

12 LIGHTING & EMERGENCY LIGHTING

12.1 Overview

- 12.1.1.1** This section describes the materials and workmanship requirements for the lighting and emergency lighting of the Castlefield Viaduct project. It outlines the areas of scope, followed by detailed performance, technical and quality requirements.

12.2 Lighting Design & Documents

12.2.1 The Lighting Design Scope

- 12.2.1.1** This specification defines the requirements for lighting within the areas of the project designed by the Lighting Designer. These include:
- All public realm - feature and functional
 - Event space
 - Store rooms

12.2.2 The Lighting Documents

- 12.2.2.1** The Lighting Documents have been prepared to define the requirements and extent of the Lighting Works for the purposes of obtaining competitive tenders.
- 12.2.2.2** The following lighting drawings shall be referred to:
- CVI-ARU-ZZ-GF-DR-E-002501
 - CVI-ARU-ZZ-GF-DR-E-002502
- 12.2.2.3** Where given, dimensions are for guidance only and represent the space allowance made. Alternative dimensions may be offered only if the space planning is adjusted accordingly, and any other specified requirements are met.
- #### 12.2.3 Lighting By Others
- 12.2.3.1** Lighting in areas outside of this package shall be developed by others. The areas not within this document are as follows:
- Welcome kiosk
 - Restrooms
 - Entrance staircase
 - Lift and lift lobby
- 12.2.3.2** This document specifies the lighting control system functionality required. The detail design of the lighting control system and associated cabling and equipment is not within the scope of this

specification. Refer to section 12.12 for the lighting control system details.

- 12.2.3.3** This document and associated drawings provide identification and layout of emergency lighting luminaires.

12.3 General

12.3.1 Introduction

- 12.3.1.1** This section of the document describes the specific detailed requirements of the proposed lighting installation works.

12.3.2 Scope of Lighting Works

- 12.3.2.1** The work as detailed in this Specification shall comprise the whole of the labour and all materials necessary to provide the complete Lighting Installation. The scope of work comprises, but is not limited to the following:

- Luminaires
- Emergency lighting luminaires
- Exit signage
- Control system

- 12.3.2.2** The works shall comprise, but not be limited to, the installation/construction detailing & documentation, co-ordination, supply, delivery, installation, testing, commissioning and placing into service the lighting installation in accordance with this specification and the accompanying drawings/schedules. This shall include the provision of appropriate certification and documentation of as-built information, luminaires, operation and maintenance manuals, noise and vibration control, warranties and shop drawings; including the provision of appropriate samples, mock-ups, prototypes, spare parts/luminaires and training.

12.4 Lighting Design Intent

- 12.4.1.1** Refer to Appendix B for the lighting design intent.

12.5 Emergency Lighting

- 12.5.1.1** The emergency lighting system shall comprise the following elements. Refer to the lighting drawings for more information:

- Portable lanterns (Type A1 and A2)
- IP65-rated enclosures housing emergency torches with charging points included in enclosures (Type V)
- Stand-alone emergency luminaires in event space (Type T)
- Self-illuminated exit signage (Type S)

12.5.1.2 In the event of an emergency, the portable lanterns shall be distributed to visitors and staff, the emergency torches shall be collected from the nearest location and operated by staff, the emergency luminaires in the event space and exit signage shall automatically energise .

12.5.1.3 The emergency lighting scheme has been designed as such that the National Trust shall employ a management procedure to ensure that portable lanterns are adequately charged at all times to manage the risks associated with the loss of power and provide emergency illumination in case of emergency.

12.6 Responsibility Matrix

12.6.1.1 The following responsibility matrix identifies elements of design work and documentation that the Contractor will be responsible for completing as part of the works. This schedule is not deemed to be comprehensive as there may be other elements of design work specifically mentioned or implied within the particular requirements and associated equipment data sheets.

Task/Area of Work	Employer Representative	Contractor	Luminaire Manufacturer	Controls Specialist
Lighting design to Stage 4 Level of information	Lead			
Specification of luminaires and equipment	Lead			
Design Intent	Lead			
Design, selection and fabrication of luminaires, fixing and accessories		Support	Lead	
Installation of luminaires, fixings and accessories		Lead		
Approval of fixing proposals & method statements	Lead			
Demonstration of correct operation of fittings with power and data.		Lead		
Lighting control systems	Support	Support	Support	Lead
Verification of compatibility of all lighting controls equipment, installation of electrical service requirements for lighting controls equipment, installation of lighting controls equipment	Support	Support	Support	Lead
On site commissioning of the lighting control system	Support	Support		Lead

Task/Area of Work	Employer Representative	Contractor	Luminaire Manufacturer	Controls Specialist
On site commissioning and aiming of lighting equipment	Support	Lead		Support

12.7 Specialist Vendors, Suppliers and Installers

- 12.7.1.1** The Contractor shall include for all specialist equipment and systems to be designed, detailed and commissioned by suitably qualified and experienced specialist vendors and suppliers for systems such as, but not limited to, emergency lighting, lighting control systems, custom brackets and fixings.
- 12.7.1.2** The Contractor shall ensure that all works carried out by the Specialist Vendors, Suppliers and Installers are physically coordinated with each other prior to commencing the installation and that all Builders Work requirements are allowed for and coordinated.

12.8 Portable Lanterns

- 12.8.1.1** Type A1 and A2 luminaires shall be procured directly by the Client.
- 12.8.1.2** Type A1 and A2 luminaires shall be charged via bank of USB charging points within the store room of the event space. It is an operational requirement of the Client to ensure that the lanterns are sufficiently charged and distributed to visitors.
- 12.8.1.3** Lanterns shall be stored within the store room or another suitable indoor enclosure at the end of each day.

12.9 Codes and Standards

- 12.9.1.1** All equipment supplied shall comply with all relevant codes standards, regulations and acts as current at the time of the returned tender.
- 12.9.1.2** All luminaires shall be subject to EMC emission and immunity testing and provided with EMC compliance certification.
- 12.9.1.3** The whole of the work and materials to be supplied shall fully comply with the relevant Standards and Regulations of the Local Authorities having jurisdiction.
- 12.9.1.4** In the event of a contradiction between this Specification and any applicable Standards and Regulations, the most stringent requirements shall be deemed to apply, and the Architect shall be notified immediately for confirmation.

12.10 Submittals

12.10.1.1 The Contractor shall obtain written approval from the Architect prior to procurement of any lighting equipment for the project.

12.10.2 Technical submittals

12.10.2.1 The Contractor shall submit shop drawings, samples and prototypes as specifically instructed below. Shop drawings shall include but not be limited to:

- Manufacturer's dimensioned scale drawings showing in complete detail the fabrication of all lighting luminaires including overall and detail dimensions, finishes, metal thickness, glass thickness, type, fabrication methods, support method, ballasts, transformers, sockets, type of shielding, reflectors, trims, hinges, gaskets, provisions for re-lamping and all other information to show compliance with the contract documents.
- Certified laboratory test data and reports including photometric data measured in accordance with BS EN 13032-1.
- Technical datasheets for all luminaire components:
 - Luminaire.
 - Light sources.
 - Luminaire LED drivers
 - Installation instructions.
- Maintenance and operating instructions, including tools required, details of cleaning methods and types / specification of appropriate materials, replacement parts identification list, and final as-built shop drawing.
- All drawings shall clearly indicate the contract drawing number used as a reference in the development of the shop drawings, the name of the project, Architect and Lighting Consultant.

12.10.2.2 The following reports, listings and information shall be completed by the manufacturer and submitted for review and approval by the Lighting Consultant prior to order:

- BS EN 13032-1:2004+A1:2012: Light and lighting. Measurement and presentation of photometric data of lamps and luminaires - Measurement and file format
- BS EN 13032-4:2015+A1:2019 Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. LED lamps, modules and luminaires. Lifetime Projections. Provide test report and certificate including lifetime projections.
- LM-79-08 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products. Provide test report and certificate.
- LM-80-08 Approved Method: Measuring Lumen Maintenance of LED Light Sources. Provide test report and certificate.
- Lumen depreciation curve of the LED luminaire.

- Photometric Intensity Distribution using absolute photometry.
- Datasheets for LED light source, detailing manufacturer and product reference.
- Datasheets for LED driver, detailing manufacturer, product reference, power factor, efficiency and dimming type (PWM or CCR or hybrid). Where PWM is used the frequency of operation shall be clearly noted.
- Light source spectral power distribution data at 10nm increments from 380nm to 780nm.
- Colour rendering index data R1 to R15.
- TM-30-15 colour data, including but not limited to Rf, Rg, colour vector graphic and colour saturation graphic.
- Colour variation test data, identifying colour temperature and chromaticity coordinates at start of life (initial) and at 6,000 hours.
- Total luminaire wattage, including driver.
- Ambient temperature at which the LED luminaire performance is rated.
- LED luminaire warranty documentation.

12.10.3 Product Substitutions and Modifications

- 12.10.3.1** Any product substitutions for those explicitly specified as a part of this package shall be submitted to the Lighting Consultant for approval at least 4 weeks prior to the placing of the order. Any product not submitted and approved for use will not be accepted.

12.11 Lighting Materials and Workmanship

12.11.1 General Requirements

- 12.11.1.1** Refer to Section 3 of this document for general material and workmanship requirements. This section details requirements specific to the lighting installation.
- 12.11.1.2** The Contractor shall provide all accessories and design features described herein, or necessary in order to provide a complete installation, regardless of whether such features are included in the catalogue reference, including, mounting hardware, louvres, lenses filters, transformers, drivers, control gear etc.
- 12.11.1.3** Luminaires shall be manufactured in strict conformance with the contract drawings and specifications. Specifications and scale drawings are intended to convey the salient features, function and character of the luminaires only, and do not undertake to illustrate or set forth every item or detail necessary for the work. Minor details not usually indicated on the drawings, or specified, but that are necessary for the proper installation, manufacture and completion of the

luminaires, shall be included, the same as if they were herein specified or indicated on the drawings.

- 12.11.1.4** Where components of a luminaire are replaceable, including but not limited to control gear, LED modules, LED replacement lamps, and drivers, it should be clearly noted within the Operation and Maintenance manuals that exact replacements should be used. Should alternative components be used, it should be clearly noted that additional EMC and CE certifications may be required.
- 12.11.1.5** The Employer shall not be held responsible for the omission or absence of any detail, construction feature, etc which may be required in the manufacture and installation of the luminaires. The responsibility of accurately fabricating and installing the luminaires to the fulfilment of this specification rests with the Contractor.
- 12.11.1.6** It is the responsibility of the Contractor to bring to the attention of the Lighting Consultant any discrepancies or installation issues before proceeding with work.
- 12.11.1.7** All luminaires shall be CE certified and shall carry a CE Marking.
- 12.11.1.8** All equipment supplied shall be capable of installation in accordance with the manufacturers' instructions (which shall be sought by the Contractor prior to commencement of the installation works).
- 12.11.1.9** The installation of non-approved luminaires will not be approved and is not acceptable.
- 12.11.1.10** For the Type C1/C2 luminaires:
- Type C1/C2 luminaires shall be mounted on a bespoke metal baseplate that will be fixed to a concrete pad buried within ground to resist luminaire overturning.
 - Type C1/C2 luminaire stem shall be securely fixed to the baseplate that will be buried under ground. The Contractor shall liaise with the luminaire manufacturer to provide drawing of fixing detail of the stem with baseplate for approval of Lighting Consultant.
 - An electrical junction box (1 cable in and 3 cables out) to electrical specification shall be positioned within the baseplate. Junction box shall be provided to reduce the cabling to each luminaire cluster. The junction box shall be kept within free draining pea gravel to landscape architect's specification. 150mm hole shall be provided on the top surface of baseplate for access to junction box.
 - 25mm diameter flexible duct for cabling shall run through the concrete foundation towards the junction box within baseplate.

12.11.2 LED luminaires (general)

- 12.11.2.1** The following requirements apply to all LED luminaires:

- All LED luminaires shall undergo a minimum 24-hour burn-in test during manufacturing.
- Unless specified otherwise, minimum luminaire lifetime shall be 50,000 hours at L80/B10. Note this is the complete luminaire, not the LED source.
- Unless specified otherwise, the maximum failure fraction of LED luminaires at the end of luminaire lifetime shall be 10%, F10.
- All LED luminaires shall have lumen maintenance code 9 according to IEC/PAS 62717, where maintained luminous flux at 6,000 hours shall be in excess of 90% of initial luminaire lumens.
- All hardwired connections to LED luminaires shall be reverse polarity protected.
- All LED luminaires shall provide a cover or other suitable protection of LED chips to allow for cleaning. LED luminaires with exposed LED chips shall not be acceptable.
- All LED luminaires and/or associated driver(s) shall have a means of thermal protection in the form of an automatic dimming or stepping/holding down the output where temperature exceeds operational limits. Thermal cut-out devices which turn the fixture completely off are not acceptable for luminaires within spaces occupied by the public.
- Audible noise from luminaire and/or drivers when at full lumen output or at any dimming level shall not be acceptable.

12.11.3 LED luminaires (white light)

12.11.3.1 The following requirements apply:

- Light output power at 400nm and below shall be 0 (zero).
- Unless specified otherwise, LED luminaires shall have a power factor > 0.9 .
- Refer to luminaire specification sheets for colour temperature and colour consistency requirements for LED luminaire types.
- The specified colour temperature variation applies to the initial colour temperature variation and at any time prior to the end of the warranty period. If not specified, this shall be 3-step MacAdam ellipse.

12.11.4 LED Drivers

12.11.4.1 LED drivers shall comply with the following:

- LED driver lifetime shall match or exceed the LED luminaire lifetime.
- LED drivers shall be RoHS compliant.
- LED drivers shall have a minimum efficiency of 85%.
- LED drivers shall have a total individual luminaire Harmonic Distortion (THD) of $< 20\%$.

- The Contractor shall ensure complete system compatibility where different manufacturers of drivers and LED sources are used.
- Unless specified otherwise, where dimming is specified the LED luminaire shall dim smoothly to 10% or less of full lumen output.
- The Contractor shall ensure the LED driver is fully compatible with the lighting control system and dimming protocol.
- Dimmable LED drivers shall dim via Pulse Width Modulation (PWM) or using a hybrid combination of PWM and Constant Current Reduction (CCR).

12.11.5 Flicker

- 12.11.5.1** Visible blinking, flickering or strobing shall not be acceptable at full lumen output, nor at any dimming level should dimming be specified.
- 12.11.5.2** The requirements of IEEE 1789–2015 shall apply to all LED drivers, where unless specified otherwise drivers shall aim to limit other biological effects of flicker.
- 12.11.5.3** For basic PWM (where percent flicker is 100%) minimum frequency shall be 1,250 Hz.
- 12.11.5.4** Relationship between percent flicker and minimum frequency shall be as defined within IEEE 1789-2015.

12.11.6 Product Variations

- 12.11.6.1** If any variants of standard luminaires are required, these shall be developed by the manufacturer of the standard luminaire, unless otherwise specifically stated and approved, and shall be manufactured to the same standards as the equivalent standard luminaire.
- 12.11.6.2** Two copies of all working drawings of proposed variants, dimensioned in mm, shall be supplied to the Lighting Consultant for approval prior to fabrication.
- 12.11.6.3** Notwithstanding the above, the manufacturer shall remain responsible for ensuring compliance with relevant standards, the accuracy of the information shown on his drawings at all times and for ensuring that the equipment shown fulfils the requirements of this specification.

12.11.7 Warranty

- 12.11.7.1** The Contractor shall warrant the luminaire, its finishes and all of its component parts, including drivers, to be free of defects for a period of 3 years from the date of acceptance. The warranty shall be provided by the luminaire manufacturer as the sole source of service.
- 12.11.7.2** Replacement of faulty materials and the cost of labour required to remove and replace faulty luminaires shall be the responsibility of the

Contractor. This shall include all necessary access, builders work and making good.

12.11.7.3 An LED Luminaire is deemed to be faulty should any of the following conditions apply. These conditions are based on the warranty period required. For warranty periods in excess of 5 years the requirements below shall be prorated accordingly.

- An LED luminaire, including all associated components and drivers, has catastrophically failed resulting full loss of light output at any time prior to the end of the warranty period.
- More than 0.2% per 1000 burning hours of individual LED devices within an LED luminaire have catastrophically failed at any time prior to the end of the warranty period.
- An LED luminaire has experienced lumen depreciation in excess of 0.6% per 1,000 burning hours at any time prior to the end of the warranty period.
- Colour variation, from results recorded initially and submitted, at any time before the end of the warranty period in excess of n-step MacAdam ellipse, where n is defined within the luminaire specification sheets for each luminaire.
- An LED luminaire experiences visible flicker or blinking at any time prior to the end of the warranty period.
- An LED luminaire produces audible noise at any time prior to the end of the warranty period. This applies at full output and at any dimming level should dimming be specified.

12.11.8 Installation

12.11.8.1 The Contractor shall coordinate exact quantities and critical dimensions with site conditions. All linear and continuous linear luminaire dimensions are to be verified by the Contractor, on site when necessary, and submitted to the Architect for approval prior to order.

12.11.8.2 The Contractor shall facilitate a mock-up of each installed luminaire installed including mounting/foundation details.

12.11.8.3 The Contractor shall facilitate one mock-up of the control protocol of three Type C1/C2 luminaires demonstrating the fade in/fade out transitions of light.

12.11.8.4 The Contractor shall verify and coordinate the provision of appropriate framing, support structures, mounting brackets and other required structural connections by the General Contractor or other trades to ensure a timely, neat installation of all luminaires.

12.11.8.5 The Contractor shall coordinate and provide any associated mounting hardware, conduit connections, or associated appurtenances for the effective installation of the luminaires. Provide each luminaire with

- 12.11.8.6** All transformers, drivers, control gear and emergency battery packs for ceiling recessed luminaires are to be accessed through the ceiling cut-out unless stated otherwise in the specification or on drawings.
- 12.11.8.7** The Contractor is to ensure the co-ordination and compatibility of all luminaire control gear/transformer types with the lighting control system.
- 12.11.8.8** Exact locations of all luminaires including mounting heights and plan dimensions are shown on the architectural drawings. Any ambiguities or conflicts in this dimensional information shall be identified to the Architect prior to ordering and installation.
- 12.11.8.9** All fixing detail/cut-out and recess dimensions are to be confirmed with manufacturers by the Contractor.
- 12.11.8.10** Luminaires shall not be suspended from duct-work or pipework.
- 12.11.8.11** Luminaires shall not be operated for work light at any time during construction, nor shall they be illuminated for any other reason apart from necessary testing and commissioning of the installation. Failure to comply with this requirement will make it necessary for the Contractor to re-lamp at no additional cost to the Employer just prior to turnover of area to the Employer.

12.11.9.1 All adjustable luminaires shall be aimed, focused, and locked by the Contractor under the supervision of the Lighting Consultant.

12.11.9.2 All focusing and adjusting shall be carried out after the entire installation is complete. All ladders, scaffolds etc. required, shall be furnished by the Contractor, at the direction of the Lighting Consultant. The Contractor will ensure that adequate personnel are provided for such aiming, focusing and scene setting as are required to commission the installation. As aiming and adjusting is completed, locking set screws, nuts and bolts, shall be securely tightened. Where possible, units shall be focused during the normal working day. Where daylight prevents this, focusing shall be carried out during the night at a time mutually agreeable to Contractor, Lighting Consultant, and Employer. Adjustments shall be made in accordance with the Lighting Consultant's stated intent, under their supervision.

12.11.9.3 The final focussing and scene setting of the installation must be undertaken with the Lighting Consultant and a lighting control technician in attendance. The programming of a lighting control

system from a written lighting scene schedule shall not constitute completion.

12.11.10 Testing, Commissioning and Handover

12.11.10.1 The Contractor shall be responsible for providing all handover documentation in accordance with industry best practice and the specific requirements of the Employer's handover procedures.

12.11.10.2 On completion of the installation The Contractor shall undertake testing and commissioning of the complete system including the following:

- Testing and commissioning of any general electrical installation works in accordance with BS7671.
- Testing and commissioning of the emergency lighting installation works in accordance with BS5266.
- Testing and commissioning of the complete lighting installation and demonstration of system operation to the Employer.
- On completion of the works The Contractor shall compile and produce a complete Operating and Maintenance Manual to include the following information:
 - Electrical Installation Completion Certificate (and/or Minor Works Certificate where applicable) in accordance with BS 7671.
 - Emergency Lighting Completion Certificate (and/or Minor Works Certificate where applicable) in accordance with BS 5266.
 - As-Installed record drawings (layouts and schematics) showing equipment locations, cable routes and equipment identification references etc.
 - Operating and Maintenance Instructions.
 - Provide 12 months parts and labour warranty for the complete installation, including at least one service visit at the end of the 12 months defects period.
 - All drawings shall be provided electronically in both PDF and AutoCAD/Revit formats.
 - All text and schedules shall be provided in both editable format (e.g. MS Word, Excel, etc.) and in PDF format.
 - Equipment data sheets shall be provided in PDF format.
 - In addition, The Contractor shall provide the Employer with one paper copy of all O&M information as detailed above.

12.11.11 Clean-up

12.11.11.1 At the time of final acceptance by the Architect, all luminaires shall have been thoroughly cleaned with materials and methods recommended by the manufacturers. All broken parts shall have been replaced and all lamps shall be operative.

12.12 Lighting Control Systems Narrative

12.12.1.1 The following section describes the performance requirements for the two lighting control systems.

12.12.1.2 The Contractor shall provide a fully functioning and fully commissioned lighting control system to meet the system and operational requirements defined within this document.

12.12.1.3 Two lighting control systems shall be provided and are described in this section. This is demonstrated in the following table.

- Hard-wired lighting control system for all lighting elements apart from those controlled by BLE (Bluetooth Low Energy), see table below.
- Wireless lighting control system- BLE lighting control for the event space lighting and for the control of type C1 and C2 luminaires.

Area	Control Type	Lighting Scenes	Local Switch	Local Dimming	Presence Detection	Astronomical Time Clock	Timings
Event Space	BLE	Static light	Y	Y	Y		Occupancy controlled timings
Store Rooms / Plant Rooms	Wired-Manual On/Off	Static light	Y				n/a
Public Realm (except C1/C2 luminaires)	Wired-Contactor On/Off	Static light				Y	Dusk – 8pm/event end
C1 and C2 luminaires	BLE	Dynamic sequence				Y*	Dusk – 8pm/event end

Lighting control strategy

* The BLE devices shall be programmed to vary between 50% and 100% output on a 20second continuous cycle following switch on of the drivers via the astronomical time clock. The drivers will not be in sequence with each other and shall be randomly energised.

12.12.2 Wired Control

12.12.2.1 Plant rooms/store rooms shall be controlled via a hard-wired wall-mounted manual switch.

12.12.2.2 A DIN rail mounted astronomical time clock shall be located in the feeder pillar next to the Welcome Kiosk and shall switch on the public

realm lighting via time-delay contactors. Refer to the control schematic.

12.12.3 Bluetooth Low Energy Lighting Control System

12.12.3.1 A Xicato Bluetooth Low Energy (BLE) lighting control system shall be provided integral to the G luminaires in the event space and the type C1 and C2 luminaires in the public realm.

12.12.3.2 The BLE system shall enable commissioning and configuration via a DPI (digital portable interface, i.e. tablet or smartphone) without the need for a head-end PC.

12.12.3.3 BLE shall be integrated within the lighting elements and controlled in the event space by:

- G type luminaire in the event space shall be provided with Integrated BLE allowing control via the BLE Mesh technology
- A BLE compatible wall mounted switch shall be provided in the event space. The switch shall use energy harvesting kinetic technology, thus requiring no external power source (i.e., EnOcean switch). This will enable on/off/dimming override of the luminaires in the event space.
- The presence detector in the event space shall be Xicato Integrated BLE and be provided in a ceiling mounted housing (complete with battery) in the locations shown on the drawing. The battery powered sensor shall have a minimum 5-year life between battery changes.
- By default, the occupancy sensor in the event space shall be configured to time-out the BLE enabled lighting after 30minutes. The exact time shall be agreed with the client at the commissioning stage.
- Event space G type luminaires are controlled as one group via the presence detector, but individual luminaires can be programmed to provide a different output as necessary via the BLE system.

12.12.3.4 BLE shall be integrated within the C1 and C2 type public realm lighting elements and controlled by:

- C1 and C2 type luminaires in the public realm shall be provided with paired BLE mains voltage Xicato 'XAD' LED driver. The BLE beacon is integral to the luminaire LED driver and shall enable dimming of the LED type C1 and C2 luminaires.
- The C1 and C2 luminaires shall be controlled in groups of up to four luminaires from one XAD driver. The control groups are defined on the lighting drawings.
- The control system shall allow for individual control of each control group.
- The XAD driver shall be located within an IP-rated plastic enclosure suitably sized to allow for heat dissipation. The

contractor shall liaise with Xicato to confirm a suitable size for each enclosure.

- The XAD driver shall be located <10m from the luminaires that it is controlling to allow for signal propagation. The Contractor shall be responsible for ensuring that the drivers are positioned to allow for the required signal strength.

12.12.3.5 The lighting control system shall provide the following level of controls and functionality:

- Event space local control: room switching via local fixed switch.
- Automatic control: the C1 and C2 type luminaires will be factory-set with a timed-fade on a regular cycle to create a dynamic, slow movement to the lighting along this stretch of the viaduct. The final sequence shall be approved by Employer Representative.
- Expert Control: for commissioning engineer, direct connection to the BLE control system via a laptop control panel app. Once configured the system shall operate autonomously, being energised either by the time clock (external) or presence detector (internal)
- Refer to the Lighting Layout drawings for the location of switches and sensors.

12.12.3.6 The Contractor shall employ the services of Xicato lighting controls specialist to finalise the configuration of the system and components. In summary, this shall include:

- Stable Xicato reliable mesh
-
- Controls planning
- On-site provisioning
- Configuration and Verification

12.12.3.7 Xicato lighting controls specialist shall be employed to carry out the following works as part of the commissioning process:

- Define network provisioning, including secure network names, passwords, and membership
- Define the node provisioning: naming and numbering of lights, sensors, switches, and other nodes
- Define groups including group names, numbers, and membership
- Configure scenes and scene names numbers, membership, and member behaviour (i.e. transitions between scenes etc.)
- Configure sensor responses and behaviours
- Configure time schedules and behaviours

12.12.3.8 Commissioning of the lighting control system shall take place once the Contractor has demonstrated that all BLE devices are connected, provisioned and operational. This shall include employing the services of a BLE Mesh lighting controls specialist to complete the following works:

- Network provisioning, including secure network names, passwords, and membership
- Node provisioning: naming and numbering of lights, sensors, switches, and other nodes
- Configuring the nodes with groups, scenes and schedules, associating switches and sensors, designating mesh relay nodes, and programming the control logic.
- Putting into service any drivers necessary for third party central interfaces.
- Complete a verification of the functionality and security of the system including, but not limited to,
- Device IDs and names, grouping, luminaire group command responses, correct scene recalls
- Verify that all devices respond correctly to occupancy and switches.
- Check security (including response to commands issued through any gateways).

12.12.3.9 Commissioning of the lighting scenes shall be undertaken with the Lighting Consultant, Client and Specialist Control Supplier in attendance. The programming of a lighting control system from a written lighting scene schedule shall not constitute completion.

12.12.3.10 The system shall be tested and commissioned, as far as possible during the normal working day. However, inevitably some commissioning will be required to be undertaken outside of normal working hours. The Contractor shall allow for night-time commissioning of the lighting installation. Final commissioning shall be carried out during the night at a time mutually agreeable to Contractor, Lighting Consultant, and Client.

12.12.3.11 Commissioning shall consist of the implementation of the programmed software, scenes, sequences, time recalls and web interface.

12.12.3.12 The Contractor shall arrange for the Client to view and agree the programmed scenes, sequences and timed recalls of the C1 and C2 luminaires of the Lighting Control System.

12.12.3.13 On completion of commissioning, the Contractor shall arrange with the Specialist Lighting Controls Supplier and the Client to provide any training required on the access, maintenance and use of the user interface.

12.12.3.14 The Specialist Controls Supplier shall provide an operation and maintenance manual for the lighting controls system detailing the day to day operation and maintenance required.

12.12.3.15 The Contractor shall provide the Lighting Designer and Client with an electronic copy of all files associated with the final commissioning,

including show files, test data and final setup parameters following acceptance of the commissioned system.

12.13 Luminaire Specification Datasheets

12.13.1.1 Luminaires data sheets are included in Appendix A of this specification.

12.13.1.2 Catalogue numbers are not included with luminaire specification sheets. The Contractor shall confirm the correct codes and catalogue numbers with the specified manufacturers prior to issuing technical submittals.