Scheme Lighting Equipment

Lantern Choice

The choice of lantern for this scheme is based on a criteria created by the client, which are as follows: good performance; tightness rated to IP65; low energy cost; low price and minimal maintenance requirements over the next 25 years. A desktop study was produced to analyse the existing products on the market that best satisfied these requirements and the lanterns are assessed against the criteria stated above which was given by Milton Keynes Council. The lantern colour temperature required for the scheme shall be intermediate and between the values of 3300 and 4200 K. Firstly, the maintenance factor needed to be calculated for each of the different light sources therefore using the manufacturers' data sheets available online for the SON-T and Cosmopolis lamp and the LED luminaires.

Maintenance Factor selection

1. Urbis ZX3 lantern with a SON-T Lamp

The maintenance factor for the SON-T lamp was calculated using data from Philips data sheet and Table B.1 from the BS5489. The lamp lumen maintenance factor (LLMF) given for a 150W SON-T lamp is 0.94 for 20000 hours. The corresponding luminaire maintenance factor for a mounting height above 6m in an E2 environmental zone for 60 months (20000 hours) is 0.93. Therefore if these are multiplied together, the maintenance factor can be calculated for this lamp, therefore;

SON-T Maintenance Factor = 0.94 x 0.93 = 0.8742 = 0.87

2. Urbis Evolo lantern with Cosmopolis lamp

The maintenance factor for the Cosmopolis lamp was calculated using data from Philips data sheet and Table B.1 from the BS5489. The LLMF given for a 140W cosmopolis lamp is 0.87 for 20000 hours. The corresponding luminaire maintenance factor for a mounting height above 6m in an E2 environmental zone for 60 months (20000 hours) is 0.93. Therefore if these are multiplied together, the maintenance factor can be calculated for this lamp, therefore;

SON-T Maintenance Factor = 0.87 x 0.93 = 0.8091 = 0.81

3. Holophane V-max LED luminaire

Holophane provided the lumen depreciation and failure fraction for their V-max luminaire and for 112,000 hours the lumen maintenance factor is L80. Over this period of time, the failure fraction will be F10; therefore10% of the LEDs would have failed over 112,000 hours. Using this information, the following equation will be used to determine the appropriate maintenance factor:

$$\left(^{Percentage\ of\ initial\ light\ output\ (x)}/_{100}\right) \times \left(^{100\ -\ y}/_{100}\right) \times LMF\ (Table\ B.1)$$

(BS5489-1:2013, 2016)

Therefore;

$(80/100) \times (100 - 10\ /100\ ) \times 0.92 = 0.66.$

Therefore the maintenance factor for this luminaire is 0.66.

Comment [TW4]: B1 – Identifying an opportunity to use the most sustainable and environmentally friendly lighting equipment to ensure the client gets value for money and a system that requires minimal maintenance requirements.

D2 – Working effectively with the client, asking for their requirements and identifying appropriate equipment to use to satisfy these requirements. My role as a highways lighting engineer was to engage with the client on a regular basis to provide options of different lighting equipment that would suit their requirements and recommending the most suitable equipment.

Comment [TW5]: C1 – Working reliably without close supervision by using the BS5489-1:2013 to identify and agree that an appropriate maintenance factor had to be calculated. Using this standard to calculate the appropriate maintenance factor for the lighting scheme and applying this to lighting calculations.

E1 – As part of the ILP's code of conduct to carry out work that can be competently carried out, this exercise was carried out in a logical and competent manner in line with current British Standard.

Lighting column selection

From the results, the optimum height column to use for this scheme is a 12m column. Using this column height allows for maximum spacing of columns to be 55.5m which significantly reduces the number of columns required and therefore reduces the maintenance and installation costs of this scheme.

Along the new traffic route the proposed 12m lighting columns will be set back behind a safety restraint barrier and will be standard tubular columns in line with BS EN 40 however there are areas where the restraint barrier stops and the need for passively safe columns may be required. To assess whether the columns exposed to vehicular traffic require a passive safety construction, the ILP technical report TR30 'Passive safety' can provide guidance on whether passively safe columns are required. Using the Passive safety flowchart provided in the document, each stage was answered and the conclusion was that passively columns would be required for this scheme, see appendix C for the design phase risk assessment. Therefore using table NA1 for a non-built up area with the column located in verges on a dual carriageway road, the required classification for these columns will be 100: NE: 1 – 3. As occupant safety is essential to high speed collisions, the chosen classification will be 3, therefore the final classification will be 100: NE3. In the event of a collision with a passively safe column, the reinstallation of a new column can be simplified by the use of NAL sockets as the columns are not planted deep into the ground, therefore NAL sockets will be used for passively safe columns.

As agreed with Milton Keynes council, columns will be located behind the working width the new road restraint barrier and where this does not apply, columns will be located 1.5m back from the edge of the carriageway. The proposed restraint system will be rated at W2 and will deflect by 0.8 metres therefore columns behind this barrier will be typically 2 metres from the edge of the carriageway. It was agreed that columns would be installed in the verges either side of the carriageway instead of in the central reserve to reduce traffic management costs and improve operative safety during routine maintenance activities.

Feeder pillar selection

For this scheme, all the columns will be fed by 2 different feeder pillars which will incorporate an below ground passively safe wiring system for the passively safe columns. The feeder pillars will be hot-dip galvanised and painted with a 2-coat epoxy resin paint, refer to Appendix A for the Standard detail drawing of the feeder pillar.

Cable Selection

The electrical supply to the columns from the new feeder pillars will be private network cabling as the Milton Keynes policy requires all traffic route cabling to electrical equipment to be privately supplied excluding feeder pillar which will be supplied by the Distribution Network Operator (DNO). The cabling will be XLPE/PVC steel wire armoured cable as this provides good mechanical protection for underground cabling which is suitable for outdoor environments. For adequate protection of the cable and to provide a good earth path for disconnection purposes, an integral earth cable will be used within the steel wired armoured cable and therefore 3 core cabling will be used.

To ensure the correct cable size is used for the lighting system, the electrical system will be separated into appropriate circuits and the cable size will be determined using cable calculations. All circuits will be calculated in line with BS7671 IEE Wiring regulations. As part of reducing the load on each circuit, every 3rd column along the scheme will be fed by a different circuit.

Comment [TW9]: B1 – Identifying correct equipment for the lighting columns and providing a suitable solution. In this section of the project, the lighting columns were located in areas where they could be a potential hazard to fast moving vehicles. Therefore a suitable solution was to assess whether these columns should be passively safe in line with BS 12767 and applying this assessment to the lighting design.

C1 – Liaising with the client and agreeing on the positioning of columns for this scheme to understand which equipment to use and the constraints with the proposed highway layout for the scheme.

D2 – As detailed above, being aware of the client requirements and agreeing these requirements for implementing the lighting design.

E1 – As part of ILP's Code of conduct, health and safety is crucial when designing new lighting installations. Demonstration of taking health and safety into account for this scheme was shown by assessing the safety of the users and using suitable equipment on a high speed road to reduce injuries to occupants if they collide with the new lighting equipment.

E2/E5 – As detailed above, using suitable equipment to suit the environment of a high speed road and ensuring that the users are not harmed by designing with passively safe equipment.

Comment [TW10]: B2 – identifying the resources required as part of the scheme and deciding on the appropriate cabling to use to provide correct disconnection times and cable sizes for the scheme to ensure it is safe whilst in operation.

Scheme Health and safety

The risk assessment of this traffic route is an important stage of the design process as specific risks can be assessed and eliminated or reduced. For the A421 traffic route, risks were identified by attending site, using statutory undertakers' drawings and using experience from previous similar schemes. In Appendix C, a designer's risk assessment has been completed for this scheme highlighting the major risks on site as detailed below and how these risks have been reduced or mitigated throughout the design process.

As part of the CDM 2015 regulations, it is the responsibility of the designer to 'eliminate, reduce or control foreseeable risks that may arise during construction, the maintenance and use of a building once built' (HSE, 2016). First, a site assessment was carried out of the existing site to identify any associated risks within the scheme including overhead lines, steep embankments, vegetation and existing hazardous electrical equipment. The next step was assessing the statutory undertakers' drawings to identify any buried or overhead services that would be a hazard to operatives. The hazards identified following this assessment were; high and low voltage buried cabling; telecom buried cabling; high pressure gas main and a water main. These buried services can be a major hazard to construction operatives during construction, therefore to reduce this risk, the proposed column positions will be located as far as practicable from these existing services and a warning box will be provided on the drawing to notify the operatives during construction when working in an area with buried services.

The major risks identified on this scheme were as follows:

- Electrocution during removal and installation of the new lighting system
- Electrocution from underground services during excavation
- Excavating in the vicinity of other buried services including high pressure gas mains, water pipes and telecoms cabling.
- Slips, trips and falls
- Working adjacent to live carriageways
- Manual handling
- Working at height

During Maintenance the major risks identified on this scheme were as follows:

- Working at height
- Electrocution during testing, inspection or replacement of electrical equipment
- Working adjacent to live carriageways
- Manual handling
- Slips, trips and falls

Comment [TW14]: E3 – Producing a methodical assessment of risk using statutory undertakers' drawings, site experience and personal experience from other projects.

E2 – Managing safe systems of work by assessing the risks on site and providing a designers risk assessment and warning box on the drawing to identify any known hazards to the contractor.

E5 – Exercising company values by assessing the risks on site and putting health and safety first to minimise injury to operatives and users.

Scheme environment issues

This scheme is located in an E2 environmental zone and therefore the potential light pollution from this scheme could impact on the surrounding environment. Initially an ecology survey was undertaken by our ecology department to determine the existing species that could be impacted by this scheme. Following the site investigation, there were many species that had habitats within the scheme area including birds, bats and brown hares located within a kilometre of the site. In order to reduce the impacts from the proposed lighting, the following solutions were identified:

- Use louvres to reduce backlight from the lanterns into the field behind the scheme
- Use warm colour temperatures for the lanterns to reduce the intensity of the light source
- Use adaptive lighting throughout the night to reduce the lighting levels within the area

These solutions can be applied to the scheme to minimise the impact from the lighting on the surrounding wildlife. One of the main concerns is the light pollution impacting on the existing bat population around the eagle farm roundabout and in the report a recommendation was given to avoid excess light spill from the roundabout to minimise the impact on the bats. Furthermore, the bats had not roosted in this area permanently but there was a potential for bats to commute within the area.

Consideration was taken when designing the scheme to take into account of any potential light pollution including sky glow, glare and trespass lighting. The sky glow has been minimised by using a luminaire installed at a luminous intensity class of G4 and this will produce no upward light above 95º. The ratings for G-classes are found in Table A.1 of BS EN 13201-2:2015 which provides the luminous intensity classes for classes G1 to G6. The design spacing and proposed luminaire reduce the number of columns to be installed and an energy efficient LED lantern has been proposed to reduce the overall energy cost. The impact on the surrounding environment will be low as the lighting class has been adapted to suit the appropriate environmental zone. Furthermore, the lantern is composed of different recyclable materials such as aluminium, polycarbonate and glass and this reduces the impact on the environment as these materials can be reused. The other steel lighting equipment including columns and cabling can also be recycled and reused as new products.

Although the luminaire has many environmental benefits one of the major constraints is that the luminaire still requires energy to operate throughout the year and this impacts the environment as power stations need to provide that energy and they produce hazardous waste into the atmosphere. Therefore one of the solutions to this is to use a central management system and adaptive lighting. By reducing the lighting over the hours of operation to suit the reducing traffic flow overnight, this could save approximately 33% in energy for this scheme. The carbon and energy calculations are provided in Appendix E for the carbon consumption and energy over the proposed 25 year life time of the scheme.

Comment [TW15]: B2 – Taking precautions within the design approach and being considerate to the surrounding environment and the potential impact the scheme had on the environment. Providing 3 additional solution to the appropriate lighting equipment used that will minimise the environmental impact of the scheme.

E3 – Assessing the existing environment impacted by the scheme and take into account of the environmental and economic factors affected by the scheme. Providing solutions such as adaptive lighting and equipment with extensive life to improve the life time of the scheme and to reduce the energy consumption and costs produced by the scheme.

Comment [TW16]: C1 – Agreeing with client what the minimum g-class to be used on this project in line with British Standard to ensure minimal sky glow and discomfort glare produced by the scheme.

Comment [TW17]: E1 – Promoting environmental and sustainable design through adaptive lighting.