Sports Lighting –
Design Considerations
For The Beijing 2008 Olympic Games

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The largest of all the venues designed for the Beijing 2008 Olympic Games is the National Stadium, also known as the Bird's Nest. Huge and powerful in appearance, it is the setting of the 2008 Olympic Games opening and closing ceremonies, and represents the image of China for these games. Even so, it alone can only support less than 100,000 spectators. But, through the technology of TV broadcasting, this number can increase at least 40,000 times; more than four billon people are expected to watch the games. And the main influence on quality of the images they will see is dependent on the type and design of the lighting used. This is well understood by the IOC (International Olympic Games Committee) and the many broadcasting organizations involved, and is why their requirements are so detailed and specific about all aspects of the lighting and the results expected. This article will share insights into some of the special considerations taken to meet these needs.

There are many classifications of lighting required for the Olympic Games. Some of these include sports lighting, general lighting, façade lighting, landscape lighting. Each of these are important for their special illumination purpose, but only sports lighting can influence the quality of the athletic competition, as well as the pictures taken of the event. If any distraction is caused by the sports lighting, such as glare or low lighting levels on the field of play, the competition and its broadcast could be delayed, cancelled, or invalidated. Most of the official lighting requirements come from BOB (Beijing Olympic Broadcasting) and are issued in their VSRs (Venue Survey Reports). But these requirements only specify the needed final effect of the lighting, not how to attain it. All these documents and requirements were reviewed for their impact on each different sporting event and the layout of its arena. Based on the reviews and clarification meetings with BOB and the DI's (Design Institutes), creative lighting design proposals were prepared based on extensive calculations, then demonstrated using three-dimensional computerized simulations. Final installation and wiring drawings were issued with instructions detailing the necessary adjustment and aiming requirements. Extensive onsite testing of the installed systems was performed for each venue by appropriate parties, including the DI's and CCTV (Central China Television), to confirm compliance with expected results, followed by final BOB acceptance. All systems further proved themselves through actual operation during the Good Luck Games, several weeks of test event sports competitions, which preceded the actual Olympic games.

Olympic Green Tennis Centre

Our experience in the case of the Olympic Green Tennis Centre project will serve as an example of a large Olympic venue sports lighting design. Listed below are four important design considerations, which will be discussed:

1. Provide enough illuminance to each camera.
2. Control the light on the foreground vs. background areas.
3. Control flicker.
4. Define the light mast height and position in order to keep the light quality uniform.

Background Information

The example case reviewed here is the Olympic Green Tennis Centre, located in the northwest section of the main Olympic Green area in Beijing. This complex includes six training courts, eight match courts and three HDTV (High Definition TV) broadcasting courts. The lighting must also support press photography, broadcast video for news in match courts, same as in TV courts. And though the lighting specifications varied considerably between the different types of courts, especially HDTV, consistency had to be maintained.

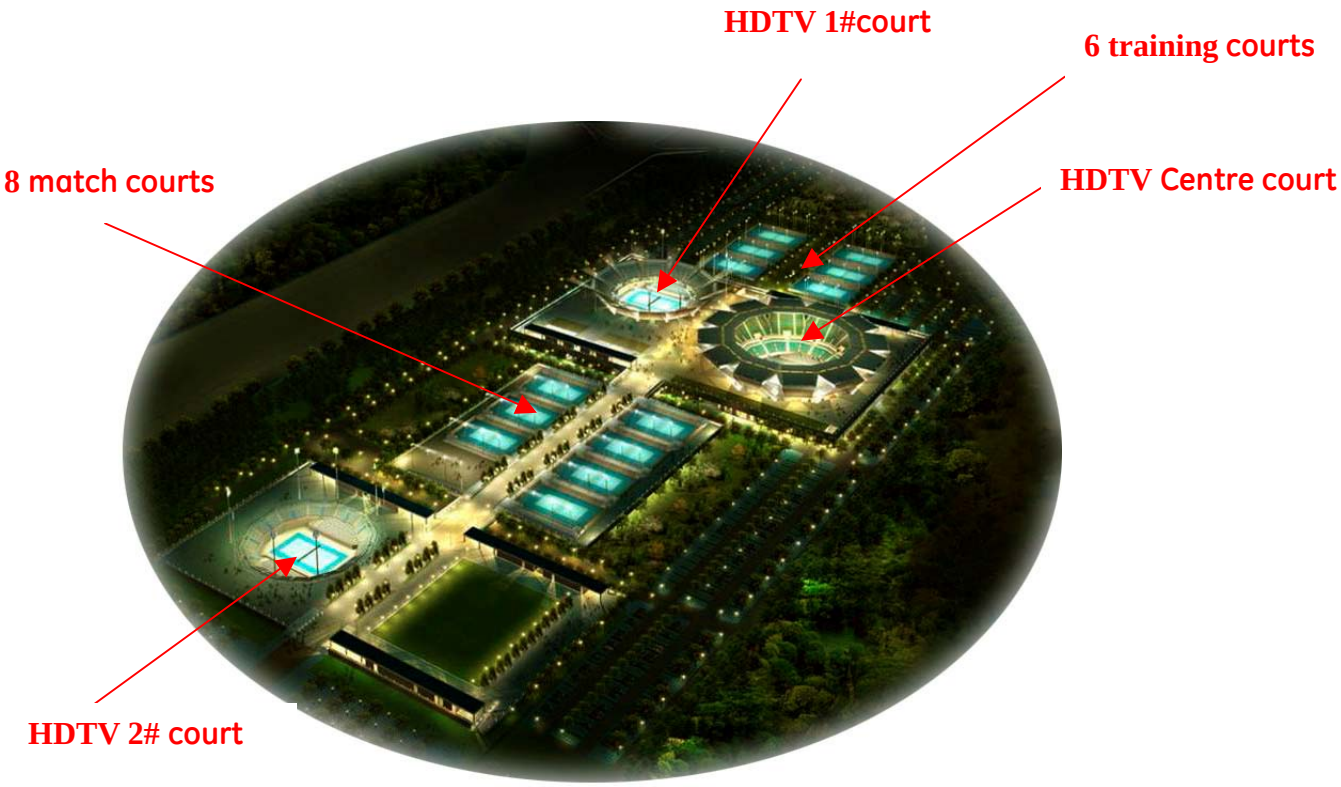


Fig. 1 Olympic Green Tennis Centre Complex

1. Provide enough illuminance to each camera

Today, many cameras are used on site for broadcasting, as shown in Fig. 2 below, to make sure every exciting moment is captured. Each of these cameras must get enough illuminance for proper picture quality, regardless of its location in the facility.

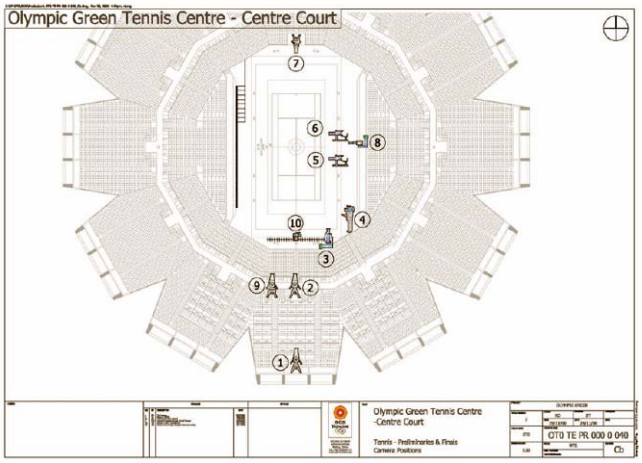


Fig. 2 Planned Camera Placement

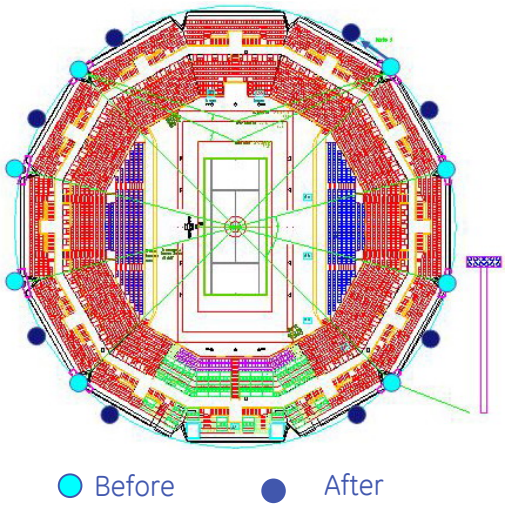


Fig. 3 Light Mast/Main Camera Placement

Study the camera layout drawing and define position for light masts

The original architectural design placed eight light masts around the building (Fig. 3) positioned in the notched outer corners of the multi-sided wall layout. But this plan was based on visual symmetry, not effective lighting impact. Considering the main camera, which is located behind the center base line, and the PPA (principal playing area) or FOP (field of play) area, which is not just the court inside the marked line, it is much bigger, enlarges to 20x40m, the light emitted from the original mast placement could not supply enough vertical illumination along the Y axis of the court. Following proper calculations and verification of results, the masts were moved to the correct positions as shown.

2 Control the light on the background

A proper ratio of illuminance between FOP and spectators must be maintained (Fig. 4) for effective broadcasting in order to focus attention on the athletic event. The ratio is 1.10:1 to 1.25:1. But a problem arises when the spectators are very near to the FOP. In such a case the ratio will be very high, without control.

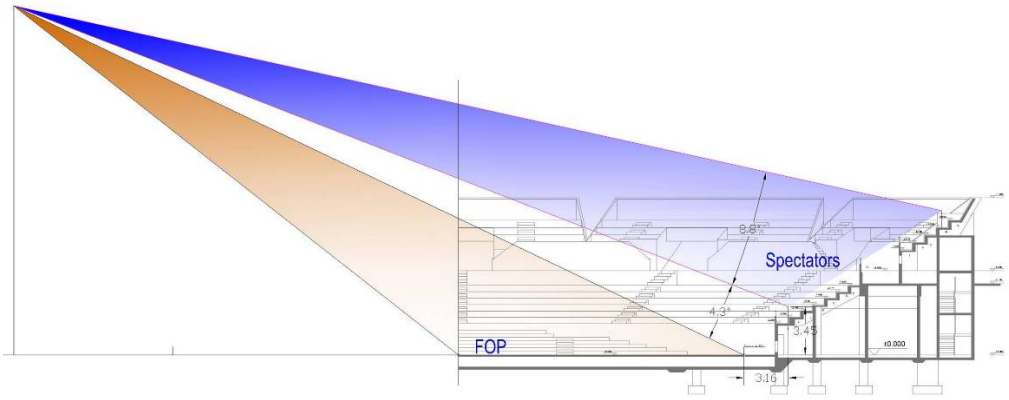


Fig. 4 FOP/Spectator Illumination Ratio For Broadcasting

The solution was found by using the best product, as shown in Fig. 5 below. These floodlights, designed with a visor for glare control and spare light control, were perfect to highlight the FOP and dark-out the background areas.

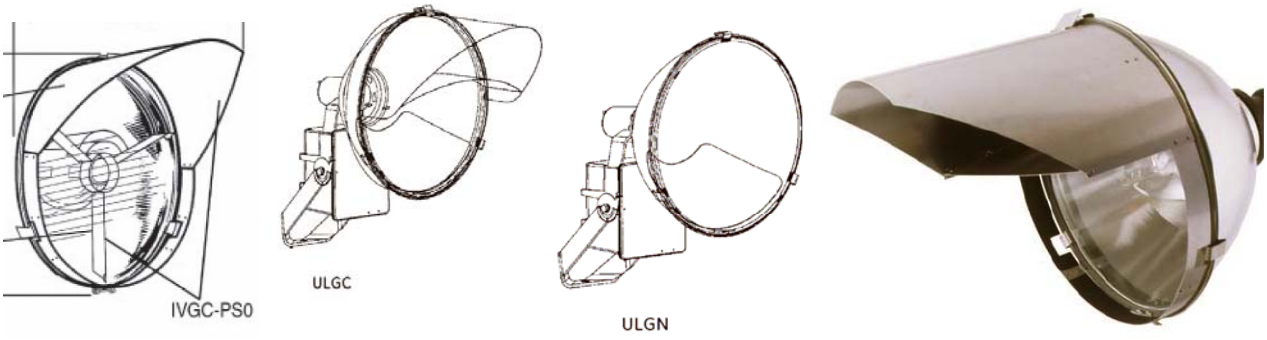


Fig. 5 GE Power Spot With Visor For Glare and Broadcast Ratio Control

3 Stop Flicker

3.1 What causes flicker?

Super slow motion (SSM) photography is commonly used today to capture critical sporting event moments. These cameras run at very high frame per second speeds. A particular problem for SSM cameras is flicker due to phasing of the light.

Gas discharge lamps should, preferably, be controlled by high frequency control gear operating at frequencies greater than that of the camera. Where luminaire control gear is not of the high frequency electronic type but operating directly on a single-phase power supply of, say 50Hz, and the SSM camera operation is 150Hz, three frames will be shot for

each cycle of the power wave. The light intensity for these three frames will vary bright-dark-bright, resulting in a light flicker (see Fig 6).

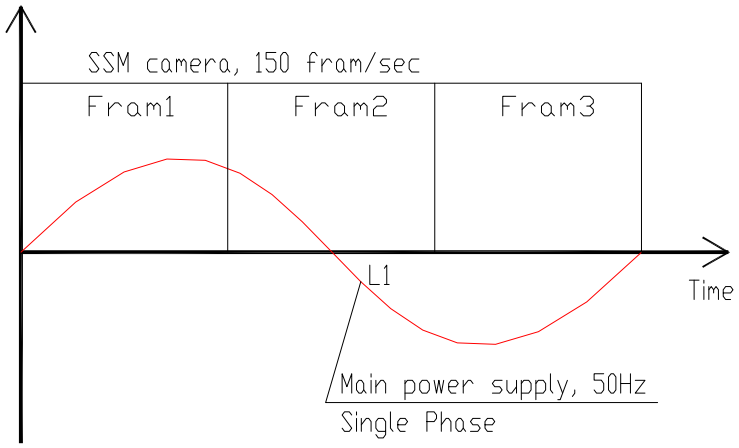


Fig.6 Power-SSM Camera Operation Cycle

For high-speed games, like tennis, SSM could cause the ball to disappear here and reappear suddenly in television images, as well as cause other annoying lighting effects.

3.2 How to control flicker

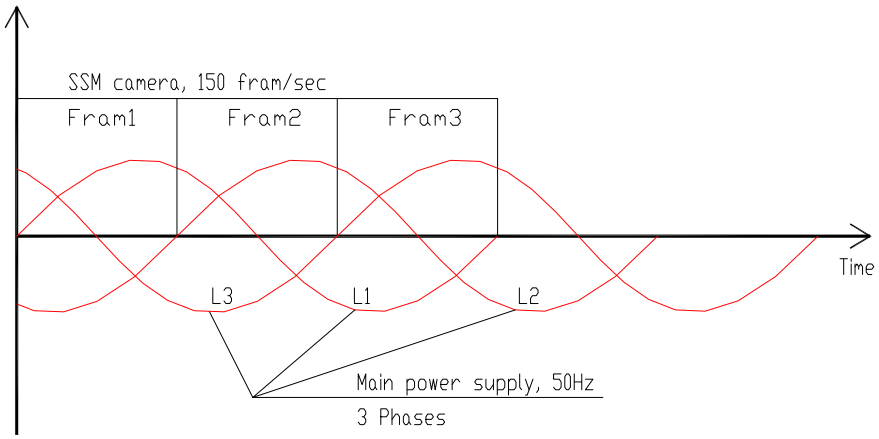


Fig. 7 Luminaires mixed and spread equally over three phases

In order to avoid the possibility of flicker, it was necessary to use all three phases to feed the lighting rather than just one. The three phases had to be spread and mixed equally throughout all the luminaires (this procedure is referred to as interlacing) so that the light

reaching any point on the FOP was supplied from all three phases. The lighting results were tested using SSM camera shots and confirmed to be flicker-free.

3.3 Solutions with Aiming and Phasing

3.3.1 Aiming

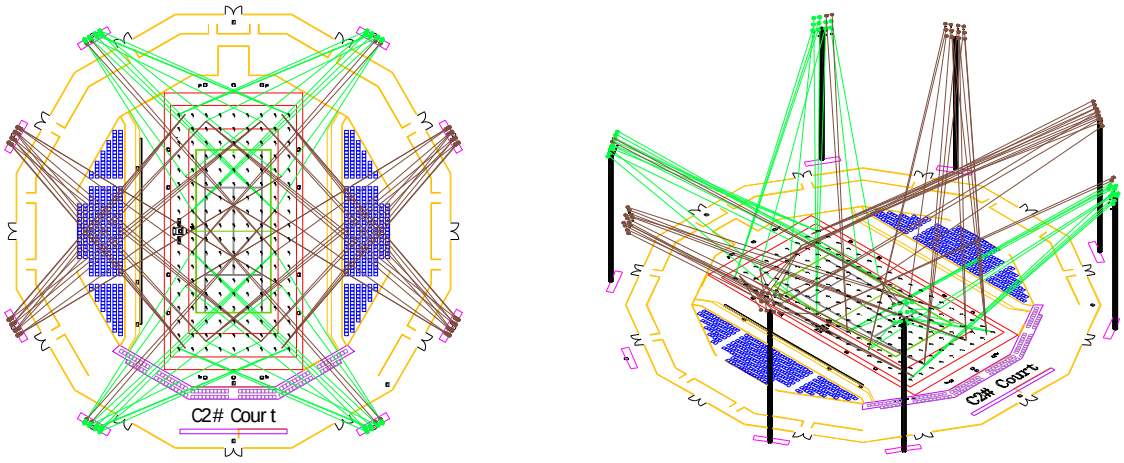


Fig. 8 Examples Of Positioning And Aiming Lighting

Lighting in each area must be aimed from different directions, and the aiming points of all luminaires optimized. With 100 fixtures around each HDTV court alone, this procedure can be challenging and requires skill and experience to achieve the required results.

3.3.2 Phasing

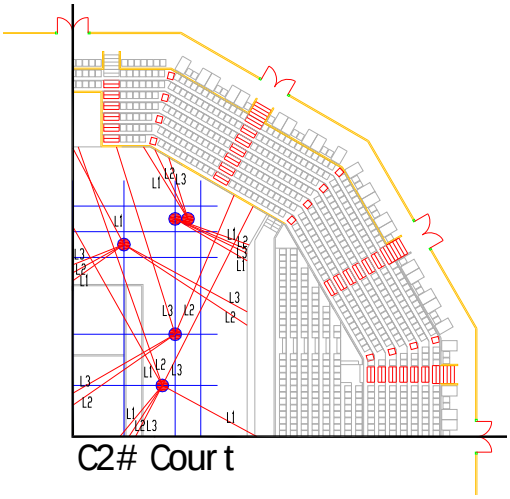


Fig. 9 Phase Distribution For Lighting

- L1, L2 and L3 are 3 phase distribution of main supply
- Each area covered with different direction luminaires were mixed and spread equally over three phases (for Horizontal illuminance)
- Light coming from a common direction was mixed and spread equally over three phases. (for Vertical illuminance, cameras)
- Circuit loading was balanced equally over all three phases

3.3.3 Wiring & Phasing drawings

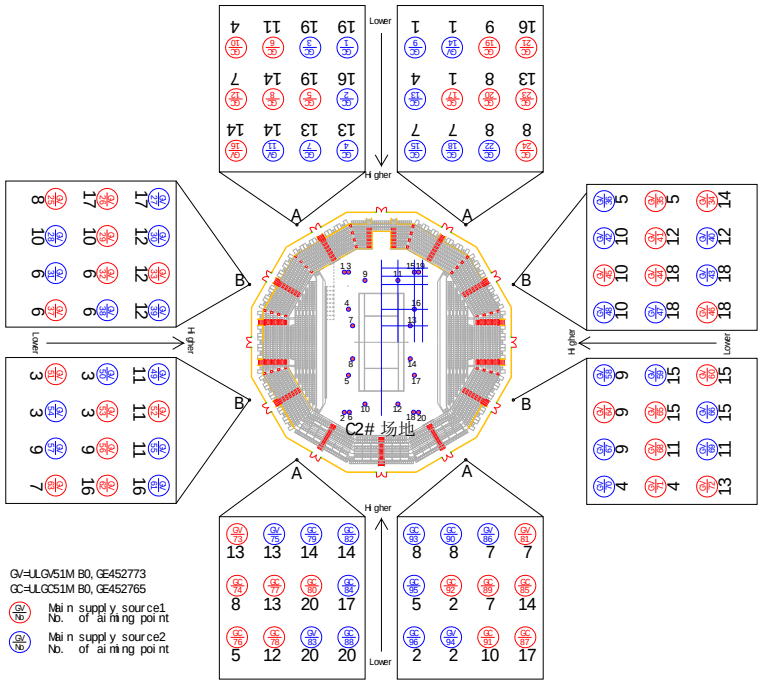


Fig. 10 Example Of Lamp Phasing Interlacing Drawing

Lighting Desing of Court C1, Tennis Centre, Beijing 2008

SeqNo	Luminaire	Mounting			Aiming Angle		Aiming Point			Main supply		Switching Modes				
		X	Y	Z	Orient	Tilt	X-Aimpt	Y-Aimpt	Z-Aimpt	Source	Phasing	HDTV	C-TV	Match1	Match2	Training
1	GE452765-uc33	-19.4	29.2	22.0	336.08	53.73	8.00	17.00	0	2	b	On	Off	Off	On	Off
2	GE452765-uc33	-19.2	28.9	23.3	321.26	56.35	8.00	7.00	0	2	a	On	On	On	On	Off
3	GE452765-uc33	-20.1	28.7	22.0	337.33	54.16	8.00	17.00	0	2	c	On	On	Off	Off	Off
4	GE452765-uc33	-19.1	28.6	24.5	316.58	56.70	8.00	3.00	0	2	c	On	Off	Off	Off	Off
5	GE452765-uc33	-20.0	28.6	23.3	337.56	52.48	8.00	17.00	0	1	a	On	On	On	Off	Off
6	GE452765-uc33	-21.0	28.3	22.0	333.84	54.31	6.50	14.75	0	1	c	On	Off	Off	Off	On
7	GE452765-uc33	-19.8	28.2	24.5	314.31	58.16	7.75	0.00	0	2	b	On	On	On	Off	Off
8	GE452765-uc33	-20.8	28.0	23.3	319.01	58.66	8.00	3.00	0	1	a	On	Off	Off	Off	Off
9	GE452765-uc33	19.4	29.2	22.0	203.92	53.73	-8.00	17.00	0	2	b	On	Off	Off	On	Off
10	GE452765-uc33	-21.6	27.9	22.0	308.94	44.62	-8.00	11.00	0	1	b	On	On	Off	Off	Off

Fig. 11 Example Of Lighting Set-up Detail

4. Maintain lighting consistency in all courts

The concept is to maintain a common lighting environment everywhere, including the training court, match courts, TV broadcasting courts. The result is a consistent appearance, style, and light quality, which provide uniformity between camera shots and an excellent environment for the athletes.

4.1 Light must come from the same direction

7 Match Courts:
4 poles located on one side, total 8

C1# Courts:
8 poles located on one circle

C2# Courts:
8 poles located on one circle

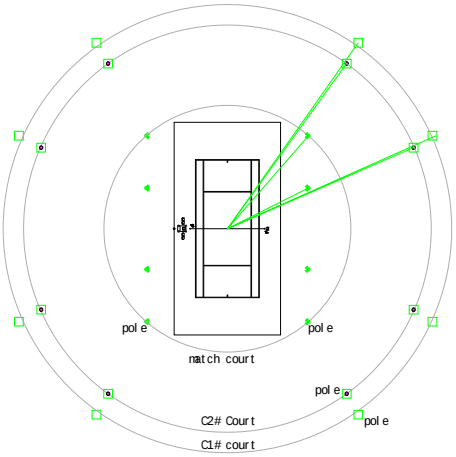
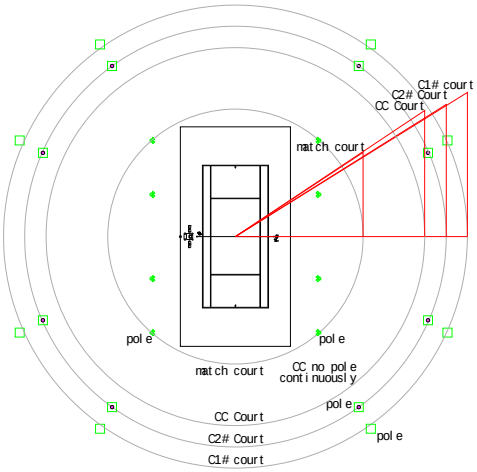


Fig. 12 Defined Masts position for each different Court

4.2 Light must come from the same aiming angle



Match Courts:
Minimum aiming angle: 41 degree
Maximum aiming angle: 59 degree

C2# Courts:
Minimum aiming angle: 40 degree
Maximum aiming angle: 63 degree

C1# Courts:
Minimum aiming angle: 40 degree
Maximum aiming angle: 64 degree

CC Courts:
Minimum aiming angle: 45 degree
Maximum aiming angle: 65 degree

Fig. 13 Defined Mast Height for each different Court

4.3 Light must have the same quality

Consistent lighting was used in all the courts, from training to match, and TV broadcasting courts. All fixtures and lamps were the same as shown in Fig. 14 below.

Fig. 14

UP: 1500w Lamp
Lumens125000, CRI=92, CCT=5500K

Left: Fixture, GE Power Spot ULGC 3x3

Conclusion

The ability to light an important event such as the Olympic Games, which includes many large facilities and spans great distances, is truly a combination of science and art. It requires an understanding of the needs for the field of play, as well as knowledge of all the technologies involved, and the tools and products necessary to meet the high expectations for success.

Appendix: Photographs Of The Tennis Centre Complex