Neil Johnson
Sports Lighting Consultants Ltd

Cheltenham Ladies College

Proposed Hockey Pitch Floodlighting

Lighting Impact Study

Project Ref : SP1048/3

Report By – Neil Johnson

5/11/2015

Introduction

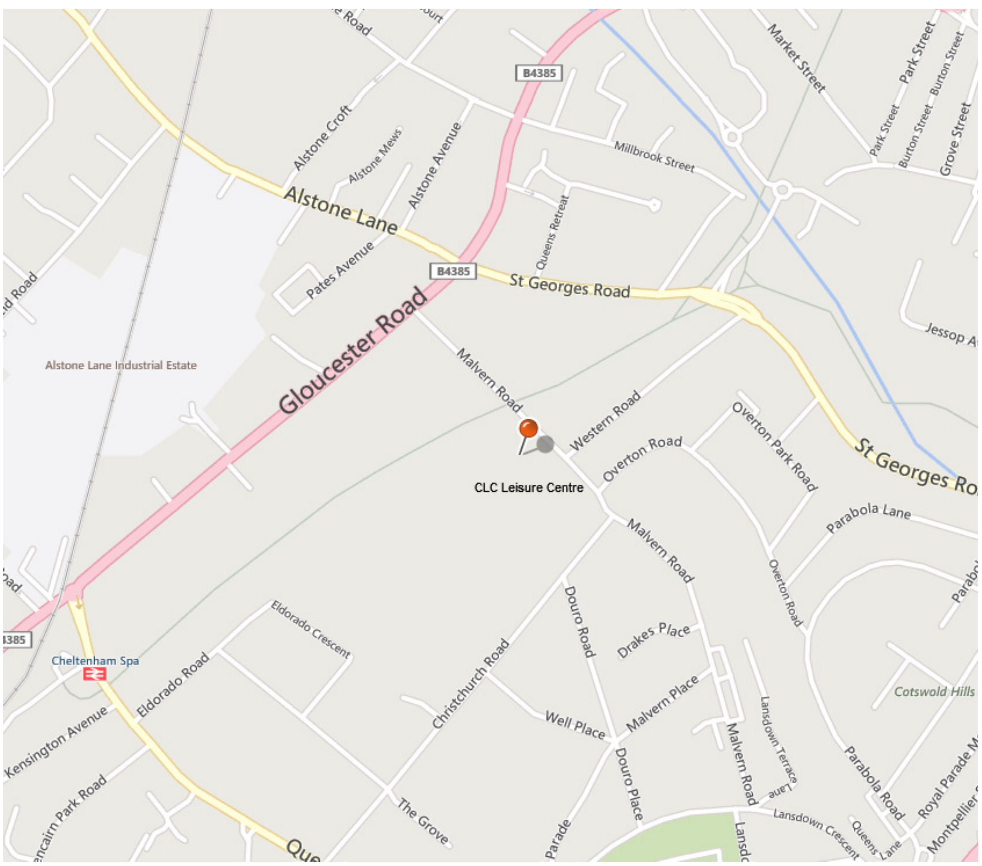
This report has been commissioned by Cheltenham Ladies College to examine the proposed Hockey Pitch lighting system at the CLC Sports Centre, Malvern Road. The school is proposing to floodlight the existing artificial sports pitch to provide lighting for training and match standard Hockey.

The report has been produced by Neil Johnson, a specialist Sports Lighting Consultant with over 30 years of experience as a Sports Lighting Engineer.

Site Location

The sports centre is located off Malvern Road, Cheltenham. The centre consists of a main indoor sports hall with swimming pool, an annex for racquet sports and external sports facilities including a floodlit all weather pitch, existing unlit tennis/netball courts and an unlit all weather pitch.

The proposed floodlit pitch is located near to the properties of Christchurch Road to the south east, which do overlook the pitch. The remainder of the site has an open aspect with the nearest properties to the west being over 150m away on Eldorado Crescent. The remainder of the site is screened by trees or existing building to the north. Beyond the northern treeline there are industrial units along Gloucester Road. The main vehicular access to the leisure centre is via the main entrance on Malvern Road. (See location plan below).



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Executive Summary

It is proposed to floodlight an existing all-weather hockey facility at Cheltenham Ladies College in order to extend the hours of use during the winter months. The pitch will be used predominantly for Hockey, however, the all-weather surface can accommodate other sports such as Netball or Tennis.

Sports lighting illuminance levels are selected by using the criteria set out in Table 3 from BS EN 12193:2007(See Below). This allows designers to classify a particular sports facility depending on the level of competition ranging from international standards to recreational and school sports. The level of expected completion has been discussed with CLC and it has been agreed that the appropriate use classification will be for Class III as the facility will be used for School Sports and Training.

EN 12193:2007 (E)

Table 3 – Selection of the lighting class

Level of competition	Lighting class		
	I	II	III
International and National	*		
Regional	*	*	
Local	*	*	*
Training		*	*
Recreational/School sports			*
(Physical education)			

The table below shows a summary of the recommended illuminance levels for Hockey and Tennis published by various sports bodies and proffesional organisations.

Organisation	Proposed Use Classification	Average Maintained Illuminance Level(Lux)
Sport England Artificial Sports Lighting Updated guidance for 2012	Class II - Hockey Class III - Hockey Class II - Tennis Class III - Tennis	200 200 300 200
England Hockey	Class II - Hockey Class III -Hockey	500 300
Lawn Tennis Association (Funded projects)	Class II - Tennis	400 lux on the PPA & 300 lux on the TPA
BS EN 12193:2007 Sports Lighting	Class III - Hockey Class III - Tennis	200 200
FIH - Guide to the Artificial Lighting of Hockey Pitches - 2011	Class II – Hockey Class III – Hockey	250 200 (non-competitive)
CIBSE - LG4 Sports Lighting - 2006	Class II – Hockey Class III – Hockey Class II – Tennis Class III - Tennis	300 200 300(PPA) 200(PPA)

Reference to the above table confirms that the range of recommended illuminance levels for the usage Class III for Hockey is between 200 Lux (BS EN 12193) and 300 Lux (England Hockey). I have sought clarification from FIH(International Hockey Federation) as to appropriate design standard for this facility. FIH has confirmed that installations should comply with the guidance of the local Hockey Federation, in this case it is England Hockey. It has therefore been agreed to design the proposed lighting system to 300 Lux average.

Many of the lighting guides available offer little design guidance, however, CIBSE Guide LG4 provides the designer with a wealth of information, including how to use floodlight beams, the control of glare and spill light containment. There is also a method of calculating the optimum mounting height for floodlights using maximum and minimum angles projected from the centre of the pitch or court. This method effectively limits the aiming angle of the floodlight in order to produce the most efficient lighting design with limited overspill or waste light. When calculated the optimum mounting height for a hockey pitch 15m. If masts of a lower height were to be used light spill and glare would be increased significantly.

The *ILP 'Guidance notes for the reduction of obtrusive light'* have been produced by the Institution of Lighting Professionals in order to offer prescriptive limits of tolerable spill light from artificial lighting systems. This document categorises the environment into five zones according to the degree of urbanisation and background illumination. The environmental zone categories are described in Table 1 along with the allowances for spill light and glare in Table 2.

Table 1 – Environmental Zones

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 or suburban locations
E4	Urban	High district brightness	Town/city centres with high levels of night-time activity

Table 2 – Obtrusive Light Limitations for Exterior Lighting Installations – General Observers

Environmental Zone	Sky Glow ULR [Max %](1)	Light Intrusion (into Windows) E_v [lux] (2)		Luminaire Intensity I [candelas] (3)		Building Luminance Pre-curfew (4)
		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	5.0	10	2	10,000	1,000	10
E4	15	25	5	25,000	2,500	25

The recommended values of spill light are cumulative and must account for ambient background illuminance produced by other light sources, such as street lighting.

Background Illuminance

The site at CLC Sports Centre is in an area with relatively high residential urbanisation to the south and east, with industrial buildings to the north. The surrounding roads are illuminated but the lighting is relatively low key and in keeping with the residential nature of the locality.

There is an existing floodlit pitch within the CLC Sports Centre grounds and this is overlooked from the rears of properties on Christchurch Road. In order to determine the effect of the existing pitch illuminance levels were recorded at the boundary of the site with the lights of the existing floodlit pitch switched on. A maximum illuminance level of 0.55 Lux and a minimum value of 0.26 Lux were recorded (in a vertical plane with the light meter aimed towards the floodlit pitch).

The existence of the floodlit pitch and the industrial units could result in the site being classified as an environmental zone E3 or suburban location. It would, however, be prudent to recommend that the spill light is controlled in line with the values for an environmental zone E2 in order to maintain the amenity of the residents and the character of the Central Conservation Area.

Proposed Lighting System

The lighting design details are shown on design drawing provided by Neil Johnson Sports Lighting Consultants Ltd, Ref: SP1048_2. The drawing shows the proposed mast locations, floodlight orientations, pitch lighting levels and overspill predictions.

The floodlights proposed are the Abacus Challenger 1 sports floodlights which feature flat style optics designed to reduce upward waste light and overspill. The wrap around reflector design projects the main floodlight beam at 60 degrees when the front glass is horizontal. The use of compact double ended 2KW Metal Halide lamps ensures beam efficiency and promotes accurate cut off. The floodlights have an internal horizontal baffle to shield the lamp and reduce glare. Additional side and rear spill screening has been included to control rear scatter. The proposed shields are very effective in controlling stray light from the rear of the floodlight.

Since the last public consultation held on 2/6/2015 the pitch lighting levels have been reduced in line with the minimum illuminance levels recommended by the sport's governing body. The predicted maintained illuminance levels are shown below:-

Hockey
Eave= 330 Lux
Uniformity(min/ave)=0.70

The designer has chosen 15m high masts for the Hockey pitch and reduced the number of masts to six in order to minimise daytime impact. By choosing mast heights from the optimum floodlight mounting range the floodlight front glasses are close to the horizontal resulting excellent light control. The floodlight beam elevations are between 62° and 65° resulting in front glass elevations between 2° and 5°. This complies with the ILP recommended maximum beam elevation of 70°.

The lighting contours represent vertical illuminance at 3m above pitch level. They indicate that the maximum vertical illuminance projected towards the nearest residential property is below 5 Lux.

Additional spill calculations are provided in tabulated form using a vertical calculation grid with an interval of 2m x 2m. The calculation points follow the rear facades of the houses on Christchurch Road from pitch level to 14m above pitch level. The calculations use initial lamp lumens and do not take into account any light loss due to dirt depreciation, or natural screening from trees, they are therefore the worst case figures.

The table below shows the maximum source intensity calculated for the installation using the vertical calculation grid described above. This shows that the maximum source intensity produced by any of the floodlights is 3143cd when viewed from the properties on Christchurch Road. This is below the recommended maximum source intensity of 7500cd for an environmental zone E2.

Calculation Summary							
Label	CalcType	Units	Avg	Max	Min	Min/Avg	Min/Max
ObtrusiveLight_1_Cd_Seg1	Obtrusive Light - Cd	N.A.	422.37	790	277	0.66	0.35
ObtrusiveLight_1_Cd_Seg10	Obtrusive Light - Cd	N.A.	869.46	2565	205	0.24	0.08
ObtrusiveLight_1_Cd_Seg11	Obtrusive Light - Cd	N.A.	836.21	2723	212	0.25	0.08
ObtrusiveLight_1_Cd_Seg12	Obtrusive Light - Cd	N.A.	691.50	2765	215	0.31	0.08
ObtrusiveLight_1_Cd_Seg13	Obtrusive Light - Cd	N.A.	592.20	1684	206	0.35	0.12
ObtrusiveLight_1_Cd_Seg14	Obtrusive Light - Cd	N.A.	641.26	2507	205	0.32	0.08
ObtrusiveLight_1_Cd_Seg15	Obtrusive Light - Cd	N.A.	761.93	2491	225	0.30	0.09
ObtrusiveLight_1_Cd_Seg16	Obtrusive Light - Cd	N.A.	558.36	1410	164	0.29	0.12
ObtrusiveLight_1_Cd_Seg17	Obtrusive Light - Cd	N.A.	609.14	1648	224	0.37	0.14
ObtrusiveLight_1_Cd_Seg18	Obtrusive Light - Cd	N.A.	573.52	2264	218	0.38	0.10
ObtrusiveLight_1_Cd_Seg19	Obtrusive Light - Cd	N.A.	873.00	3143	206	0.24	0.07
ObtrusiveLight_1_Cd_Seg2	Obtrusive Light - Cd	N.A.	425.31	827	242	0.57	0.29
ObtrusiveLight_1_Cd_Seg20	Obtrusive Light - Cd	N.A.	731.86	2062	194	0.27	0.09
ObtrusiveLight_1_Cd_Seg21	Obtrusive Light - Cd	N.A.	873.57	2855	207	0.24	0.07
ObtrusiveLight_1_Cd_Seg22	Obtrusive Light - Cd	N.A.	765.54	2703	198	0.26	0.07
ObtrusiveLight_1_Cd_Seg23	Obtrusive Light - Cd	N.A.	600.21	1734	201	0.33	0.12
ObtrusiveLight_1_Cd_Seg3	Obtrusive Light - Cd	N.A.	446.77	1218	234	0.52	0.19
ObtrusiveLight_1_Cd_Seg4	Obtrusive Light - Cd	N.A.	522.90	1224	238	0.46	0.19
ObtrusiveLight_1_Cd_Seg5	Obtrusive Light - Cd	N.A.	549.86	1591	231	0.42	0.15
ObtrusiveLight_1_Cd_Seg6	Obtrusive Light - Cd	N.A.	586.93	1564	213	0.36	0.14
ObtrusiveLight_1_Cd_Seg7	Obtrusive Light - Cd	N.A.	608.71	1592	209	0.34	0.13
ObtrusiveLight_1_Cd_Seg8	Obtrusive Light - Cd	N.A.	606.14	1583	225	0.37	0.14
ObtrusiveLight_1_Cd_Seg9	Obtrusive Light - Cd	N.A.	736.54	2134	238	0.32	0.11

The table below show the maximum vertical illuminance using the same vertical calculation grid as previously described. This shows that the maximum vertical illuminance calculated on the rear facades of any property on Christchurch Road will be 3.1 Lux. This is below the maximum vertical illuminance of 5 Lux recommended for an environmental zone E2 even when the cumulative effect of ambient background illuminance is accounted for.

ObtrusiveLight_1_Ill_Seg1	Obtrusive Light - Ill	Lux	0.17	0.4	0.1	0.59	0.25
ObtrusiveLight_1_Ill_Seg10	Obtrusive Light - Ill	Lux	0.76	1.9	0.3	0.39	0.16
ObtrusiveLight_1_Ill_Seg11	Obtrusive Light - Ill	Lux	0.83	1.9	0.3	0.36	0.16
ObtrusiveLight_1_Ill_Seg12	Obtrusive Light - Ill	Lux	0.83	2.6	0.1	0.12	0.04
ObtrusiveLight_1_Ill_Seg13	Obtrusive Light - Ill	Lux	0.72	1.5	0.2	0.28	0.13
ObtrusiveLight_1_Ill_Seg14	Obtrusive Light - Ill	Lux	0.76	1.8	0.2	0.26	0.11
ObtrusiveLight_1_Ill_Seg15	Obtrusive Light - Ill	Lux	0.86	1.8	0.2	0.23	0.11
ObtrusiveLight_1_Ill_Seg16	Obtrusive Light - Ill	Lux	0.32	0.9	0.0	N.A.	N.A.
ObtrusiveLight_1_Ill_Seg17	Obtrusive Light - Ill	Lux	0.47	1.2	0.1	0.21	0.08
ObtrusiveLight_1_Ill_Seg18	Obtrusive Light - Ill	Lux	0.22	0.5	0.1	0.45	0.20
ObtrusiveLight_1_Ill_Seg19	Obtrusive Light - Ill	Lux	1.22	3.1	0.4	0.33	0.13
ObtrusiveLight_1_Ill_Seg2	Obtrusive Light - Ill	Lux	0.39	0.7	0.2	0.51	0.29
ObtrusiveLight_1_Ill_Seg20	Obtrusive Light - Ill	Lux	0.03	0.1	0.0	N.A.	N.A.
ObtrusiveLight_1_Ill_Seg21	Obtrusive Light - Ill	Lux	0.77	1.8	0.3	0.39	0.17
ObtrusiveLight_1_Ill_Seg22	Obtrusive Light - Ill	Lux	0.42	1.2	0.1	0.24	0.08
ObtrusiveLight_1_Ill_Seg23	Obtrusive Light - Ill	Lux	0.44	1.1	0.2	0.45	0.18
ObtrusiveLight_1_Ill_Seg3	Obtrusive Light - Ill	Lux	0.35	1.0	0.1	0.29	0.10
ObtrusiveLight_1_Ill_Seg4	Obtrusive Light - Ill	Lux	0.38	0.9	0.1	0.26	0.11
ObtrusiveLight_1_Ill_Seg5	Obtrusive Light - Ill	Lux	0.33	0.9	0.1	0.30	0.11
ObtrusiveLight_1_Ill_Seg6	Obtrusive Light - Ill	Lux	0.46	1.0	0.2	0.43	0.20
ObtrusiveLight_1_Ill_Seg7	Obtrusive Light - Ill	Lux	0.54	1.1	0.2	0.37	0.18
ObtrusiveLight_1_Ill_Seg8	Obtrusive Light - Ill	Lux	0.00	0.0	0.0	N.A.	N.A.
ObtrusiveLight_1_Ill_Seg9	Obtrusive Light - Ill	Lux	0.79	2.0	0.2	0.25	0.10

The obtrusive light calculations show that the proposed lighting installation will fully comply with the ILP recommendations for an environmental zone E2 for both maximum vertical illuminance and source intensity.

Measurement of Obtrusive light

The measurment and recording of spill lighting should be carried out using the following guidance:-

CIE 150:2003 – Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations

6.4.3 Measurement conditions and procedures

Measurements should be made when the atmosphere is clear.

Telescopic Masts

In order to minimise daytime visual impact it is proposed that telescopic masts are used instead of 15m raise and lower. The proposed masts will lower to a maximum of 4.5m when not in use and will raise to their working height of 15m when operational. The use of telescopic masts will reduce the day time visual impact whilst allowing the floodlights to be positioned at their optimum working height at night.

The telescopic masts are fitted with an automated, proxy sensor, height management system which ensures that the masts will raise and lower to the same pre-set heights during each operation. They also have auto adjusting, Nyoil self-lubricating bearing pads which reduce the effect of vertical torsion, reduces mast sway and ensures that the masts are almost silent in operation.

Alternative Light Sources

During the design process various floodlight options were evaluated as an alternative to the Abacus Challenger 1. This included the latest LED light sources from the major manufacturers marketing products available in the UK. Whilst LED would have advantages including instant light without a warm up period, dimming and constant illuminance, there is still no product available to match the light control of a conventional product.

LED floodlights clusters light emitting diodes arranges in what are commonly known as 'Light Bars'. The light bars are arranged to produce a flat panel of light which is elevated to project light into the centre of the pitch. Whilst huge strides have been made in the development of LED technology the current range of floodlights do not produce light at high elevations and as a result there is no product available with flat style optics.

The largest LED projector currently available has a total of 240 LEDs which produce the equivalent light output as a 1KW Metal Halide. The project at CLC would therefore require a minimum of 5 luminaires per mast to produce the same performance as the conventional equivalent.

An LED system would offer some benefits in energy saving and longevity of lamp life, however, these benefits would be far outweighed by the negatives:-

- Increased floodlight numbers and headframe size(100% bigger)
- Significantly increased vertical spill light(400% higher at the nearest property)
- Increased glare(50% Higher due to increased light emitting surface area)
- Increased source intensity(80% higher due to increased floodlight elevation)

Conclusion.

The lighting system has been designed to allow participants to play hockey and other ball sports in safety whilst strictly following the principals of obtrusive light containment. The use of conventional HID floodlights with flat optics is still the most efficient method of controlling spill and waste light.

The use of telescopic masts will minimise day time impact whilst ensuring that spill light is minimised by maintaining the optimum working height for the floodlights. These measures coupled with reducing the proposed lighting system from 8 masts with a total of 20 floodlights down to 6 masts with 18 floodlights will offer a significant improvement over any previous proposal.

For and on behalf of

Neil Johnson Sports Lighting Consultants Ltd

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Standards and Guidance

The following lighting guides and documents have been used for reference.

ILP 'Guidance notes for the Reduction of Obtrusive Light' 2011

The Society of Light and Lighting(CIBSE), Lighting Guide 4 "Sports Lighting" 2006

BS EN 12193 'Sports Lighting'.

FIH – Guide to the Artificial Lighting of Hockey Pitches

England Hockey – Guide to the Artificial Lighting of Hockey Pitches

CIE 150:2003 – Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations

Sport England - Artificial Sports Lighting Updated guidance for 2012

Clean Neighbourhoods and Environment Act 2005

Glossary

Lumen

The standard unit of light (luminous flux) used in describing light emitted by a source or received by a surface.

Iluminance and Maintained Illuminance(lumens/m2 or lux)

Illuminance is the term used to describe the level of light on a surface in lumens/square metre or lux. Maintained illuminance is the term used to describe the average illuminance on a reference surface e.g. desktop, at the time maintenance has to be carried out.

Horizontal Illuminance

The level of light falling on to a horizontal plane(ie The Ground).

Vertical Illuminance

The level of light falling on to a vertical plane(ie The walls of a house).

Light Output Ratio (LOR)

This is the ratio of the total light output of a luminaire, relative to the total light output of the lamp/s under reference conditions. Total LOR can be divided into downward(DLOR) and upward(ULOR) light output ratios if appropriate.

Light Intrusion (Light trespass, Overspill, Light into windows).

The flow of light spilling outside the location boundary. With inadequate control Intrusive light may be sufficiently great as to provide a serious nuisance and disturbance to adjacent areas.

Glare.

Glare may be divided into 2 types known as disability and discomfort glare. In a Sports Lighting context it relates primarily to direct viewing of the floodlights. Only in severe situations would disability glare be experienced. In most instances it is discomfort glare that may result, causing annoyance to the viewer if inadequate screening of floodlights is not provided.

Sky Glow

The general term for the Halo-effect caused by upwardly directed light, forming a glow in the night sky. It can cause diminished contrast of stars against their dark background making astronomical observations difficult and often impossible. The upwardly directed light can be caused by direct waste light from floodlights or indirect redirected light from the sports surface.

ILP

The Institution of Lighting Professionals.

ILP ‘Guidance notes for the reduction of light pollution’

A booklet produced by the ILP providing advice on reducing the impact of exterior lighting installations on the environment. The degree of permissible overspill & ULOR varies depending on the environmental zone as categorized in the guidance notes. Due to the higher ambient lighting levels in built up areas the restrictions are not as stringent in city centres, were as dark landscapes & rural areas require tighter control

Curriculum Vitae

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Education: Salford Technical College
Ashfield School, Nottinghamshire

Qualifications: BTEC ONC Building Services Engineering (Lighting)
ILE Parts 1,2 & 3
LIF Advanced Exterior Lighting
GCE 'A' Levels – 3(Engineering Design, TD, Geography)
GCE 'O' Levels – 8 including Maths, English & Physics

Professional Qualifications: Associate Member of the Institution of Lighting Engineers
Engineering Council - Engineering Technician

Personal Details
Date of birth: 24th May 1966
Status: Married, 2 children(Aged 5 & 2).
Hobbies: Golf, football, rugby & travel.

Employment History:
2013 to Date Neil Johnson Sports Lighting Consultants

In 2013 I started my own lighting consultancy business. I undertake lighting designs, lighting impact studies and planning applications. I have a regular client base which includes planning consultants, pitch designers and sports governing bodies. I designed and project managed the floodlighting installation at Yorkshire County Cricket Club, which included representing the club during the planning process and overseeing the installation. I also work for FIFA on development projects which involves undertaking lighting evaluations(both desktop and site visits) as well as feasibility studies. My work for FIFA has also involved co-writing a lighting guide for use by developing Member Associations, this included producing the technical content and advising on all aspects of the installation process.

2012 to 2013 Kingfisher Lighting Limited

Sports Lighting Manager responsible for the sales, design and installation of sports lighting installations.

2011 to 2012 CU Phosco Limited, Ware, Hertfordshire.

Sports Lighting Manager responsible for the sales, design and installation of sports lighting installations.

1984 to 2010 Abacus Lighting Limited, Sutton-in-Ashfield, Nottingham.

During 26 years of continuous employment with Abacus Lighting Ltd my role & levels of responsibility have evolved with experience. Details are as follows:-

2002 to 2010 Sports Lighting Manager(UK)

Senior sales management position, responsible for the design & sales of sports lighting projects within the United Kingdom. Directly responsible to the National Sales Director my key tasks include the servicing of key accounts, designing sports lighting schemes, undertaking technical presentations & negotiating contracts with clients. As part of a highly motivated sales team I am also required to seek new business through face to face meetings with specifiers & end users.

Due to the success of the UK Sports Lighting Division additional staff have been recruited, including design engineers & external sales engineers. My role has developed significantly since 2002, the major projects won have given me the experience to deliver a complete sports solution from planning through to final commissioning.

Key achievements

- Development of UK Sports Lighting Division.
  - Increased turnover from £500K PA to £7.5 Million in 2010
- Delivered projects for Kempton Park Racecourse, Trent Bridge, Lord's & Brit Oval Cricket Ground.
- Projects won in 2010 include Edgbaston & Kent County Cricket Grounds, Eaton Manor & Broxbourne WWCC for 2012 Olympic Games.

1998 to 2002 Lighting Project Engineer

Senior technical position, responsible for the design & project management of lighting installations both in the UK & abroad. Directly responsible to the Head of Lighting Operations my key tasks included the training & supervision of four junior staff as well as providing technical assistance for the UK & worldwide sales teams, this often involved foreign travel. The role was very 'hands on' & involved site supervision of installations, as well as aiming & final commissioning of lighting projects. The project base was extremely varied covering all aspects of exterior lighting design, from car parks to international standard colour TV stadia. It was during this time that I began to specialise in sports lighting & was involved in designing many major projects, including Nad Al Sheba Racetrack, Kanpur Cricket Stadium & Dubai Creek Golf Academy.

Key achievements

- Development of design team.
- Implementation of AutoCAD based lighting design software.
- Project management of major installations.
- Overseas site commissioning.

1996 to 1998 Sales Engineer – Midlands

External sales position, responsible for sales of exterior lighting products & street furniture with an annual sales target of £1.5 Million. The client base included local authorities, consulting engineers, architects & end users.

Key achievements

- Increased turnover of area.
- Gained extensive knowledge of the lighting market

1994 to 1996 Sales Engineer – Architectural Lighting Division

External sales position, responsible for the design & sales of interior architectural lighting products in the Midlands & North of England. The client base was architect & specifier orientated. This role was my first experience of direct external sales & the first venture into interior lighting by Abacus.

Key achievements

- Annual turnover of £0.5 million
- Developed key accounts

1986 to 1994 Lighting Design Engineer

Design engineer responsible for the design of exterior lighting projects. The design process was computer based & the ability to work with minimal supervision was essential. Duties included site surveys, night assessments & luminaire design. During this time the Lighting Design Department expanded & I assisted with the training of several trainees.

1984 to 1986 Trainee Lighting Design Engineer

Attended Salford Technical College in addition to extensive in house training under the supervision of Kelvin Austin.