## Lighting Controls

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Lighting Controls

1.0 System Description

1.1 The Electrical Contractor shall provide, install and connect a complete lighting installation as described in this specification and indicated on the tender drawings and luminaire schedule.

1.2 The internal lighting installation shall generally comprise of the following luminaires:

- Office and Teaching Areas - Semi-recessed direct/indirect linear fluorescent / LED luminaires.
- Circulation areas – Recessed LED down lights.
- Plant Areas – Impact resistant sealed fluorescent / LED luminaires.

1.3 The external lighting installation shall generally comprise of the following luminaires:

- Soffit – Recessed LED or fluorescent sealed down lights.
- Circulation – Recessed LED or fluorescent sealed down lights
- Specified locations – Decorative LED type Architectural/feature luminaires.

1.4 All fluorescent luminaries shall have high frequency control gear compact fluorescent and T5 lamps as detailed on the luminaire schedules. There shall be no incandescent, tungsten halogen or compact fluorescent light sources.

1.5 Unless noted otherwise all luminaires ballasts shall be of the digital addressable lighting interface (DALI) type. The control protocol shall be set out to technical standard IEC 6029.

1.6 No mains switching is required to DALI luminaires. The ballasts shall receive a permanent unswitched supply via circuits emanating from local distribution boards as detailed on the tender plan drawings and distribution boards schedules.

2.0 Lighting Control

2.1 The Electrical Contractor shall employ the lighting control specialist to supply, commission and demonstrate an addressable KNX / DALI lighting control system as detailed within this specification and illustrated on drawing No.

The Lighting Control Specialist shall be as follows:
Schneider Electric
Tec 6.
Byfleet Technical Centre
Canada Road
Byfleet
Surrey
KT14 7JX
Ian O’Reilly
01932 341200/07718 707116
3.0 Lighting Control System Overview

3.1 This system shall control all building lighting in the defined areas including all fluorescent, discharge and LED lamp types, except plant rooms which shall be controlled by conventional switching.

3.2 The lighting control system shall have a graphical user interface and this user interface shall be capable of time clock and daylight control etc.

3.3 Where the installation is to a new area the designer and contractor shall be responsible for providing or updating a suitable interface to the head end located in the College Maintenance Office.

3.4 The graphical user interface shall include floor plan layouts for each level indicating luminaries/zone status, ability to switch or dim any area, scheduling and fault monitoring. The contractor shall submit for approval a pro-type graphical user interface (which complements the overall building BMS) prior to installation.

3.5 The Lighting Control Specialist shall commission the system using these devices on circuits agreed with the Design Team.

3.6 A photocell system shall provide adjustable dawn/dusk detection.

3.7 Both the time-clock and photocells be overridden by manual switches provided by the Electrical Contractor. The Electrical Contractor shall provide manual override and control switches on purpose made switch plates in each electrical switch-room and riser or other agreed locations.

3.8 The lighting control systems shall allow the control of lighting in specific zones from control input and output devices. Addressed output devices shall switch and/or dim lighting circuits as required.

3.9 Addressed input devices shall control output devices. Activation of any input device shall allow activation of any or multiple groups of output devices anywhere in the building.

4.0 Control System Bus protocol

4.1 The luminaries shall operate using the DALI protocol. The Control system backbone shall utilize an equivalent standard protocol. The bus shall be short circuit protected to ensure that accidental short circuit will not damage any system components. The bus wiring shall not require shielding.

4.2 There shall be no visible delay between a command being issued and action executed. A data transfer rate of over 5000 Baud shall be used. There shall be no restrictions on bus wiring configuration. Star, Daisy-chain or any combination thereof should be possible.

4.3 The System shall be capable of easy expansion. Additional units shall be able to be added at anytime at any point without re-configuration of any other component or the control devices. An existing system shall not need to be powered down during the expansion.
5.0 Distributed intelligence

5.1 The system shall be capable of operating without a central/area processor connected, including the operation of all system wall switches, detectors, photoelectric/PIR's, etc. It is not acceptable for the logical relationship between input devices and output loads to be dependent on a central processor being connected.

5.2 Any failure of a module on the system shall not affect any other module on the system. All devices shall be able to communicate directly with each other without the need for a computer or a centrally based/floor processor to receive and transmit signals. During times of computer maintenance, full lighting control shall continue.

6.0 Reconfiguration Requirements

6.1 It shall be possible for a system module or additional control to be added or changed without powering down the control bus. No reconfiguration of existing units or network shall be required during any system reconfiguration. All existing units shall be left undisturbed.

6.2 No additional wiring or connections shall be required during reconfiguration. The control network shall automatically recognize new control modules.

7.0 Safety requirements

7.1 The system shall have a failsafe default mode and default to an 'on' state upon power or system failure. Modules shall be able to be programmed to re-start to 'on', 'off', or resume in previous state after power or system failure.

8.0 Networking and Expansion Capabilities

8.1 A minimum of 10,000 unique unit addresses shall be possible on the one system. Only 1 Bus pair (or a modem connection) shall be required to link any number of rooms, buildings, projects or sites. Localised input devices shall be able to be added at any time, and shall be able to be programmed to perform any function.

8.2 The system shall have a software controlled network structure. Any input device shall be able to control any output device, or any group of devices. The devices shall be able to be located anywhere on the network without a direct connection. It shall be possible to change the relationship of devices at any time, without re-wiring. The system shall have distributed intelligence to allow full control over any module even if on another electrical sub-system.

9.0 Programming Capabilities

9.1 The system shall be able to be programmed to perform logic functions if required. Allowance shall be made for the addition of additional PIR and daylight sensors in the future. Starting of lights shall be able to be "staged" on and "staged" off. Peak starting current should be minimised by ensuring lights start in a controlled manner.
10.0 Occupancy detection

10.1 Install occupancy detection to switch lights off after a variable period of 10 - 120 minutes after the sensors fail to detect movement. The period before lights are switched off should be variable (between 10min to 120 min) and set based on the building requirements. Before any lights are switched off, the lighting control system shall dim the lights momentarily to warn occupants. Activation of any input device within that lighting zone, or the automatic detection of occupancy shall cause the lights in that zone to remain on until the preset time has again elapsed.

10.2 Provide manual switches locally to allow occupants to override the automatic control.

10.3 In office and computer lab areas lighting control zones shall be no larger than eight workstations including cellular offices.

10.4 Any manual switching required shall be off the SELV type connected to the lighting control system.

10.5 All luminaire switches shall be of the recessed type as Schneider Electric GET switch range with white moulded plastic cover plates or approved equal.

11.0 Dimming

11.1 Provide combined dimming photoelectric/PIR lighting controls to all areas where day lighting levels are sufficient to provide a significant proportion of the required design illuminance levels. The system should ensure that the sum of daylight and electric lighting always reaches the design level by sensing the total illuminance in the controlled area and adjusting the level of artificial light to meet the design requirements.

11.2 The KNX Lighting Control System shall use distributed/addressable technology to achieve individual control and monitoring of the main and emergency luminaires as described within this document.

11.3 The lighting control system shall be a dedicated stand-alone system and shall allow for:

- Operation, Testing and commissioning – independent of other systems
- Duty/Standby PC Terminal providing
- Provision for future upgrades independent of other systems
- Contingency planning of independent fallback operation (failure of any one part of the system will not affect the functioning of the rest of the upstream or downstream system).

12.0 Scope of Works

12.1 The KNX lighting control system shall provide control of:

- Office, teaching and circulation areas - the emergency luminaries may be in a dimmed or switched off state. They should be brought ON to 100% output upon a local mains failure.
- Fire alarm – All emergency luminaries, which are in a dimmed or switched off state should be brought ON to 100% output upon activation of a fire alarm within the local fire alarm zone. Every floor controller shall be linked to the fire alarm system (local fire alarm interfaces already in riser).
13.0 Environmental Conditions

13.1 The equipment shall be mounted adjacent to local distribution boards or within the various electrical services risers/cupboards and switch rooms shall be capable of operating under the following environmental conditions:

- Relative Humidity (RH) of up to 60%@ 20ºC
- Maximum Temperature (Tmax) of +40ºC
- Minimum Temperature (Tmin) of -5 ºC
- Relative Humidity (RH) of 80% at 25 ºC

14.0 Overall Description

14.1 The KNX system is a computerised open protocol networked addressable lighting control system and shall provide a Gateway to a DALI sub system.

14.2 KNX/DALI – are global protocols developed by major international manufacturers, which enable standard messages to be broadcast to any KNX/DALI devices, irrespective of make, type or supplier.

14.3 DALI allows multiple ECGs to be connected to a single two-wire cable, yet each ECG is individually addressed, switched and dimmed. Digital communication ensures precise control, while each ECG provides operational feedback and monitoring of faults.

14.4 The KNX system shall function as a stand-alone system and shall be installed in a programmed sequence to follow the construction programme. There shall be a requirement for early beneficial use of the system(s).

14.5 It shall be possible to programme, configure, test and commission the system in stages without the need for a head end computer. The programme/intelligence should reside on a monitor-less PC or a server (it can also reside on an OPC server provided by the LCS supplier), which shall be sited within a cubicle (rack) in an agreed location.

14.6 The KNX lighting control system hardware shall provide the latest tried and tested technologies and equipment available at the time of the final hand over date (future proofing).

14.7 The software shall provide for a full Internet connection so that the specialist supplier from their offices can monitor the system via the Internet and assist in trouble shooting. This shall require positive action from the client to allow access. In addition the software shall have the ability to provide the data required for the head end to generate planned maintenance reports, alarms, energy reports etc.

14.8 The lighting control system shall collate information to be relayed to the head end.

14.9 The information to be collated by the LCS shall include the numbers of hours run by each switchable group as well as non switchable group of lighting (and individual luminaires utilising DALI ECGs).

14.10 The head end would use this information for monitoring lamp life, energy consumption and for producing planned maintenance schedules and act as a management tool for monitoring status and historical performance of the building and load centres.
14.11 The entire lighting operation shall be monitored in real time through graphical software on the control system.

14.12 The LCS installer shall mark up “As fitted” drawings for the lighting system and hand it over to the project in stages for integration into the head end graphical package. The final version of all “as fitted” drawings must be handed over to the project task team within an agreed time period to enable the project team to meet their programme requirements of integrating all sub-systems within the head end package.

14.13 The lighting control system shall respond to operator’s commands in a timely manner. In this context “timely” means that the operation is not compromised by delays in system responses i.e. heavy communications traffic on the backbone.

14.14 Central automatic commands are to be generated by a calendar software programme utilising an astronomical time clock. The calendar programme shall enable different switching and scene regimes to be allocated for different times of the day or year. It shall also allow programming and planning of weekend and special events. This calendar function shall be made available to allow coordination of services during events.

14.15 Where luminaires are equipped with regulated ECGs, this shall enable luminaires to be automatically dimmed to preset levels. Equally luminaires in a dimmed or “held off” state shall be capable of returning to 100% output in the event of the failure of an adjacent sub circuit or upon receipt of an over-ride signal from the head end or an emergency signal from the fire alarm system.

14.16 Scenes reflecting time of day and daylight levels in specific zones can be automatically controlled via the central commands.

14.17 The system shall also have the capacity to interface bi-directionally with small specialist sub-systems for lighting control in specific locations around the building and if required interface with other equipment and systems. The system should allow for programmable communication with subsystems.

15.0 System Arrangement

15.1 The lighting control system shall be capable of working with an array of differing lamp sources i.e. able to control DALI as well as non-DALI controlled luminaires. Careful consideration must be given to ensure compatibility of system components. The distributed intelligence shall allow each DALI controller or DALI ECG to operate independently and without dependence upon the central controller or inline router. The lighting control network shall be capable of operating without a head end controller (PC)/ Area controller. The lighting control system shall incorporate the following:

- Floor controller/router in electrical risers and/or SCR’s (as fire alarm/BMSC) subject to buildings and zones to be controlled.
- DALI controllers for controlling a minimum of 50 luminaires on any one DALI sub circuit.
- DALI regulated ECGs (subject to lamp type).
- DALI converters for lamp types where DALI ballasts are not available.
- Multi circuit lighting control modules.
- Ceiling mounted sensors.
- Photocells.
- ELV switches.
- ELV cable to luminaires.
- Interface to emergency central battery static inverter control modules.
- Monitoring the whole of the lighting installation for status of luminaires – either individually or circuits as the case may be.
Monitoring and collecting data for the whole of the lighting installation for energy consumption, management and reporting to the head end.

An OPC / BACnet server to communicate with the head end and site wide SCADA network.

16.0 System Requirements

16.1 The LCS shall be capable of providing full management control and monitoring of the combined lighting and emergency lighting system including:

- Calendar timing schedule.
- Addressing of individual luminaires as well as groups of luminaires.
- Time and date stamping including Time synchronisation signal.
- Naming of scenes, loads and controllers.
- Allocation of group switching arrangements.
- Active status of luminaires (on/off/dimmed etc).
- Lamp/ballast failure indication (DALI and emergency luminaires only).
- Software enabling local switching arrangements to be easily reconfigured.
- Automatic and manual control of system including any override facility (subject to password level acceptance within system).
- Password protection with various levels of access.
- Adjust set parameters for control devices.
- Production of planned maintenance reports (via the head end).
- Inputs to the lighting control system will come in various forms:
  - Local over-rides by means of button panels/key switches/presence detectors. These input units are to be supplied as part of the lighting control system.
  - Automatically generated events triggered by the KNX system.
  - Externally mounted photocell units, which shall monitor changes in daylight levels and set the pattern for scene setting, in conjunction with information received from other inputs. Multiple photocells are likely to be required on each major building.
  - Direct signals from other emergency/fire alarm systems, not necessarily routed via the head end.
- Logical Grouping/Patching Requirements

16.2 In order to simplify programming and maintenance of lighting control, the system should allow for the patching of physical lighting circuits/luminaires into logical groups via the software. The scale of this installation is such that not all luminaires need to have a requirement for individual programming or addressing. Luminaires and circuits must be patchable into different logical areas / zones. Each zone must then be capable of independent scene setting.

17.0 Daylight Tracking Requirements

17.1 To provide energy saving, artificial and natural light levels will need to be balanced. Hence the lighting control design shall incorporate complex daylight tracking and be able to monitor external daylight levels via combined ceiling mounted PIR/photocell sensors. The LCS will then respond to these inputs by dimming local luminaires to pre-determined levels.

18.0 System Components

18.1 The open protocol system utilised for the LCS shall be KNX, with a DALI sub-system. The next higher level open protocol required is OPC/BACnet, so that the head end can interface with the LCS and provide management and control functions as required. It is envisaged that the head end will use the OPC/BACnet protocol to communicate with the site wide SCADA system and the rest of the sub systems.
18.2 To this end, the LCS supplier shall be able to provide an OPC/BACnet server with full read write capability assigned to the head end for overall management.

19.0 Lighting System Floor Controllers/Routers

19.1 Floor control routers shall divide the various buildings-wide systems into discrete entities, optimising the routing of data between the server and the lighting control modules (switching modules and DALI modules).

19.2 The routers may be equipped with an integral Time Scheduler for stand-alone operation of a floor or a particular area. It shall also be equipped with a connection point for laptop PC to allow reconfiguring & monitoring of system prior to the installation of the OPC/BACnet server. The floor controller shall be supplied in enclosures and be suitable for mounting adjacent to distribution boards or in electrical riser cupboards and switch rooms. They shall be suitable for the local environment (minimum IP31) and where located in plant rooms shall be IP 54 rated.

19.3 An IP network or SELV twisted pair network (mains rated cable) shall provide a vertical network link between the server and the floor controllers as well as a horizontal link between the floor controllers and the lighting control modules.

19.4 The supplier shall provide details of the type of cable to be used for his system. It is envisaged that the LCS cable will be laid on cable baskets with other services such as BMS.

20.0 KNX - DALI Controller

20.1 Depending on the area of control and the luminaire type employed, floor controllers/routers shall be connected to DALI controllers (or net to DALI converters) via ELV twisted pair cable. Again, a single pair of bus-wire shall run from the DALI controller to DALI ballasts within the luminaires – mains wiring shall run directly to the luminaires. Subject to the final wiring requirements. Each controller shall be capable of addressing a minimum of 50 DALI ECGs. If a DALI ECG does not exist for a particular lamp type and wattage, and if individual monitoring and control is still required, then a DALI interface unit shall be specified, which shall be capable of accepting DALI signals and provide similar functionality to a DALI ECG. The vast majority of luminaires within the estate shall utilise linear fluorescent, LED, or metal halide lamps.

20.2 The system shall provide distributed intelligence such that operational software and data is stored within control device – this avoids dependence upon floor controllers/routers and other devices and therefore avoids single point of failure issues.

21.0 Circuit switching modules

21.1 Where control of individual luminaires is not required such as Mechanical and Electrical Plant rooms, circuit switching modules shall be employed which shall provide secure control of multiple lighting circuits. These modules shall be located adjacent to the distribution boards serving the area, electrical cupboards or switch rooms.

21.2 The modules shall accept up to a minimum of 8 incoming circuits spread across 3 phases, controlled as individual addressed outputs from the KNX network. In the event of power loss to the module or electronics fault, the system shall default to an “ON” position. The enclosure shall be of robust steel construction. Where they are located in terminals or a damp environment, the modules shall be IP 54 rated.
22.0 Local Switching Devices

22.1 Subject to the areas the local switching methods to be employed include:
- Pushbutton Interfaces for - Momentary action (centre bias) 24 volt ELV switches.
- Pushbutton Interfaces for - Two way and off retractive switches.
- Pushbutton Interfaces for - Key switch operated held in.
- Pushbutton Interfaces for - In front of house or areas multi-function scene set switches.

22.2 Multi sensors comprising a combined passive, active and photocell.
The multi-sensor shall combine infra-red receiver, movement detector and a photocell sensor into a single device enabling individuals to switch and dim lighting and override presence and daylight related commands using hand held personal infra-red transmitter.

22.3 Multi-sensors enable lighting to be switched or dimmed from a hand-held transmitter, while retaining the energy saving benefits of lighting switching off once areas have been vacated. The sensor functions should be individually configurable through the software to disable those not being used.

23.0 Emergency Lighting System requirements

23.1 In addition to maintaining and operating the lighting control system, an additional requirement for the system is to control, monitor and test the emergency lighting system.

System Interfaces

24.0 Fire Alarm System Interface

24.1 The building shall be divided into a number of zones when interfacing with the fire alarm system. Under an emergency condition when the fire alarm system is activated, the LCS shall bring ON to 100% output within the times set out in the relevant British Standard, all those emergency luminaires, that have been held in a switched off or dimmed position, within the fire zone of the particular building.

24.2 Upon failure of this function, the LCS should have an option of manually over-riding the current emergency lighting status to “fail safe” to 100% output.

25.0 Interface Test Facility

25.1 To ensure a satisfactory implementation of the head end and the plant interfaces, a facility will be provided where a reduced scale version of the systems will be configured and tested.

25.2 Each building system supplier shall provide the necessary equipment and personnel as required to facilitate these tests before installation on site occurs.

25.3 This will greatly reduce the onsite problems that would normally be expected to occur on a project of this scale as well as ensuring a satisfactory implementation of the head end and the plant interfaces. The tenderer shall allow for all costs associated with these tests.

26.0 Reports able to be generated

26.1 The lighting control system shall be able to provide data to allow the client to produce energy data over daily, monthly or yearly periods. This data shall then be utilised by the head end to generate energy prediction spreadsheets and graphical representations of energy.
consumption based on input data and then comparing this with the project energy targets (GJ/m²/ya).

26.2 The reports shall generate the following information:

- Run time data (the cumulative number of hours the luminaires have been in operation).
- Location and allocation of cost centres within a building.
- Weekly reports detailing kW hours per department.
- Maintenance Reports
- Throughout all areas of the building, the LCS could help the maintenance engineers to plan and schedule workload profiles by generating planned maintenance schedules.
- The system shall provide the following information for the client to prepare a planned maintenance report:
  - Active status of luminaires.
  - Run time data (the cumulative numbers of hours the luminaires have been in operation.
  - Recommended re-lamping schedules based upon a comparison of actual lamp usage to the manufacturer’s lamp life.
  - Recommend schedule to test emergency lighting on an area-by-area basis and to schedule emergency tests a regular intervals.
  - Recommend schedule to test and monitor central battery systems including static inverters and DC battery systems.

27.0 Site installation and Commissioning

27.1 Prior to the delivery of any item to site, the supplier shall prepare and obtain approval for his Installation and Commissioning Method Statement.

27.2 This shall detail each aspect of equipment installation covering:
  - Requirements upon others
  - Installation procedure
  - Health & Safety considerations
  - Disposal of waste
  - Security and communication
  - Testing and verification process

27.3 During the above phase the supplier shall provide weekly status update reports detailing on-site progress, holding issues, accidents and injuries, 4 week look-ahead and work undertaken in the previous week.

28.0 O & M Documentation

28.1 The O&M manuals shall be in the English language and contain all information that might be required by ‘technicians’ in understanding the general theory of operation, practical operation, corrective and preventative maintenance, repair & maintenance functions etc. In particular, for the first step of fault finding, a fault finding analysis flow chart shall be provided with further flow charts for more detailed analysis.

28.2 The O&M manuals shall primarily contain the following:
  - Name, Address & Contact details of each Supplier / manufacturer.
  - Index sheets
  - Comprehensive glossary where specialised terminologies and acronyms are explained.
  - Full Technical System Description.
29.0 Training

29.1 All necessary training of the CUL Maintenance Team in a minimum of two sessions and/or the End User to operate and maintain the system shall be provided, including fault finding and rectification. Training sessions shall be arranged to occur prior to project handover, for which a draft O&M manual will be made available together with current copies of the working project drawings. Supporting documentation for the training courses in the form of project specific training notes shall be provided.

29.2 The quantity and type of training sessions will be determined based upon operator and maintenance staff availability.

30.0 Handover

30.1 Project handover shall not be offered to the End User until the SAT has been completed, including the satisfactory addressing of all observations, approval of the O&M manuals, provision of training and the handing over and approval of as-built / installed documentation.

31.0 Asset Selection

31.1 The supplier shall, during the course of design and prior to CUL approval, issue a list of all items and item quantities that will be used to fulfil the project solution. A recommended list of spares and associated quantities shall be provided.

32.0 Warranty

32.1 Warranties on all hardware, software, configuration and system operation shall be provided for the following:

- An extended warranty / caretaker maintenance from system operation to project handover
- A warranty for a minimum period of 12 months after formal project handover.
33.0 Electronic Documentation

33.1 Documentation including project programmes, drawings, specifications, correspondence and all other information shall be provided in the latest electronic format. These currently comprise:

- Word
- Acrobat
- AutoCAD
- Excel