Failed Power Tunnel Lighting Output Calculation

In case of power failure, the power required for all low powered lamps to achieve specified lumens output shall be calculated

Links: SYS\_0030, SYS\_0060, SYS\_0090, SYS\_0100

HLR\_0230: Failed Lamp Output Handling

Commands shall be sent to each individual lamp to achieve appropriate output

Links: SYS\_0030, SYS\_0060

## Lamp output

HLR\_0231: Lamps maximum output

A lamp shall provide an output of 120lm/W when used at the maximum output more text

Links: SYS\_0030, SYS\_0120

HLR\_0232: Lamp output

Lamp output deterioration shall be computed linearly from 120 lm/W output from each lamp at maximum output, down to 0.2 x 120 / 0.4 = 60 lm/W at 20% output

Links: SYS\_0030, SYS\_0110, SYS\_0120

HLR\_0233: Minimum lamp output threshold

No lamp shall be used at a required output of less than a configurable minimum percentage of its maximum output

Links: SYS\_0030, SYS\_0120

HLR\_0234: Lamp extinguishing condition

If for a given lamp the lighting demand drops to levels below the minimum percentage of the it’s maximum output, the lamp shall be extinguished

Links: SYS\_0030, SYS\_0120

HLR\_0235: Lamp on condition

No lamp shall be turned on unless demand dictates to minimise efficiency overhead and unnecessary toggling

Links: SYS\_0030, SYS\_0120

HLR\_0236: Large lamp use

Larger lamps shall be used to establish the minimum lighting level demanded of any particular set, with a combination of large and small lamps used to respond to fluctuations

Links: SYS\_0030, SYS\_0120

## Photometer signal

HLR\_0237: Photometer signal conversion

Photometer measurements shall be converted into an output signal of 4-20m/A (directly proportional to the luminance measurement (i.e. 4.0 m/A being given as zero luminance and 20 m/A as 6,500 cd/m2) for signal transmission to the Lighting Control Unit

Links: SYS\_0040

## System initialisation

HLR\_0340: System Data Initialisation

All software data shall be stored for management, tracking, and reporting

Links: SYS\_0020

HLR\_0350: Mountings Configuration

Mountings shall be configured by dimensions to describe the number of lamps within a mounting

Links: SYS\_0020

HLR\_0360: Cell Configuration and output

Cells output shall be computed based on demand for a given area

Links: SYS\_0020, SYS\_0030