APPENDIX 8.6

LIGHTING ASSESSMENT

UNITED BY OUR DIFFERENCE

WSP

EBBERSTON MOOR GAS FACILITY

Lighting Assessment & Strategy

18/06/2013

Quality Management

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
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Ebberston Moor GAS FACILITY
Lighting Assessment & Strategy

18/06/2013

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1 Introduction

1.1 Scope

1.1.1 This report covers an assessment of a proposed development located near Ebberston Moor, North Yorkshire, in consideration of the requirements for the external lighting to avoid any potential obtrusive lighting to surrounding property owners and light pollution issues.

1.1.2 An outline lighting design has been undertaken based upon the proposed site layout. The design has taken due account of the environmental classification of the site and meets the National Guidance and Standards for the UK for such an installation as published by the ILP and CIE. The design has also taken due account of any wild life issues through careful choice of light source and location of lighting luminaires.

1.1.3 The report has been produced following a desk top inspection of the proposed assessment site, supporting data, site plans and aerial photography.

2 Project Description

2.1 Site Location

2.1.1 The area surrounding the proposed assessment site consists of forest to the north and west and open fields to the east and south. To the northeast there is South Moor Farm and to the south east there is Ebberston Moor Farm other than these two dwellings the environment around the proposed assessment site is predominantly dark. The area should be considered as intrinsically dark as it is within the North York Moors National Park.

2.1.2 From the review of maps and aerial photography it indicates that there are two residential properties that will have a direct or indirect view of the proposed assessment site. These are detailed in Appendix A photometric calculations (identified as sensitive receptors) of this report.

2.1.3 This report will give due consideration with regard to the impact of artificial lighting on wildlife in general and set out appropriate measures to mitigate potential impacts caused by exterior lighting at the proposed assessment site.

2.2 Light Pollution & Nuisance.

2.2.1 We need light to see and artificial lighting has become an essential part of modern life. It is provided to encourage a safe environment for a range of activities including driving, cycling, walking and sporting activities. It is also used to enhance the environment by means of decorative and flood lighting of areas, features and buildings as well as providing safe means for working during the hours of darkness and security

2.2.2 Whilst it is recognised that lighting needs to be provided, the incorrect use of such light can become a problem, cause a nuisance and affect the environment by unwanted light intruding into properties as well as wasting energy and therefore money. It can also have an impact on the wider environment, influencing the night sky, visual amenity and wildlife. Appropriate measures need to be taken where possible to limit these effects.

2.3 How Much Light is required?

2.3.1 The level of lighting depends upon the task or activity to be undertaken to ensure that it can be performed safely. In general, national bodies including British Standards, The Institution of Lighting Professionals (ILP) and The Chartered Institution of Building Services Engineers (CIBSE) prescribe required lighting levels.

2.3.2 It is important that any exterior lighting installation does not over light, controls energy consumption and avoids light pollution or spill wherever practicable.

2.4 Light Pollution

2.4.1 Light pollution is a term that describes the release of light that serves no useful purpose as it falls outside the required area.

2.5 Sky Glow

2.5.1 The release of light into the night sky brightening the horizon, creates what is known as sky glow (as can been seen over most towns and cities) and reduces the enjoyment of the night sky reducing the visibility of stars. Picture 1 below is a good example that clearly demonstrates sky glow caused by poorly controlled lighting.

Picture 1 Typical example of sky glow

2.6 Glare

2.6.1 Another form of pollution is glare, where the brightness presented to viewers is a visual distraction and may present a hazard.

2.7 Legislation Controlling Light Pollution

2.7.1 The 1990 Environmental Protection Act was revised on the 6th April 2006 by a supplementary section of the Clean Neighbourhoods and Environmental Act adding “artificial light emitted from premises as to be prejudicial to health or a nuisance” to a list of statutory nuisances.

2.7.2 However it must be noted that these changes do not affect artificial light emitted from an airport, harbour premises, railway premises, tramway premises, a bus station and any associated facilities, a public vehicle operating centre, a goods vehicle operating centre, a light house or a prison.

2.7.3 Other premises would also comply with the legislation where the operator employs “best practicable means” to prevent, or to counteract the effects of any light nuisance in respect to;

- (i) Artificial light emitted from industrial, trade or business premises; or
- (ii) The artificial light (not being light to which (i) applies) is emitted by lights used for the purpose only of illuminating an outdoor relevant sports facility.

2.8 Preventing Light Nuisance

2.8.1 Careful consideration at the design / planning stage can ensure that the task that requires lighting can be achieved whilst controlling light pollution and the first question has to be “do I need to light it?” If this is the case then the design must ensure that only the right amount of light is provided for the required task and that this is controlled to avoid light pollution.

2.9 National/International Guidance

2.9.1 The following documents are recognised as National and International Guidance on the control of light pollution / nuisance:

- CIE 150: 2003 Guide on the limitation of the effects of obtrusive light from outdoor lighting installations;
- CIE 126: 1997 Guidelines for minimising sky glow; and
- ILP Guidance notes for the reduction of obtrusive light (2011).

2.9.2 The requirements for the lighting of the proposed development have been assessed against the requirements of the above International, UK Standards and current relevant guidance.

3 Environmental Considerations

3.1 Environmental Considerations

3.1.1 There are various environmental considerations that need to be taken into account when considering the installation of exterior lighting. These are the direct energy usage, the visual impact of the lighting equipment during the day, the effect of light spillage on surrounding areas, and the spill of light into the night sky, the effects on animal and plant life.

3.1.2 The above mentioned factors vary depending on the location of the proposed lighting installation.

3.1.3 The Institution of Lighting Professionals (ILP) document "Guidance notes for the reduction of obtrusive light (2011)" and CIE 150: 2003, establish four Environmental Zones (the ILP guidance has recently been revised to include 5 environmental zones). Refer to **Table 1** below. Each zone has a different approach to the provision of external lighting. These zones establish 'Obtrusive Lighting Limitations for External Lighting Installations' and include the effects of 'Sky Glow' and light into windows. The document also includes 'source intensity', the potentially obtrusive direction of light outside the area being lit.

3.1.4 The limits published with these documents set upper performance levels above which the lighting would be considered as a nuisance within each environmental zone. Curfews are normally applied after a locally agreed hour when the lighting levels may be reduced or switched off.

3.1.5 In general, the effect of distance from the lighting source / installation has the effect of reducing the lighting levels falling on a surface but has little effect regarding source intensity which tends to be more affected by the background against which it is viewed. In basic terms a bright torch shining towards an observer will appear brighter when the background it is viewed against is dark than it would, say, in a town or city centre which is likely to have high background lighting levels.

Table 1 - The guidance referred to in item 3.1.3 above are summarised below:

Environmental Zone	Sky Glow ULR [Max %]	Light Intrusion (into windows) E_v [lux]		Luminaire Intensity I [cd]		Building Luminance Pre-curfew
		Pre-curfew	Post-curfew	Pre-curfew	Post-curfew	Average L [cd/m^2]
E0	0	0	0	0	0	0
E1	0	2	0(1*)	2,500	0	0
E2	2.5	5	1	7,500	500	5
E3	5	10	2	10,000	1,000	10
E4	15	25	5	25,000	2,500	25

Where UWLR (Upward Waste Light Ratio) = Maximum permitted percentage of luminaire flux that goes directly into the sky.

EV = Vertical Illuminance in Lux
I = A measure of light intensity in Candelas (cd)
* Acceptable from public road lighting installations only

3.1.6 The five environmental zones are defined as follows:

Table 2 – ILP Environmental Zones Classification

Zone	Surrounding	Lighting Environment	Examples
E0	Protected	Dark	UNESCO starlight reserves, IDA dark sky parks
E1	Natural	Intrinsically dark	National parks, Areas of Outstanding natural Beauty etc.
E2	Rural	Low district brightness	Village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Small town centres of sub-urban locations
E4	Urban	High district brightness	Town / City centres with high levels of night-time activity

3.1.7 The environmental zones are normally grouped as E1/E2 and E3/E4 and are considered as rural and urban respectively. Given the location of the project site the area has been defined as E1 natural.

3.1.8 The desk top study carried out for the proposed development to determine the environmental zone classification revealed that there are no significant light sources within the vicinity of the site.

3.1.9 From the point of view of the impact of artificial lighting on wildlife there have been a number of reports published over the years with the main focus being on bats. A key document being 'Wildlife and Roads, The Ecological Impact', this incorporates a section regarding 'The ecological effects of road lighting on wild life' by A. Outen. He has investigated the general impact of artificial lighting on wildlife and in conclusion has found that the colour of the light source used is significant to its impact on the wildlife.

3.1.10 Outen's research shows that the use of:

- Low Pressure Sodium (SOX) light sources, an orange monochromatic source has a negligible affect;
- High Pressure Sodium (SON) lighting, a more golden light source has minimal effect, attracts insects;
- White Lighting (Metal Halide, CDO, CPO, PLL…) has a significant effect on wildlife disrupting its 24 hour cycle in part due to the high ultra violet content of the light to which insects in particular are very sensitive.

3.1.11 Other research carried out by many others has shown that the disturbance of insects in relation to the use of artificial lighting has a knock on effect to the 24 hour patterns of other wildlife such as birds and bats.

3.1.12 Research tends to direct us to avoiding the use of white light sources, with a preference towards SOX sources or SON with good light / optical control.

3.1.13 It should be noted that the SOX lamp gives no colour rendering, is large in size and therefore makes good light control through the use of reflectors and louvers difficult and is one of the main causes of sky glow within the UK. The current British Standards for road and amenity lighting preclude its use.

4 Lighting Strategy

4.1 The Need for Lighting the Proposed Development

4.1.1 Any lighting proposed for the assessment site should be implemented with due consideration for the use of best practicable means to prevent, or to counteract the effects of the artificial light on the surrounding area, this should include any sensitive receptors (observers) who have views of the site. The outline lighting design has been designed by competent designers as defined by the institution of Lighting Professionals (ILP) and assessed against the guidance documentation mentioned within this report.

4.1.2 All lighting should be designed under the principal of Ultra Efficient Lighting (UEL) which means that the right light will be provided at the right time in the right place controlled by the right system. This is effectively broken down as follows:

- Right light, look to the correct application of the lighting standards which define the required lighting levels dependent upon the tasks being undertaken and the level of activity. This also looks to the use of the right light source which should be as energy efficient as possible and will include due consideration of LED lighting whilst taking due consideration of the mitigation requirements for the impact of the light source on bats and wildlife as previously identified.
- Right time, the standards permit light levels to be changed dependent upon use, i.e. when traffic levels fall then the light class can be redefined. With respect to this development this could be at times when site usage is low, for example when associated facilities are not open and thus a security level of lighting can be adopted or even the lighting turned off. This may affect the whole site but may also be zoned within the proposed development.
- Right place, ensuring that only the tasks required are illuminated thus reducing spill and obtrusive light and is achieved through the careful consideration of luminaires and how they are mounted / installed.
- Right system, the most energy efficient lighting installation requires a suitable control system that could also permit monitoring and the operation of the lighting dependent of the operating parameters.

4.2 Design Recommendations

4.2.1 As described earlier, the area has been classed as an E1 Environmental Zone. Therefore the limitations given in the **Table 3** below apply:

Table 3 – ILP Environmental Zone Criterion

Environmental Zone	Sky Glow ULR [Max %]	Light Intrusion (into windows) E_v [lux]		Luminaire Intensity I [cd]		Building Luminance Pre-curfew
		Pre-curfew	Post-curfew	Pre-curfew	Post-curfew	Average L [cd/m^2]
E0	0	0	0	0	0	0
E1	0	2	0(1*)	2,500	0	0
E2	2.5	5	1	7,500	500	5
E3	5	10	2	10,000	1,000	10
E4	15	25	5	25,000	2,500	25

4.2.2 As can be seen from the table above, figures are given against both before and after curfew. At this stage of the development application, no indication has been given if a curfew will be applied to any proposed lighting installations.

4.3 Access Road and Building Circulatory Roads Lighting Design Recommendations

4.3.1 The standard that addresses the lighting performance/levels for Outdoor work places is BS EN 1264-2:2007 Lighting of work places- Part2: Outdoor work places.

4.3.2 An appropriate level of lighting would be selected from section 5 of BS EN 1264-2:2007, table 5.1 ref no 5.1.2 as indicated Table 4 below:

Table 4 – Petrochemical &other hazardous industries

Ref No.	Type of area, task or activity	E_m [lux]	U_o	GR_L	R_a	Remarks
5.1.1	Walkways exclusively for pedestrians	5	0.25	50	20	
5.1.2	Traffic areas for slow moving vehicles (max 10km/h), eg bicycles, trucks and excavators	10	0.40	50	20	
5.1.3	Regular vehicle traffic (max 40km/h).	20	0.40	45	20	
5.1.4	Pedestrian passages, vehicle turning, loading & unloading points	50	0.40	50	20	

4.3.3 Further analysis of future levels of usage and traffic counts/flows should be considered to determine the final required lighting level at the time of detailed design.

4.4 Parking Area

4.4.1 The standard that addresses the lighting performance/levels for Outdoor work places is BS EN 1264-2:2007 Lighting of work places- Part2: Outdoor work places.

4.4.2 An appropriate level of lighting would be selected from section 5 of BS EN 1264-2:2007, table 5.9 ref no 5.9.1 as indicated Table 5 below:

Table 5 – Petrochemical &other hazardous industries

Ref No.	Type of area, task or activity	E_m [lux]	U_o	GR_L	R_a	Remarks
5.9.1	Light traffic, eg parking areas of shops, terraced and apartment houses, cycle parks	5	0.25	55	20	
5.9.2	Medium traffic, eg parking areas of department stores, office buildings, plants, sports and multipurpose building complexes	10	0.40	50	20	
5.9.3	Heavy traffic, eg parking areas of school, churches, major shopping centres, major sports and multipurpose building complexes	20	0.25	50	20	

4.5 Gas Well / Water Well Production Areas & Storage Tank Area

4.5.1 The standard that addresses the lighting performance/levels for Outdoor work places is BS EN 1264-2:2007 Lighting of work places- Part2: Outdoor work places.

4.5.2 An appropriate level of lighting would be selected from section 5 of BS EN 1264-2:2007, table 5.10 ref no 5.10.1 as indicated **Table 6** below:

Table 6 – Petrochemical &other hazardous industries

Ref No.	Type of area, task or activity	E_m [lux]	U_o	GR_L	R_a	Remarks
5.10.1	Handling of servicing tools, utilisation of manually regulated valves, starting and stopping motors, lighting of burners	20	0.25	55	20	
5.10.2	Filling & emptying of container trucks and wagons with risk free substances, inspection of leakage, piping and packaging	50	0.40	50	20	
5.10.3	Filling & emptying of container trucks and wagons with dangerous substances, replacements of pump packing, general service work reading of instruments	100	0.40	45	40	
5.10.4	Fuel loading & unloading	100	0.40	45	20	
5.10.5	Repair of machines and electric devices	200	0.50	45	60	Use local lighting

4.5.3 As can be seen in Table 4 above, a level appropriate for handling of servicing tools, utilisation of manually regulated valves, starting and stopping motors, lighting of burners has been selected. However, further analysis of future levels of usage and work undertaken in these areas should be considered to determine the final required lighting level at the time of detailed design.

4.6 Loading Area Lighting Design Recommendations

4.6.1 The standard that addresses the lighting performance/levels for Outdoor work places is BS EN 1264-2:2007 Lighting of work places- Part2: Outdoor work places.

4.6.2 An appropriate level of lighting would be selected from section 5 of BS EN 1264-2:2007, table 5.10 ref no 5.10.3 as indicated **Table 7** below:

Table 7 – Petrochemical &other hazardous industries

Ref No.	Type of area, task or activity	E_m [lux]	U_o	GR_L	R_a	Remarks
5.10.1	Handling of servicing tools, utilisation of manually regulated valves, starting and stopping motors, lighting of burners	20	0.25	55	20	
5.10.2	Filling & emptying of container trucks and wagons with risk free substances, inspection of leakage, piping and packaging	50	0.40	50	20	
5.10.3	Filling & emptying of container trucks and wagons with dangerous substances, replacements of pump packing, general service work reading of instruments	100	0.40	45	40	
5.10.4	Fuel loading & unloading	100	0.40	45	20	
5.10.5	Repair of machines and electric devices	200	0.50	45	60	Use local lighting

4.6.3 As can be seen in Table 6 above, a level appropriate for filling & emptying of container trucks and wagons with dangerous substances, replacements of pump packing, general service work reading of instruments has been selected. However, further analysis of future levels of usage and work undertaken in these areas should be considered to determine the final required lighting level at the time of detailed design.

4.7 General Lighting Design Information

4.7.1 In order to put the lighting levels mentioned previously into context the following comparable examples can be used:

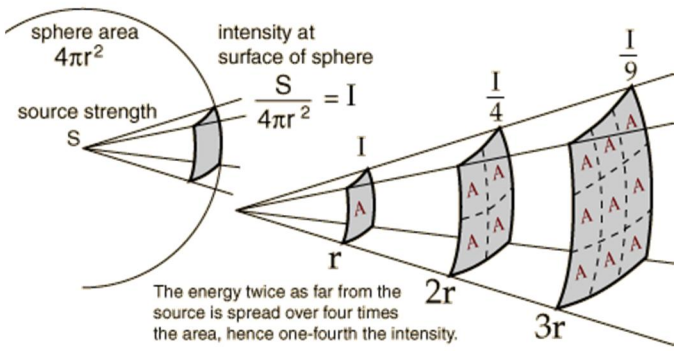
Illuminance

1 lx	Moon light
10 Lx	Subsidiary roads with medium traffic flow
20 lx	Parking area for shopping centre
50 lx	City centre / family living room
100 lx	School circulation halls
200 lx	Railway waiting room
300 lx	Office reception areas
1,000 lx	Overcast day

Luminance / source intensity

Candle	1 cd
100 W incandescent lamp	80 cd
Car head lamp	15,000 cd

4.7.2 The effect of viewing distance on the impact that a light source has on the observer is described by the principals of the 'Inverse square law'. Essentially an object twice the distance from the light source will receive a quarter of the amount of illumination. The reason why the amount of light received diminishes so rapidly is not because it 'runs out of energy' but because it spreads and so a smaller proportion of the light hits the object or is received by the observer. The following diagram illustrates the point.



4.7.3 However the inverse square law does not relate to the intensity of a source, as this is a measure of the illuminance received at a surface multiplied by the square of the distance between the source and the receiver. As such the value is constant no matter what the observers distance is from the source. The only aspect that will change is the observer's view of the size of the source which will reduce with distance.

4.7.4 The choice of equipment, especially luminaires, their mounting height and location will be critical and the following is considered appropriate:

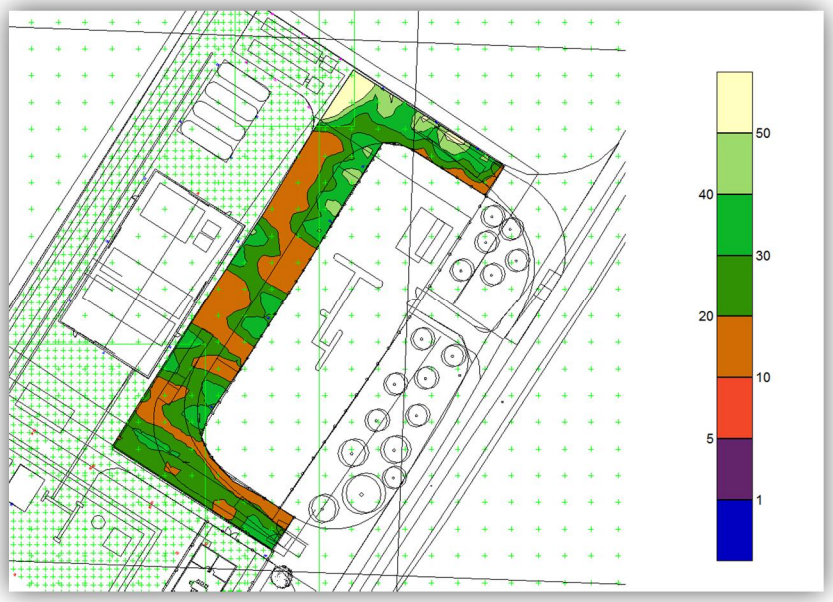
- Lighting should be mounted on the buildings where possible but where a column mounting is required heights for the car park, access roads and vehicle routes around buildings should not exceed 6 metres in height.
- Building mounted luminaires should not exceed 6 metres in mounting height.
- High pressure sodium (SON) should be used where practicable to reduce the impact of artificial lighting on wildlife, given the proposed developments location bordering open countryside. However, the use of more energy efficient light sources such as LED's should not be ruled out if no overriding ecological case is put forward.
- Luminaires designed and installed to meet the requirements of sky glow for an E1 environmental zone, in general this will require the luminaires to be installed such that they emit no light above the horizontal (within lighting design this is termed G6). Design calculations for this criterion will need to be calculated in accordance with CIE document 126.
- Where possible luminaires shall be positioned away from existing and proposed new hedgerows/trees/landscaping on site or any sensitive areas that may be used by bats, breeding birds and wintering roosting birds.
- Security lighting and non-essential lighting should be considered for dimming or switch off after curfew, if a curfew is applicable. Dimming or switching off will reduce the installations energy and carbon consumption.

5 Outline Lighting Design

5.1 Loading Access Road Design Recommendations

5.1.1 All calculations referred to in this report have been performed as an indication of the likely effects caused by the use of artificial lighting within the proposed development area for use as supporting landscaping report. Further calculations and refinement of the outline design should be performed at the detailed design stage.

5.1.2 The modelling of the outline lighting design for the loading access road of the proposed development has been carried out utilising Calculux lighting design software package. Calculux has been used to determine the overall lighting layout in accordance with the standards highlighted in Section 4 and light spill contours to the immediate surrounding environment. The isolux contour results can be viewed in Appendix A.



Calculux screen shot Loading Access Road

5.1.3 The luminaire utilised for the outline lighting calculations of the Loading Access Road is a Sill 453 Plane Projector complete with a 60 Watt Cosmopolis lamp and flat glass. It should be noted that the cut off of the luminaire is a G6 when mounted at zero degrees, which results in no light being emitted above the horizontal.

Sill 453 Plane Projector
(Metal Halide lamp shown in image)

5.1.4 As detailed above in 5.1.3, a G6 complaint luminaire has been utilised for the Loading Access Road lighting. The G rating of a luminaire relates to the luminous intensity of light emitted at angles of 70, 80 and 90 degrees when the luminaire is mounted at a tilt of zero degrees to the finished surface that it is lighting. The classification ranges from G1 to G6, with G6 being the most stringent of the class. The G6 compliant luminaire is more commonly utilised for motorway lighting and where light pollution could potentially be an issue. Table A1 below has been extracted from BS EN13201-2:2003 to show the levels of luminous intensity at specified angles for a luminaire to be complaint with the six levels of G Class.

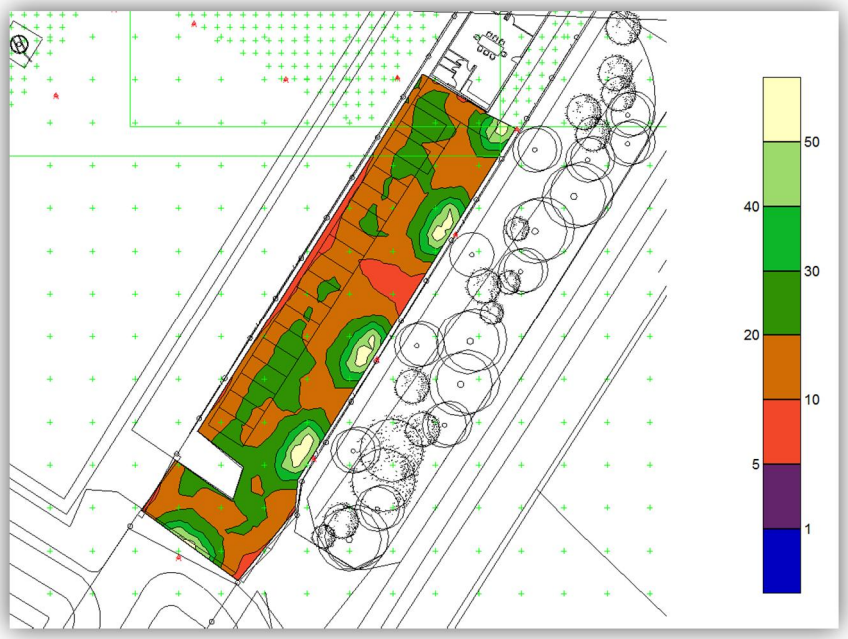
Table A.1 — Luminous intensity classes

Class	Maximum luminous intensity in cd / klm			Other requirements
	at 70° [a]	at 80° [a]	at 90° [a]	
G1		200	50	None
G2		150	30	None
G3		100	20	None
G4	500	100	10	Luminous intensities above 95° [a] to be zero
G5	350	100	10	Luminous intensities above 95° [a] to be zero
G6	350	100	0	Luminous intensities above 90° [a] to be zero

[a] Any direction forming the specified angle from the downward vertical, with the luminaire installed for use.

5.2 Car Park Outline Lighting Design

5.2.1 The modelling of the outline lighting design for the car parking area of the proposed development has been carried out utilising Calculux lighting design software package. Calculux has been used to determine the overall lighting layout in accordance with the standards highlighted in Section 4 and light spill contours to the immediate surrounding environment. The isolux contour results can be viewed in Appendix A.



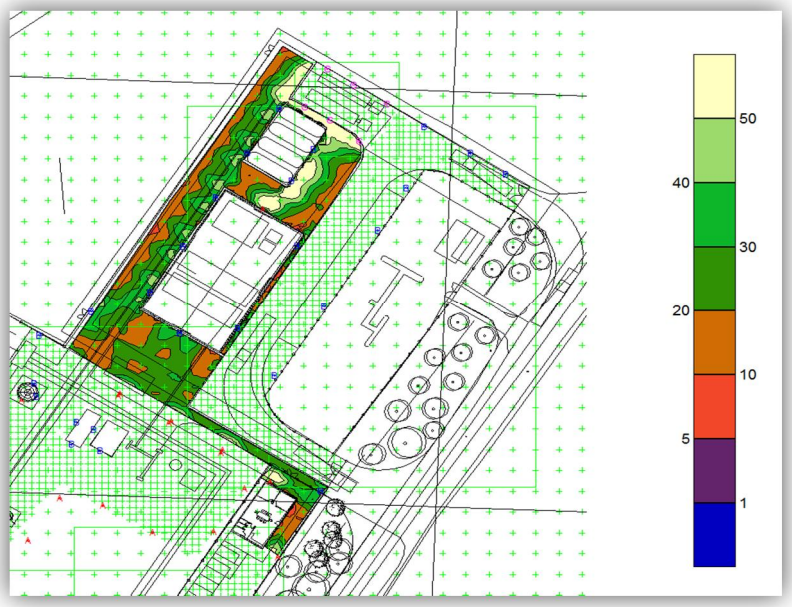
Calculux screen shot Car Park

5.2.2 The luminaire utilised for the outline lighting calculations of the car park is a Sill 453 Plane Projector complete with a 60 Watt Cosmopolis lamp and flat glass. It should be noted that the cut off of the luminaire is a G6 when mounted at zero degrees, which results in no light being emitted above the horizontal.

5.3 Well Head Working Area & Gas Conditioning Building / Tank Working Area

5.3.1 The modelling of the outline lighting design for the well head and tank working areas of the proposed development has been carried out utilising Calculux lighting design software package to determine the overall lighting layout in accordance with the standards highlighted in Section 4 and light spill contours to the immediate surrounding environment. The isolux contour results can be viewed in Appendix A.

Calculux screen shot well head working area

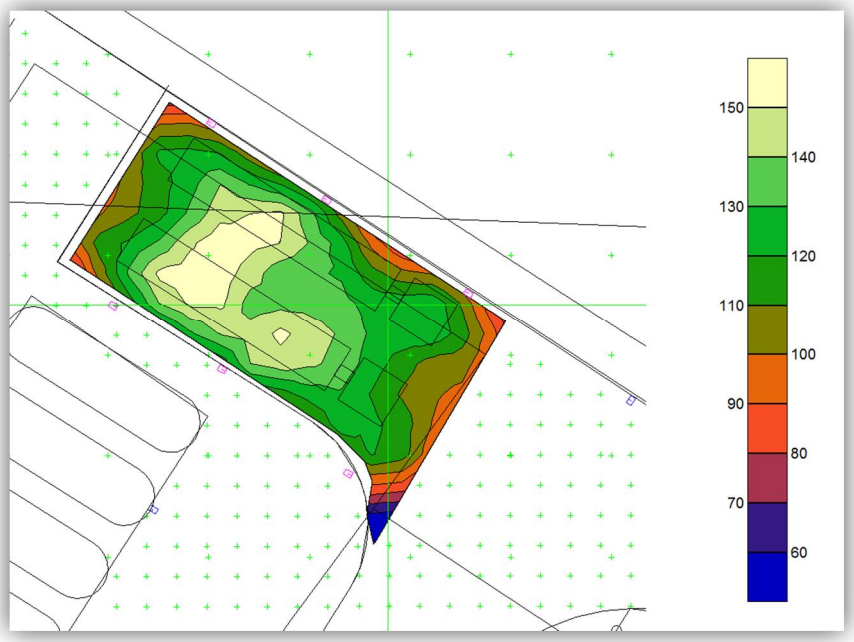


Calculux screen shot tank working area

5.4 The luminaire utilised for the outline lighting calculations of both the well head working area and the tank working area is again a Sill 453 Plane Projector complete with a 60 Watt Cosmopolis lamp and flat glass. It should be noted that the cut off of the luminaire is a G6 when mounted at zero degrees, which results in no light being emitted above the horizontal.

5.5 Tank Loading Area Outline Lighting Design

5.6 The modelling of the outline lighting design for the tank loading area of the proposed development has been carried out utilising Calculux lighting design software package to determine the overall lighting layout in accordance with the standards highlighted in Section 4 and light spill contours to the immediate surrounding environment. The isolux contour results can be viewed in Appendix A.



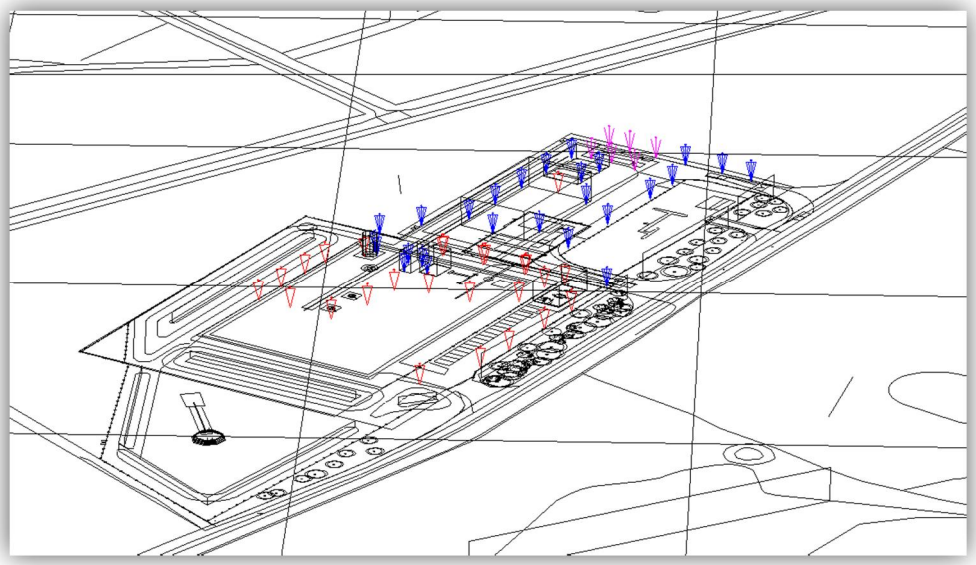
Calculux screen shot tank loading area

5.7 The luminaire utilised for the outline lighting calculations of the tank loading area is again a Sill 453 Plane Projector complete with a 90 Watt Cosmopolis lamp and flat glass. It should be noted that the cut off of the luminaire is a G6 when mounted at zero degrees, which results in no light being emitted above the horizontal.

5.8 Source Intensity & Sky Glow Calculations

5.9 Calculux has been utilised to determine the impact of the proposed lighting for the combined areas of the proposed development in terms of sky glow and source intensity (obtrusive light) to the identified sensitive receptors as outlined in section 4 of this report.

5.10 Where possible and based on information provided, the site layout in terms of proposed buildings and planned or existing planting have been modelled into the calculation to give as accurate as possible results to represent the effect from artificial lighting on identified sensitive receptors.



Calculux 3D screen shot of proposed development

5.11 Source Intensity Calculation Results

5.11.1 The results of the source intensity calculations have been summarised in the Table 8 below. Refer to Appendix A for full detailed calculations.

Table 8 – Source Intensity (SI) calculation results

Sensitive Receptor	Observer Code (Calculux)	Zone E1 Limit (cd)	Maximum Intensity (cd)
Ebberston Moor Farm	Aa	2500/0	4
South Moor Farm	Bb	2500/0	2

5.11.2 As can be seen from the source intensity results in the table above, the outline lighting design for the proposed development is within the 2,500 cd (pre-curfew) and is just exceeding for receptor A and B the 0 cd (post-curfew) requirements of an E1 environmental zone in terms of source intensity as set out by the ILP guidance notes and CIE 150.

5.12 Sky Glow Calculation Results

5.12.1 The upward light ratio (ULR – Sky glow) for the proposed assessment site has been calculated as being 0%. The result is compliant with the requirements of the ILP and CIE 126 guidance, which requires a maximum figure of 0% ULR for an E1 environmental zone. Refer to **Appendix C** for full calculation details.

5.13 Spill Light Calculation Results

5.13.1 As can be seen from the photometric calculations in appendix A the spill light to the immediate surrounding environment associated with all lighting equipment located within the proposed assessment site is minimal, with levels of between 1 and 5 Lux being present outside of the site boundary. The calculation was performed in Calculux and screening features have been included as part of the calculation where known.

6 Mitigation Measures

6.1 Operational Requirements

6.1.1 As previously discussed in Section 5, the lighting installation for the proposed development meets the requirements of the ILP and CIE guidance. Therefore mitigation measures should not be applicable to the outline lighting installation. However, it is suggested that during the detailed design of the lighting installation that the levels outlined in this report are adhered to or given due consideration for revision based on more detailed information as the design develops.

6.1.2 At present the outline design assumes that all the lighting on the site will be in operation during the production hours. It maybe that only certain areas of the lighting will be required to be on during hours of operation and therefore other areas can be switched off and only energised for maintenance work or in an emergency thus further reducing the impact of the development.

6.2 Source Intensity Mitigation Measures

6.2.1 As found in Section 5, the source intensity calculations are within the required levels recommended by the ILP and CIE guidance for an E1 environmental zone pre curfew and is only just outside the post curfew requirements. Therefore further mitigation measures are required to the frontage and northern edge of the site. It is recommended that the density of the planting be increased and is extended along the northern boundary. During the detailed lighting design further mitigation could be put in place by providing a front baffle to the luminaires where required.

6.3 Sky Glow Mitigation Measures

6.3.1 The design requirements for sky glow do not require the design to take account of the reflective nature of the surface being lit. As such there will be a percentage of light reflected upwards which is outside the control of the lighting designers.

6.3.2 As found by the results in Section 5, the sky glow calculations for the proposed assessment site have returned a figure of 0%. Therefore, the outline lighting design for the proposed assessment site is considered to be compliant with the ILP and CIE guidance.

6.4 Post-Installation Commissioning Recommendations

6.4.1 It is important that the lighting is installed to the design requirements and checked / signed off on site by the designer. All fittings should be carefully installed and the views of the lighting from the point of view of all sensitive receptors / observers visually checked and any required adjustments made at the time of commissioning.

6.4.2 Illumination within the proposed development buildings should also be carefully considered. Although light emitted from within buildings tends to fall outside the requirements of lighting nuisance /

pollution, it can have an impact. The consideration of these aspects must carefully control the internal lighting such that it ‘remains within the building’ and what light is emitted out is controlled such that it is directed downwards through the use of suitable blinds.

7 Conclusions

7.1 Conclusions

7.1.1 The outline lighting design, equipment specification and commissioning; together with the proposed planting at the proposed assessment site will be effective in containing the spread of light at ground level, and no spillage effects will occur. Within the surrounding landscape, views from local residential properties towards the proposed assessment site will be filtered and interrupted by existing intervening tree and shrub planting. However motorists passing on local roads will be aware of the presence of the development at night when the lighting is operational, as light cast down from luminaries will illuminate the faces of lighting columns on which they are fixed, and will also be reflected off dust particles and moisture in the air, an effect that will be more obvious in misty conditions but will have no effect on the surrounding area or national park.

7.1.2 The design aspect is not sufficient alone and too many good designs fail when they are not installed correctly, it is therefore important that the lighting is installed to the design requirements and checked / signed off on site by the designer.

7.1.3 Whilst development in the countryside has to be lit to provide safe working conditions and security to the premises, the application of appropriate design guidance has ensured that lighting impacts are minimised and acceptable.

7.1.4 Overall, from the information provided in respect of the outline lighting design, it is concluded that although from some night views towards the proposed assessment site there will be awareness that the site is lit, the installation can be considered as complying with best practicable means with regard to addressing light pollution and obtrusive light.

Appendices

Appendix A

Ebberston EDS

Date: 01-07-2013
Customer: Barton Willmore

The nominal values shown in this report are the result of precision calculations, based upon precisely positioned luminaires in a fixed relationship to each other and to the area under examination. In practice the values may vary due to tolerances on luminaires, luminaire positioning, reflection properties and electrical supply.

WSP Lighting
Unit 9
The Chase, John Tate Road
Foxholes Business Park
Hertford
SG13 7NN

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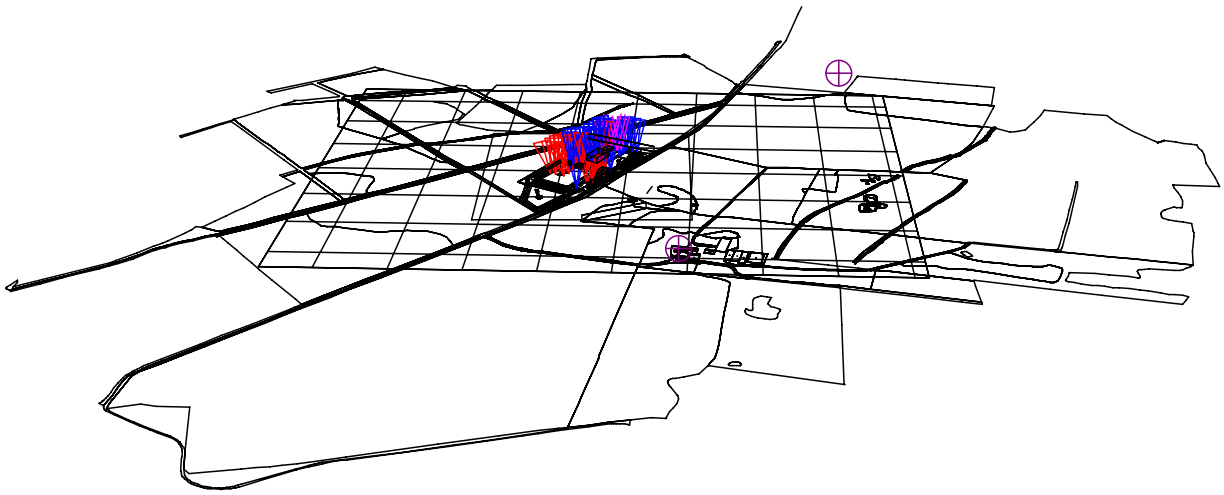
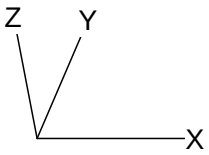
1. Project Description

1.1 3-D Project Overview





Plane Projector 150
Planstrahler
Planstrahler 150

1.2 Top Project Overview

Scale
1:12500

2. Summary

2.1 General Information

The overall maintenance factor used for this project is 1.00.

2.2 Observer Information

Code	Observer	Position		
		X (m)	Y (m)	Z (m)
Aa	Ebberston Moor Farm	129.43	-298.59	1.50
Bb	South Moor Farm	422.52	432.71	-0.00

2.3 Obstacle Information

Obstacle	Transparency (%)	Position		
		X (m)	Y (m)	Z (m)
Gas Conditioning Bld	0	0.00	0.00	0.00
Office Building	0	0.00	0.00	0.00
Gas Heater Building	0	0.00	0.00	0.00
Water Building	0	0.00	0.00	0.00
Tanks	0	0.00	0.00	0.00
Rear bund	0	0.00	0.00	0.00
Side 2m bund	0	0.00	0.00	0.00
front 2m bund	0	0.00	0.00	0.00
Back Flare Bund	0	0.00	0.00	0.00
Flare side bund	0	0.00	0.00	0.00
Flare front bund	0	0.00	0.00	0.00
Water Tank	0	-34.36	3.77	0.00
trees	25	0.00	0.00	0.00
Trees	25	0.00	0.00	0.00
Trees of EM Farm	25	0.00	0.00	0.00
Trees on NG	25	0.00	0.00	0.00
Poly Block1	0	0.00	0.00	0.00
Trees 2	0	0.00	0.00	0.00
trees 3	25	0.00	0.00	0.00
trees 4	25	0.00	0.00	0.00

2.4 Project Luminaires

Code	Qty	Luminaire Type	Lamp Type	Power (W)	Flux (lm)
A	25	Plane Projector 150	1 * CosmoPolis CPO-T 60W/728	67.0	1 * 6600
B	27	Planstrahler 150	1 * CPO-TW 60W/728	68.0	1 * 6800
C	6	Planstrahler	1 * CPO-TW 90W/728 PGZ12	99.0	1 * 10450

The total installed power: 4.11 (kWatt)

2.5 Calculation Results

(Il)luminance Calculations:

Calculation	Type	Unit	Ave	Min	Max	Min/Ave	Min/Max
Tanker Loading Area	Surface Illuminance	lux	126	58	157	0.46	0.37
Loading Access Road	Surface Illuminance	lux	26.3	10.5	90.2	0.40	0.12
Car Park Area	Surface Illuminance	lux	19.2	5.1	58.7	0.27	0.09
Well Site Working Area	Surface Illuminance	lux	40.6	11.1	91.7	0.27	0.12
Gas Bld Working Areas	Surface Illuminance	lux	29.1	7.9	106.0	0.27	0.07
General	Surface Illuminance	lux	2.18	0.00	158.58	0.00	0.00

Obtrusive Light Calculations:

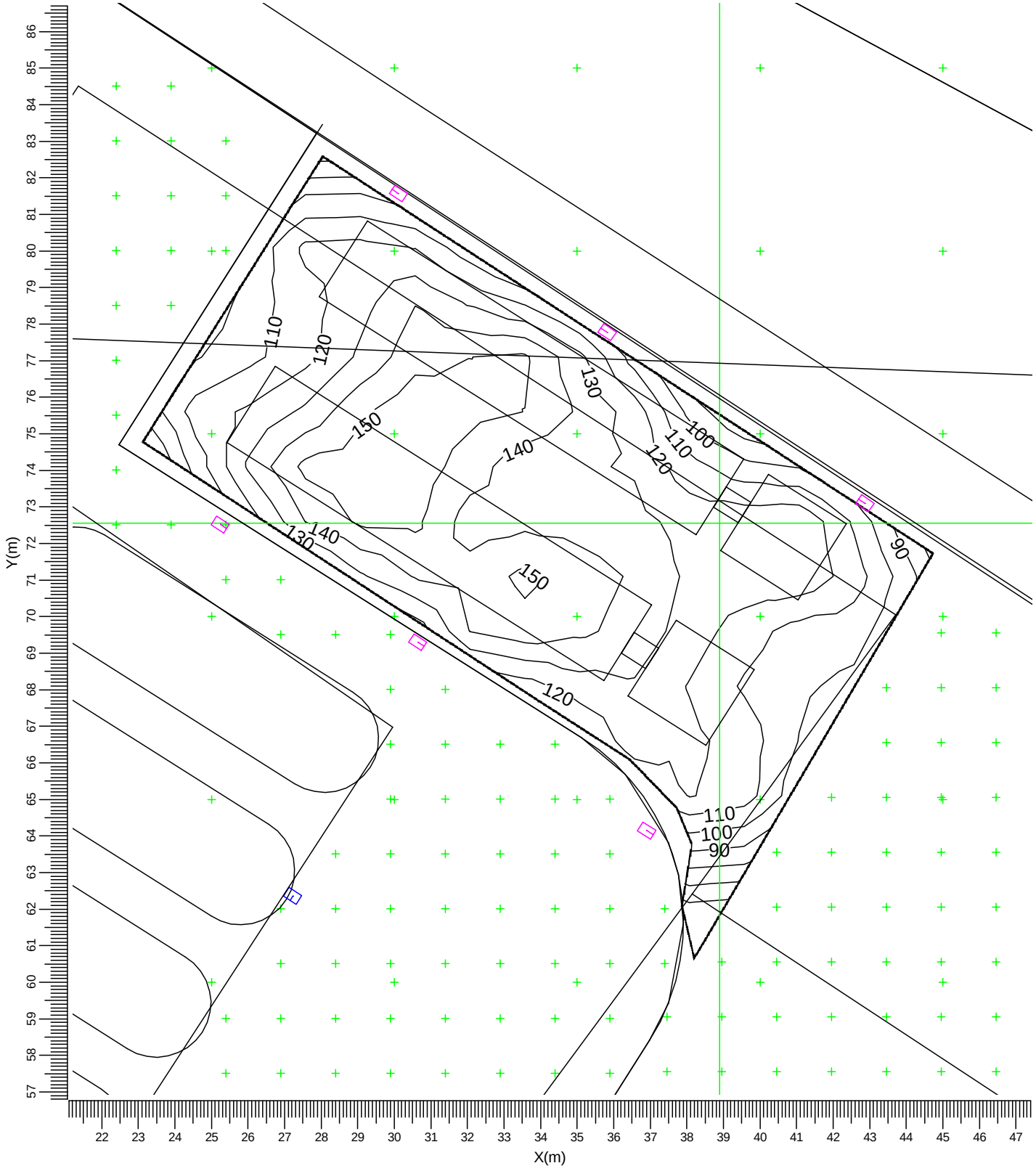
Observer Code	Luminaire Code	Position			Aiming Angles			Maximum Intensity (cd)
		X (m)	Y (m)	Z (m)	Rot.	Tilt90	Tilt0	
Aa	A	-41.80	-39.69	6.00	94.89	0.00	0.00	4
Bb	B	-20.10	-85.66	6.00	54.71	0.00	0.00	2

The upward light ratio (ULR) is 0.00.

3. Calculation Results

3.1 Tanker Loading Area: Iso Contour

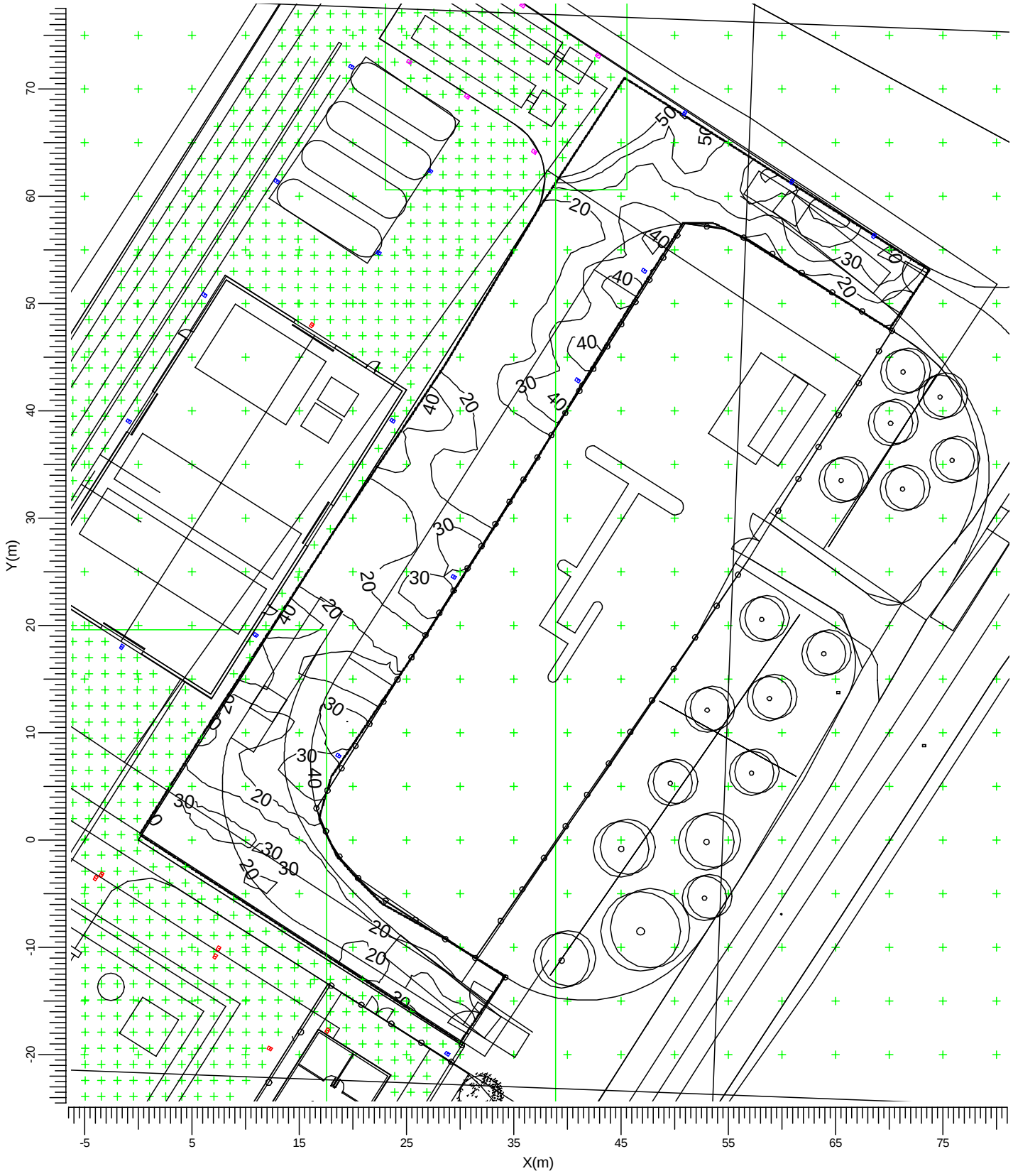
Grid : Tanker Loading Area at Z = -0.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Min/Max	Project maintenance factor	Scale
126	58	157	0.46	0.37	1.00	1:150

3.2 Loading Access Road: Iso Contour

Grid : Loading Access Road at Z = -0.00 m
Calculation : Surface Illuminance (lux)

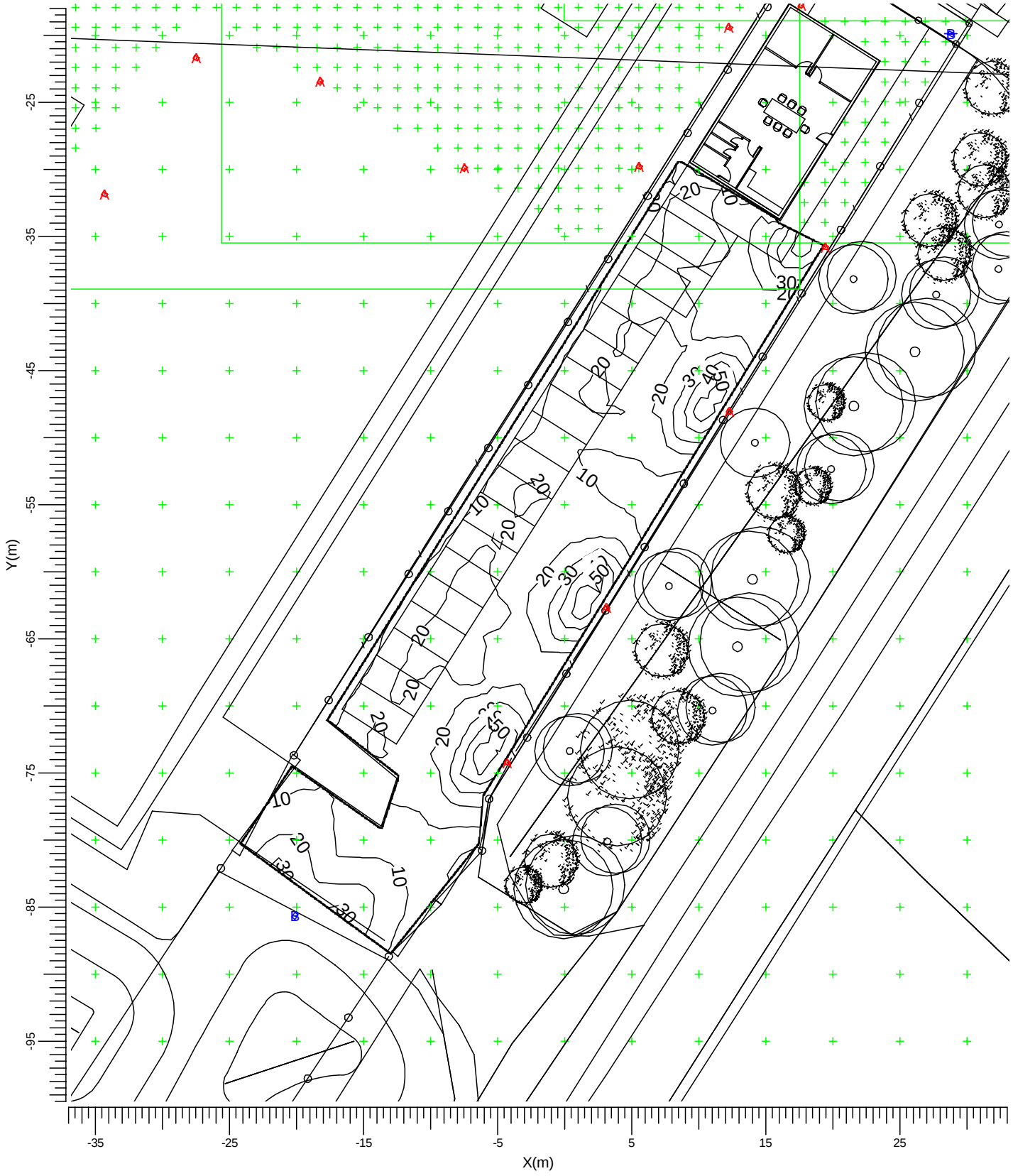


Plane Projector 150
Planstrahler
Planstrahler 150

Average	Minimum	Maximum	Min/Ave	Min/Max	Project maintenance factor	Scale
26.3	10.5	90.2	0.40	0.12	1.00	1:500

3.3 Car Park Area: Iso Contour

Grid : Car Park Area at Z = -0.00 m
Calculation : Surface Illuminance (lux)

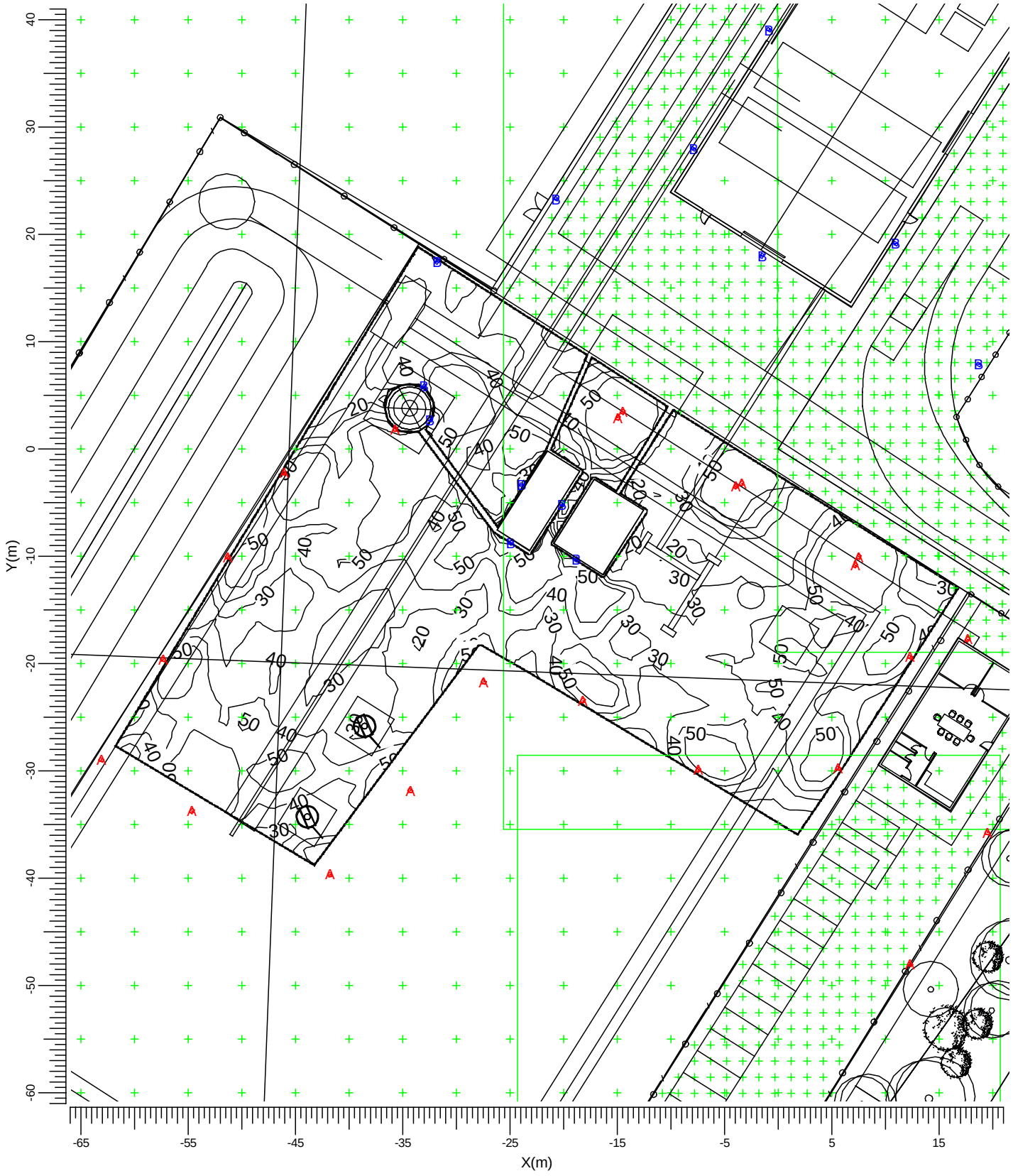


A Plane Projector 150
B Planstrahler 150
C Planstrahler

Average	Minimum	Maximum	Min/Ave	Min/Max	Project maintenance factor	Scale
19.2	5.1	58.7	0.27	0.09	1.00	1:400

3.4 Well Site Working Area: Iso Contour

Grid : Well Site Working Area at Z = -0.00 m
Calculation : Surface Illuminance (lux)

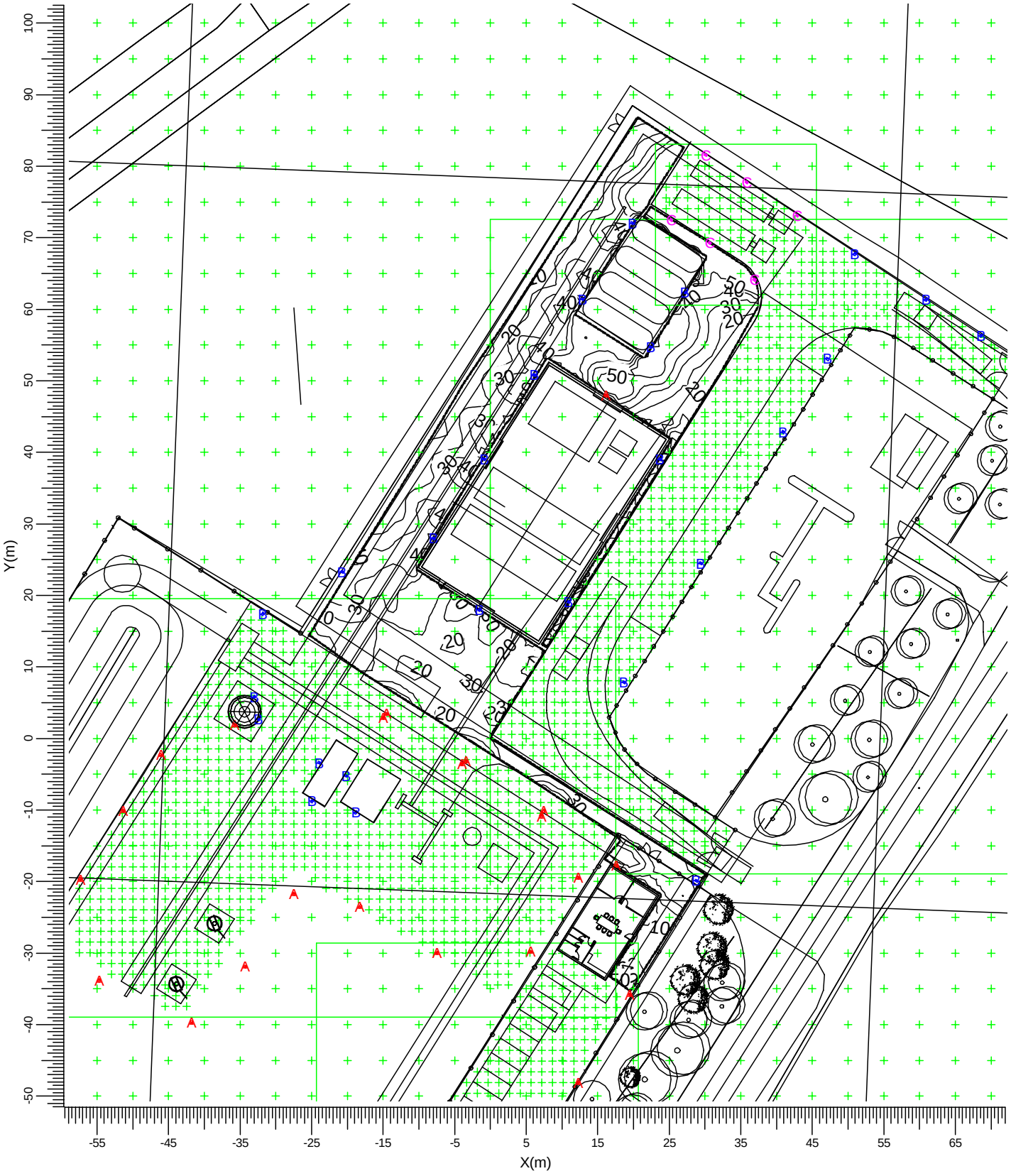


A Plane Projector 150
B Planstrahler 150
C Planstrahler

Average	Minimum	Maximum	Min/Ave	Min/Max	Project maintenance factor	Scale
40.6	11.1	91.7	0.27	0.12	1.00	1:500

3.5 Gas Bld Working Areas: Iso Contour

Grid : Gas Bld Working Areas at Z = -0.00 m
Calculation : Surface Illuminance (lux)



A Plane Projector 150
B Planstrahler 150
C Planstrahler

Average	Minimum	Maximum	Min/Ave	Min/Max	Project maintenance factor	Scale
29.1	7.9	106.0	0.27	0.07	1.00	1:750

3.6 General: Iso Contour

Grid : General at Z = -0.00 m
Calculation : Surface Illuminance (lux)

A Plane Projector 150
B Planstrahler 150
C Planstrahler

Average	Minimum	Maximum	Min/Ave	Min/Max	Project maintenance factor	Scale
2.18	0.00	158.58	0.00	0.00	1.00	1:2500

4. Luminaire Details

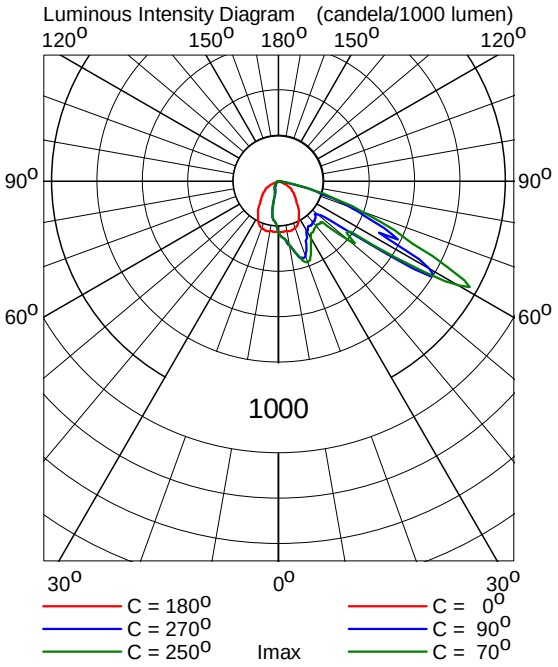
4.1 Project Luminaires

Plane Projector 150 1xCosmoPolis CPO-T 60W/728

Light output ratios
- DLOR : 0.77
- ULOR : 0.00
- TLOR : 0.77

Lamp flux : 6600 lm
Luminaire wattage : 67.0 W
Measurement code : 0130/07

Note: Luminaire data not from database.

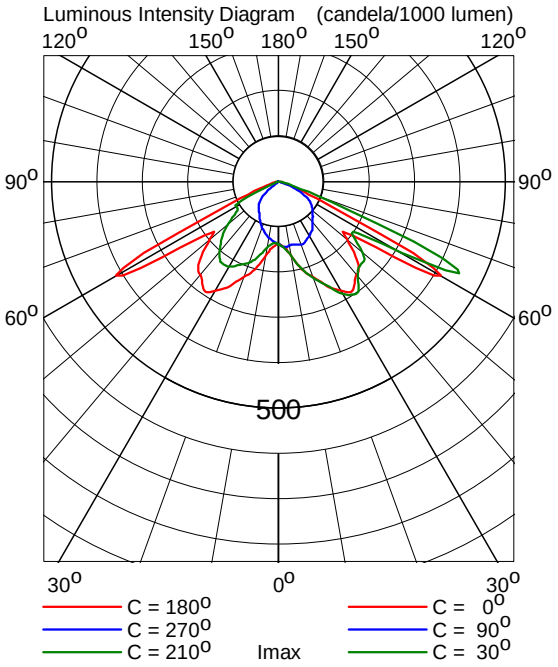


Planstrahler 150 1xCPO-TW 60W/728

Light output ratios
- DLOR : 0.71
- ULOR : 0.00
- TLOR : 0.71

Lamp flux : 6800 lm
Luminaire wattage : 68.0 W
Measurement code : 023/09

Note: Luminaire data not from database.

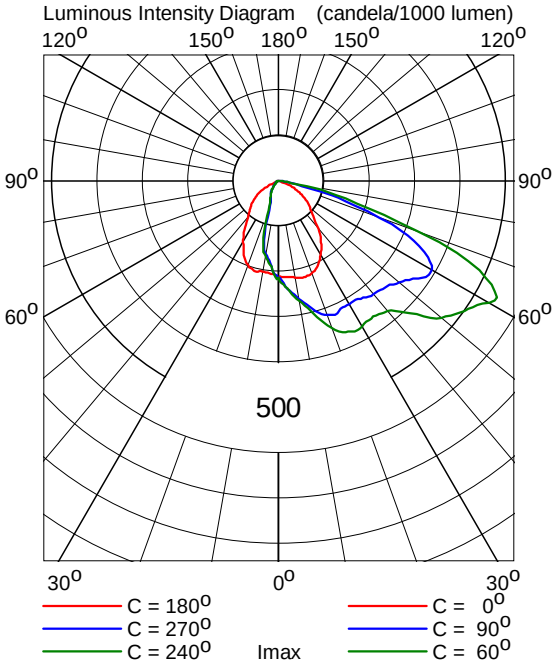


Planstrahler 1xCPO-TW 90W/728 PGZ12/ww / 2880K

Light output ratios

DLOR	:	0.69
ULOR	:	0.00
TLOR	:	0.69
Lamp flux	:	10450 lm
Luminaire wattage	:	99.0 W
Measurement code	:	001/09

Note: Luminaire data not from database.



5. Installation Data

5.1 Legends

Project Luminaires:

Code	Qty	Luminaire Type	Lamp Type	Flux (lm)
A	25	Plane Projector 150	1 * CosmoPolis CPO-T 60W/728	1 * 6600
B	27	Planstrahler 150	1 * CPO-TW 60W/728	1 * 6800
C	6	Planstrahler	1 * CPO-TW 90W/728 PGZ12	1 * 10450

5.2 Luminaire Positioning and Orientation

Qty and Code	Position			Aiming Angles			ULR	ULOR_i	Switching (%)
	X (m)	Y (m)	Z (m)	Rot.	Tilt90	Tilt0			
1 * A	-63.10	-28.98	6.00	-31.3	0.0	0.0	0.00	0.00	100
1 * A	-57.35	-19.63	6.00	-34.5	0.0	0.0	0.00	0.00	100
1 * A	-54.67	-33.78	6.00	56.9	0.0	0.0	0.00	0.00	100
1 * A	-51.33	-10.08	6.00	-33.3	0.0	0.0	0.00	0.00	100
1 * A	-46.09	-2.29	6.00	-33.3	0.0	0.0	0.00	0.00	100
1 * A	-41.80	-39.69	6.00	94.9	0.0	0.0	0.00	0.00	100
1 * A	-35.71	1.84	6.00	-122.1	0.0	0.0	0.00	0.00	100
1 * A	-34.30	-31.86	6.00	148.5	0.0	0.0	0.00	0.00	100
1 * B	-33.03	5.83	6.00	57.1	0.0	0.0	0.00	0.00	100
1 * B	-32.45	2.70	6.00	-32.6	0.0	0.0	0.00	0.00	100
1 * B	-31.81	17.44	6.00	-121.8	0.0	0.0	0.00	0.00	100
1 * A	-27.48	-21.72	6.00	148.5	0.0	0.0	0.00	0.00	100
1 * B	-24.92	-8.75	6.00	-124.7	0.0	0.0	0.00	0.00	100
1 * B	-23.92	-3.39	6.00	148.4	0.0	0.0	0.00	0.00	100
1 * B	-20.70	23.29	6.00	-31.5	0.0	0.0	0.00	0.00	100
1 * B	-20.19	-5.21	6.00	-31.8	0.0	0.0	0.00	0.00	100
1 * B	-20.10	-85.66	6.00	54.7	0.0	0.0	0.00	0.00	100
1 * B	-18.81	-10.34	6.00	-124.7	0.0	0.0	0.00	0.00	100
1 * A	-18.22	-23.47	6.00	52.6	0.0	0.0	0.00	0.00	100
1 * A	-14.95	2.90	6.00	-122.1	0.0	0.0	0.00	0.00	100
1 * A	-14.51	3.44	6.00	58.5	0.0	0.0	0.00	0.00	100
1 * B	-7.94	27.94	6.00	148.8	0.0	0.0	0.00	0.00	100
1 * A	-7.47	-29.94	6.00	54.9	0.0	0.0	0.00	0.00	100
1 * A	-4.26	-74.24	6.00	147.8	0.0	0.0	0.00	0.00	100
1 * A	-3.99	-3.54	6.00	-122.1	0.0	0.0	0.00	0.00	100
1 * A	-3.43	-3.20	6.00	58.5	0.0	0.0	0.00	0.00	100
1 * B	-1.54	18.00	6.00	-121.4	0.0	0.0	0.00	0.00	100
1 * B	-0.88	39.04	6.00	148.2	0.0	0.0	0.00	0.00	100
1 * A	3.12	-62.70	6.00	147.8	0.0	0.0	0.00	0.00	100
1 * A	5.57	-29.78	6.00	147.6	0.0	0.0	0.00	0.00	100
1 * B	6.14	50.80	6.00	149.0	0.0	0.0	0.00	0.00	100
1 * A	7.16	-10.85	6.00	-122.1	0.0	0.0	0.00	0.00	100
1 * A	7.49	-10.09	6.00	59.5	0.0	0.0	0.00	0.00	100
1 * B	10.93	19.12	6.00	-33.7	0.0	0.0	0.00	0.00	100
1 * A	12.27	-19.43	6.00	147.6	0.0	0.0	0.00	0.00	100
1 * A	12.28	-48.06	6.00	147.8	0.0	0.0	0.00	0.00	100
1 * B	12.89	61.40	6.00	147.7	0.0	0.0	0.00	0.00	100
1 * A	16.16	47.98	6.00	57.5	0.0	0.0	0.00	0.00	100
1 * A	17.63	-17.75	6.00	58.5	0.0	0.0	0.00	0.00	100
1 * B	18.67	7.86	6.00	148.2	0.0	0.0	0.00	0.00	100
1 * A	19.46	-35.79	6.00	147.8	0.0	0.0	0.00	0.00	100

Qty and Code	Position			Aiming Angles			ULR	ULOR_i	Switching (%)
	X (m)	Y (m)	Z (m)	Rot.	Tilt90	Tilt0			
1 * B	19.84	72.08	6.00	149.3	0.0	0.0	0.00	0.00	100
1 * B	22.38	54.73	6.00	-32.4	0.0	0.0	0.00	0.00	100
1 * B	23.71	39.08	6.00	-33.7	0.0	0.0	0.00	0.00	100
1 * C	25.24	72.52	6.00	57.2	0.0	0.0	0.00	0.00	100
1 * B	27.22	62.36	6.00	-32.4	0.0	0.0	0.00	0.00	100
1 * B	28.81	-19.91	6.00	147.8	0.0	0.0	0.00	0.00	100
1 * B	29.39	24.52	6.00	148.2	0.0	0.0	0.00	0.00	100
1 * C	30.11	81.57	6.00	-122.9	0.0	0.0	0.00	0.00	100
1 * C	30.64	69.30	6.00	57.2	0.0	0.0	0.00	0.00	100
1 * C	35.82	77.78	6.00	-123.7	0.0	0.0	0.00	0.00	100
1 * C	36.90	64.15	6.00	57.5	0.0	0.0	0.00	0.00	100
1 * B	40.93	42.85	6.00	148.2	0.0	0.0	0.00	0.00	100
1 * C	42.87	73.10	6.00	-123.7	0.0	0.0	0.00	0.00	100
1 * B	47.14	53.05	6.00	148.2	0.0	0.0	0.00	0.00	100
1 * B	50.94	67.76	6.00	-123.7	0.0	0.0	0.00	0.00	100
1 * B	60.91	61.36	6.00	-123.7	0.0	0.0	0.00	0.00	100
1 * B	68.57	56.31	6.00	-123.7	0.0	0.0	0.00	0.00	100

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