Cours E314
Principe d'éclairagisme

ÉCOLE POLYTECHNIQUE MONTRÉAL

Module 9

Éclairage Sportifs

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Module 9:

Éclairage Sportifs

- Calculs, normes et recommandations

Éclairage Sportifs

Éclairage Sportifs

Quel sont les facteurs qui influences les recommandations des différent niveaux pour chaque sport?

Éclairage Sportifs

•Les vitesses de déplacements des individus et objets.
(balles , rondelles, ballons, …)

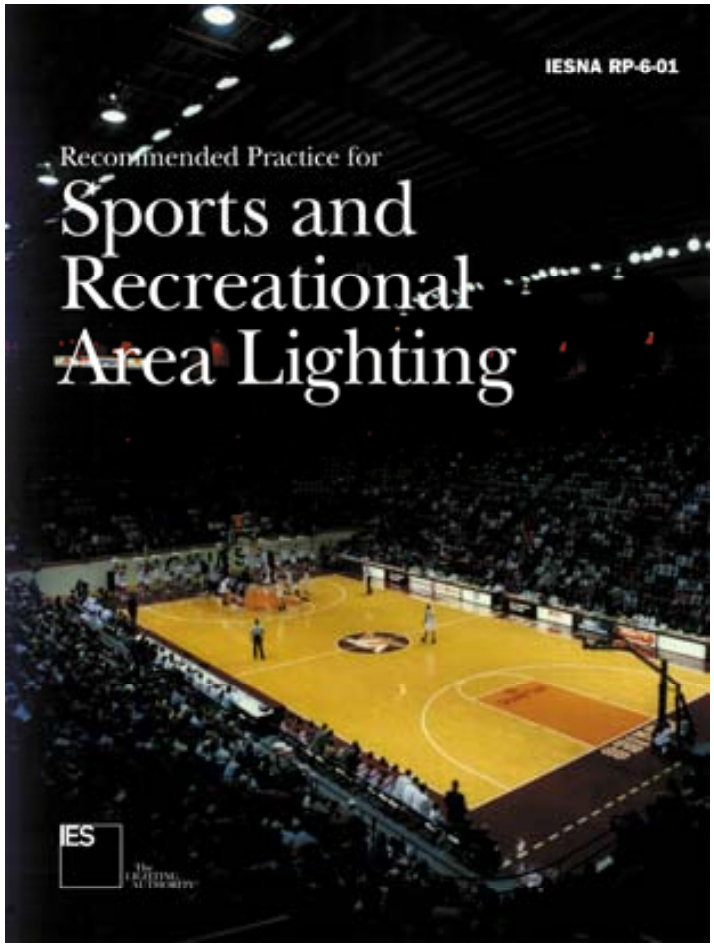
Les dimensions de terrains ou aire de jeux
(ex: une piste de course équestre ,l'arrivé sera plus éclairé tout comme l'avant champ au baseball)

Dimensions et couleurs des objets
(ex: Balle de crosse, rondelle de hockey, ballon de soccer ,de football, …)

•Les couleurs typiques des installations sportive. (ex: gazon, glace,…)

Éclairage Sportifs

L'important lorsque que l'on design un éclairage sportif, c'est le niveau bien sur , mais surtout l'uniformité. Les facteurs d'éblouissement et de débordement de la lumière sont aussi à être considérés.



Référez vous au RP6

Éclairage Sportifs

Coefficient de variation (CV)

Coefficient de variation (CV) est une mesure utilisée pour mesurer l'uniformité de l'éclairage de sport. CV est défini comme le ratio de l'écart type de toutes les valeurs à la moyenne des valeurs. S'il vous plaît voir IES RP-6-88 pour diverses recommandations sur les limites acceptables de CV.

Coefficient of Variation

Coefficient of Variation (CV) is a metric used to measure uniformity in sports lighting. CV is defined as the ratio of the standard deviation of all values to the mean (average) value. Please see IES RP-6-88 for various recommendations on acceptable limits of CV.

$$CV = \frac{\sigma}{\bar{X}}$$

$$\sigma = \sqrt{\frac{\sum (X_L - \bar{X})^2}{n}}$$

σ = Standard Deviation

X_L = Horizontal value at each point

$\bar{X}$ = Mean (average) of all points

n = Total number of points

Éclairage Sportifs

Uniformity Gradient (UG) Dégradé d'uniformité

Le dégradé d'uniformité(UG) est généralement utilisé pour mesurer l'uniformité de l'éclairage dans les sports, mais elle peut être utilisée pour mesurer le taux de variation calculés pour toute métrique. Ce système métrique mesure à quelle vitesse les valeurs tombe entre les points de mesures. Plus précisément, l'UG mesures du taux de variation des valeurs entre les points de mesure adjacents, d'un côté à l'autre, haut, bas ou en diagonale. Le taux de variation est pondéré par la distance entre les points (plus la distance, moins taux de variation). La valeur UG est exprimé en pourcentage des valeurs.

La valeur UG signalé indique le ratio le plus élevé ou le plus grand taux de variation.

UG représente le plus grand écart de valeurs entre deux points , pondéré par la distance.

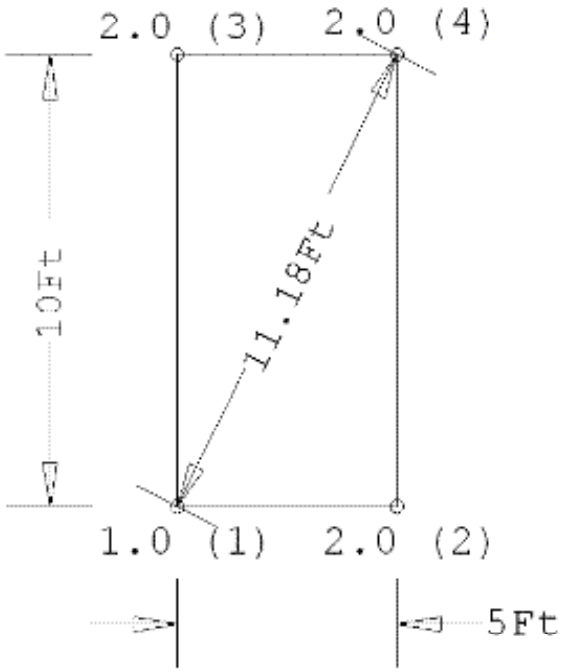
Éclairage Sportifs

Uniformity Gradient

Uniformity Gradient (UG) is typically used to measure uniformity in sports lighting applications, however it can be used to measure the rate of change for any calculated metric. This metric measures how fast the values falls off between measuring points. Specifically, the UG measures the rate of change of values between adjacent measuring points, side to side, up, down or diagonal. The rate of change is weighed by the distance between the points (the greater the distance, the less rate of change).The UG value is expressed as a ratio of values.

The reported UG value indicates the highest ratio or greatest rate of change.

Example:



UG représente le plus grand écart de valeur entre deux points , pondéré par la distance.

UG (Pt. 1 => Pt. 2) = 2/1 = 2.0 (reference distance; distance represent unit vector)

UG (Pt. 1 => Pt. 3) = 2/1* (5/10) = 1.0 (value weighed due to greater distance than Pt. 1 => Pt.2)

UG (Pt. 1 => Pt. 4) = 2/1* (5/11.18) = 0.89 (value weighed due to greater distance than Pt. 1 => Pt. 2)

Reported UG = 2.0

Please see IES RP-6-01 for various recommendations on acceptable limits of UG for sports lighting.

Éclairage Sportifs

Facility	Class			
	I	II	III	IV
International	X			
National	X			
Professional	X			
College	X	X		
Semi-professional	X	X		
Sports clubs	X	X	X	
Amateur leagues		X	X	X
High schools		X	X	X
Training facilities			X	X
Elementary schools				X
Receational events				X
Social events				X

Class I - Facilities with spectator capacity over 5000
Class II - Facilities for spectators of 5000 or less
Class III - No special provision for spectators
Class IV - Social and recreational

Éclairage Sportifs

Sports intérieurs

A. Indoor Applications*								
SPORT	Lighted Area	Class of Play	Horizontal		Vertical		Uniformity	
			Lx	Fc	Lx	Fc	CV	Max: Min
Basketball‡		I	1250	125			0.13 or Less	1.7:1 or Less
		II	800	80			0.21 or Less	2.5:1 or Less
		III	500	50			0.25 or Less	3:1 or Less
		IV	300	30			0.3 or Less	4:1 or Less
Curling	Hack to Hog†	I	1500	150			0.13 or Less	1.7:1 or Less
	Hog to Hog†		1000	100				
	Hack to Hog†	II	1000	100			0.21 or Less	2.5:1 or Less
	Hog to Hog†		800	80				
	Hack to Hog†	II & IV	500	50			0.25 or Less	3:1 or Less
	Hog to Hog†		300	30				
Gymnastics		II	800	80			0.21 or Less	2.5:1 or Less
		III	500	50			0.25 or Less	3.1 or Less
		IV	300	30			0.3 or Less	4:1 or Less
Ice Hockey and Figure Skating		I	2000	200			0.13 or Less	1.7:1 or Less
		II	1500	150			0.21 or Less	2.5:1 or Less
		III	1000	100			0.25 or Less	3:1 or Less
		IV	500	50			0.3 or Less	4:1 or Less
Ice Skating (Speed†)		III	300	30			0.25 or Less	3:1 or Less
		IV	200	20			0.3 or Less	4:1 or Less

Éclairage Sportifs

Sports intérieurs

A. Indoor Applications*

SPORT	Lighted Area	Class of Play	Horizontal		Vertical		Uniformity	
			Lx	Fc	Lx	Fc	CV	Max: Min
Indoor Soccer - Arena Football		I	2000	200			0.13 or Less	1.7:1 or Less
		II	1500	150			0.21 or Less	2.5:1 or Less
		III	1000	100			0.25 or Less	3:1 or Less
		IV	500	50			0.3 or Less	4:1 or Less
Swimming (Water Sports)	Luminances of the Pool Surface (Candelas per Square Meter)	I		35			0.13 or Less	1.7:1 or Less
		II		25			0.21 or Less	2.5:1 or Less
		III		15			0.25 or Less	3:1 or Less
		IV		15			0.3 or Less	4:1 or Less
	Illuminances on Pool Deck	I	750	75			0.13 or Less	1.7:1 or Less
		II	500	50			0.21 or Less	2.5:1 or Less
		III	300	30			0.25 or Less	3:1 or Less
		IV	300	30			0.3 or Less	4:1 or Less
Tennis		I	1500	150			0.13 or Less	1.7:1 or Less
		II	1000	100			0.21 or Less	2.5:1 or Less
		III	750	75			0.25 or Less	3:1 or Less
		IV	500	50			0.3 or Less	4:1 or Less
Volleyball		II	700	70			0.21 or Less	2.5:1 or Less
		III	500	50			0 25 or Less	3:1 or Less
		IV	300	30			0.30 or Less	4:1 or Less

Éclairage Sportifs

Sports extérieurs

B. Outdoor Applications

SPORT	Lighted Area	Class of Play	Horizontal		Vertical		Uniformity	
			Lx	Fc	Lx	Fc	CV	Max: Min
Baseball & Softball	Infield	I	1500	150			0.13 or Less	1.7:1 or Less
	Outfield		1000	100				
	Infield	II	1000	100			0.21 or Less	2.5:1 or Less
	Outfield		700	70				
	Infield	III	500	50			0.25 or Less	3:1 or Less
	Outfield		300	30				
	Infield	IV	300	30			0.3 or Less	4:1 or Less
	Outfield		200	20				
Basketball		III	300	30			0.25 or Less	3:1 or Less
		IV	200	20			0.3 or Less	4:1 or Less
Field Hockey		II	500	50			0.21 or Less	2.5:1 or Less
		III	300	30			0.25 or Less	3:1 or Less
		IV	200	20			0.3 or Less	4:1 or Less
Football*		I	1000	100			0.13 or Less	1.7:1 or Less
		II	500	50			0.21 or Less	2.5:1 or Less
		III	300	30			0.25 or Less	3:1 or Less
		IV	200	20			0.3 or Less	4:1 or Less
Ice/Roller Hockey*		II	500	50			0.21 or Less	2.5:1 or Less
		III	300	30			0.25 or Less	3:1 or Less
		IV	200	20			0.3 or Less	4:1 or Less
Ice Skating (Speed*)		III	300	30			0.25 or Less	3:1 or Less
		IV	200	20			0.3 or Less	4:1 or Less
Lacrosse		II	500	50			0.21 or Less	2.5:1 or Less
		III	300	30			0.25 or Less	3:1 or Less
		IV	200	20			0.3 or Less	4:1 or Less

Éclairage Sportifs

Sports extérieurs

B. Outdoor Applications

SPORT	Lighted Area	Class of Play	Horizontal		Vertical		Uniformity	
			Lx	Fc	Lx	Fc	CV	Max: Min
Soccer		II	1500	150			0.21 or Less	2.5:1 or Less
		III	1000	100			0.25 or Less	3:1 or Less
		IV	500	50			0.3 or Less	4:1 or Less
Swimming (Water Sports)	Luminances of the Pool Surface (Candelas per Square Meter)	II	25				0.21 or Less	2.5:1 or Less
		III	15				0.25 or Less	3:1 or Less
		IV	15				0.3 or Less	4:1 or Less
	Illuminances on Pool Deck	II	500	50			0.21 or Less	2.5:1 or Less
		III	300	30			0.25 or Less	3:1 or Less
		IV	300	30			0.3 or Less	4:1 or Less
Tennis		I	1500	150			0.13 or Less	1.7:1 or Less
		II	1000	100			0.21 or Less	2.5:1 or Less
		III	750	75			0.25 or Less	3:1 or Less
		IV	500	50			0.3 or Less	4:1 or Less
Track & Field		II	500	50			0.21 or Less	2.5:1 or Less
		III	300	30			0.25 or Less	3:1 or Less
		IV	200	20			0.3 or Less	4:1 or Less
Volleyball		III	300	30			0.25 or Less	3:1 or Less
		IV	200	20			0.3 or Less	4:1 or Less

Éclairage Sportifs

Sports extérieurs

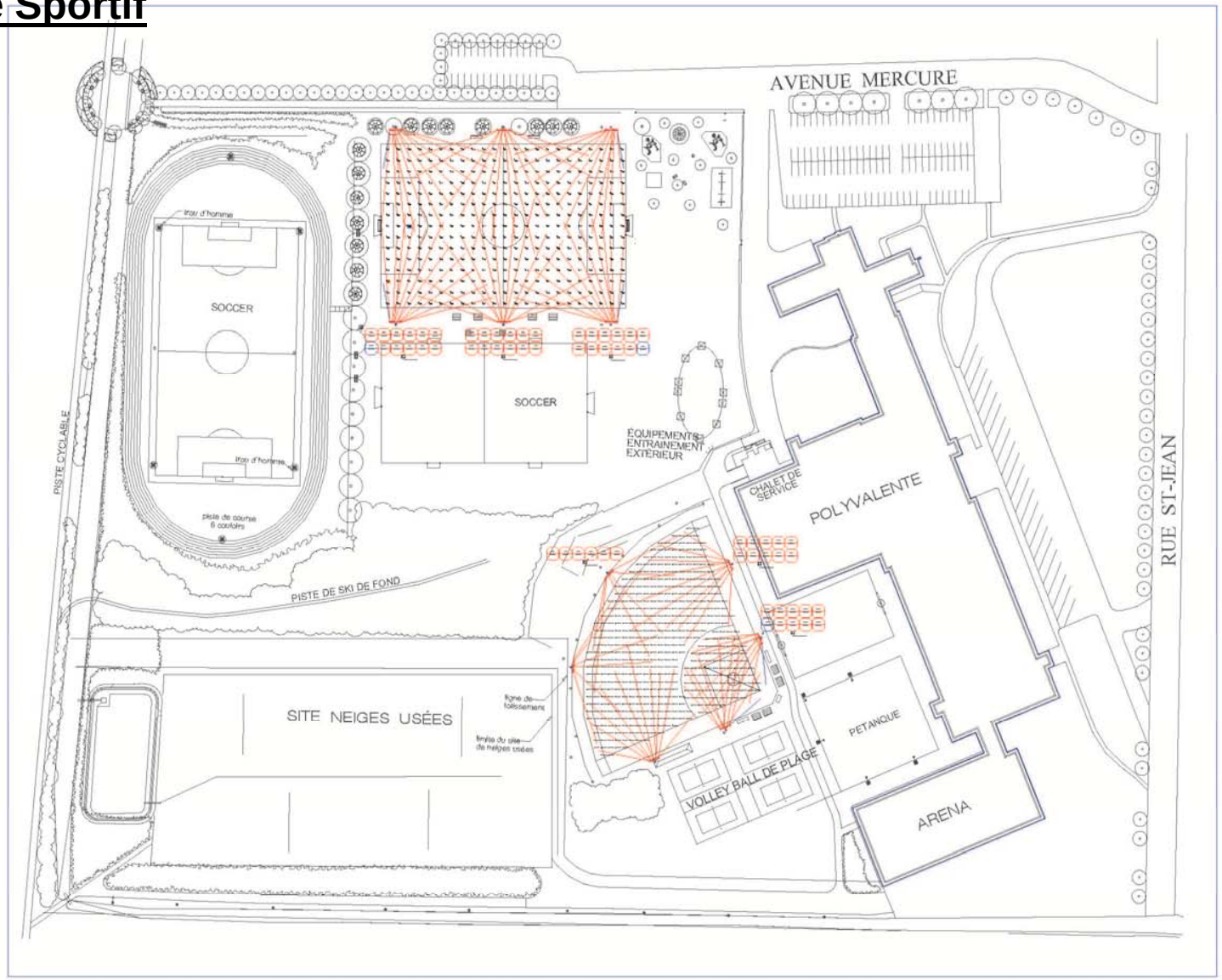
C. Specialty Sports				
Badminton	100	10	0.25 or Less	3:1 or Less
Bowling Green	50	5	0.25 or Less	3:1 or Less
Miniature Golf	100	10	0.25 or Less	3:1 or Less
Horseshoes				
(General Area)	50	5	0.3 or Less	4:1 or Less
Night Fishing				
(At Dock)	100	10	0.3 or Less	4:1 or Less

Figure 20-2. *Continued*

C. Specialty Sports								
SPORT	Lighted Area	Class of Play	Horizontal		Vertical		Uniformity	
			Lx	Fc	Lx	Fc	CV	Max: Min
Quoits								
(General Area)			50	5			0.25 or Less	3:1 or Less
Shuffle Board								
(General Area)			50	5			0.25 or Less	3:1 or Less
Skating Pond								
(General Area)			10	1			0.3 or Less	4:1 or Less
Washer Pitching			50	5			0.3 or Less	4:1 or Less

* Readings taken at grade. All other readings taken at 36″.

Éclairage Sportif



Luminaire à 56' et 60'

Luminaire Schedule								
Symbol	Qty	Label	Description	Lumens/Lamp	Total Lamp Lumens	Lum. Watts	LLF	Filename
	118	RSL JSL M1000 Type III	JSL RSL SP50 AR3M1000D	110000	110000	1080	0.720	RSL JSL M1000 Type III.ies
	6	RSL JSL M1000 Type V	RSL JSL SP50AR45M1000B	110000	110000	1080	0.720	RSL JSL M1000 Type V.ies

Calculation Summary									
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min	CV	UG
Baseball infield	Illuminance	Lux	556.17	725	374	1.49	1.94	0.12	1.45
Baseball outfield	Illuminance	Lux	294.85	440	202	1.46	2.18	0.18	1.87
Soccer	Illuminance	Lux	332.97	409	241	1.38	1.70	0.10	1.40

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Project name : Demo Sport

Prepared for:

Filename: Sport.AGI

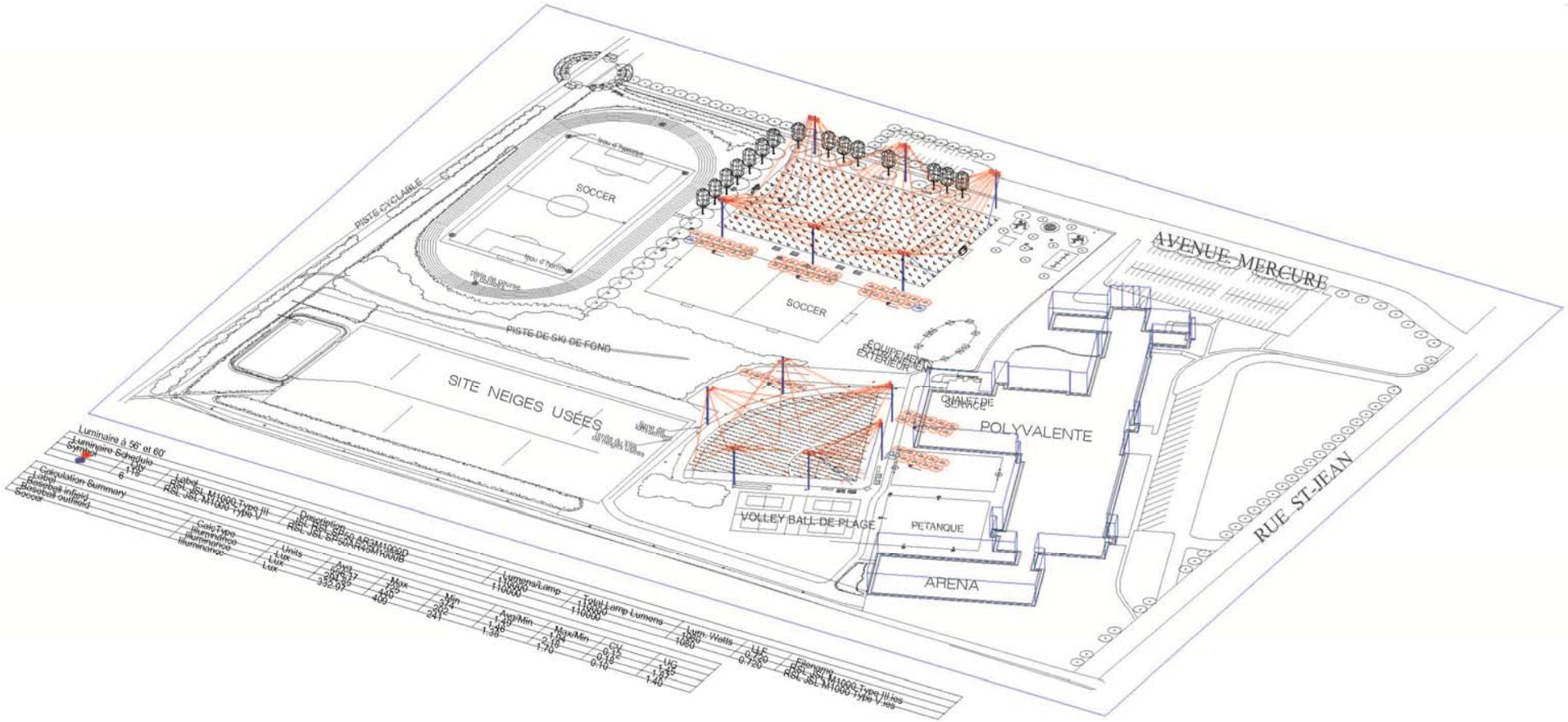
By : Peer Eric Moldvar **Units: Feet/Inches**

Date:7/7/2010

AGi32 Version 2.14 Rev. 4

Total Time (Hrs.): 5.2

Éclairage Sportif



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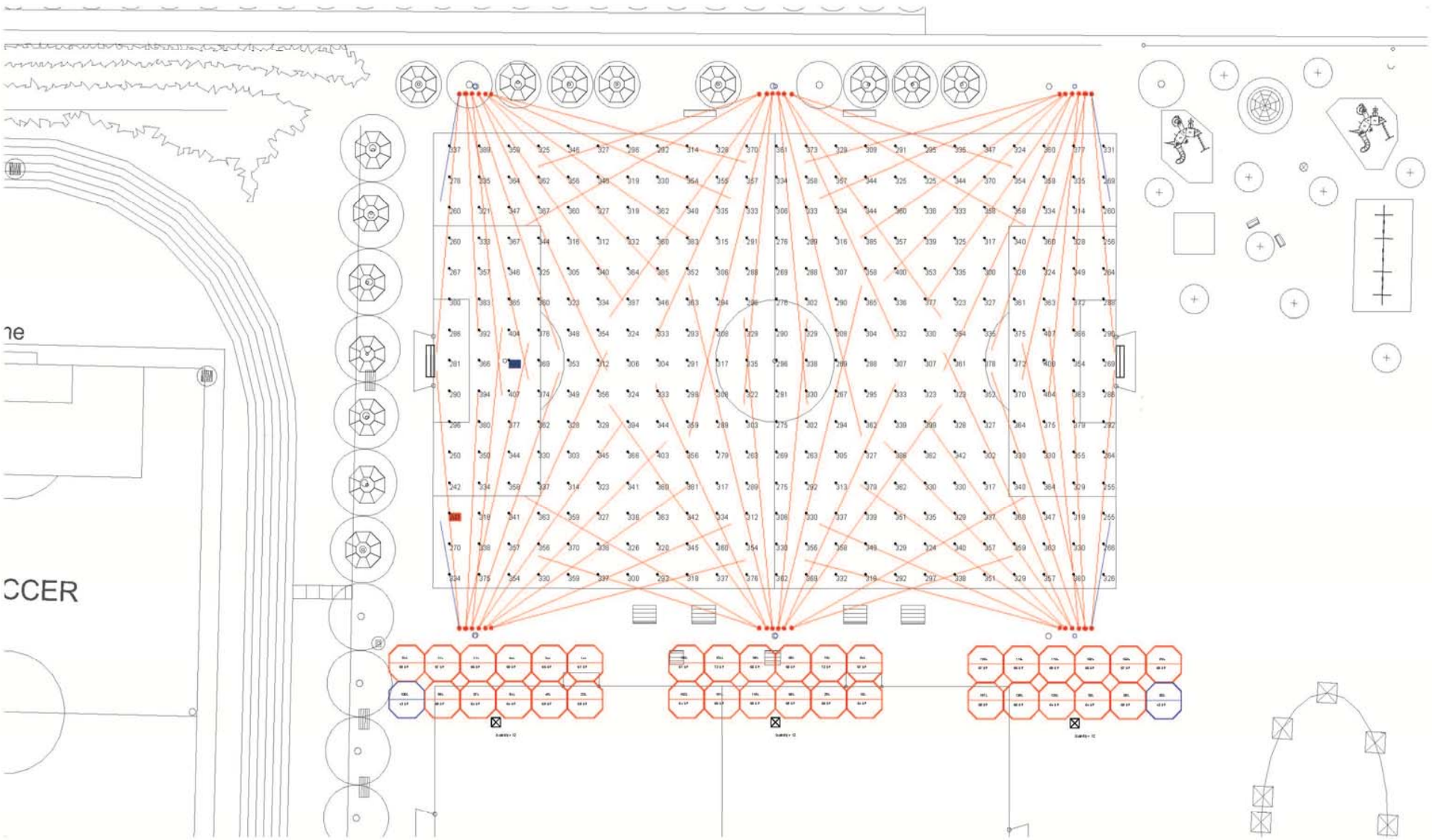

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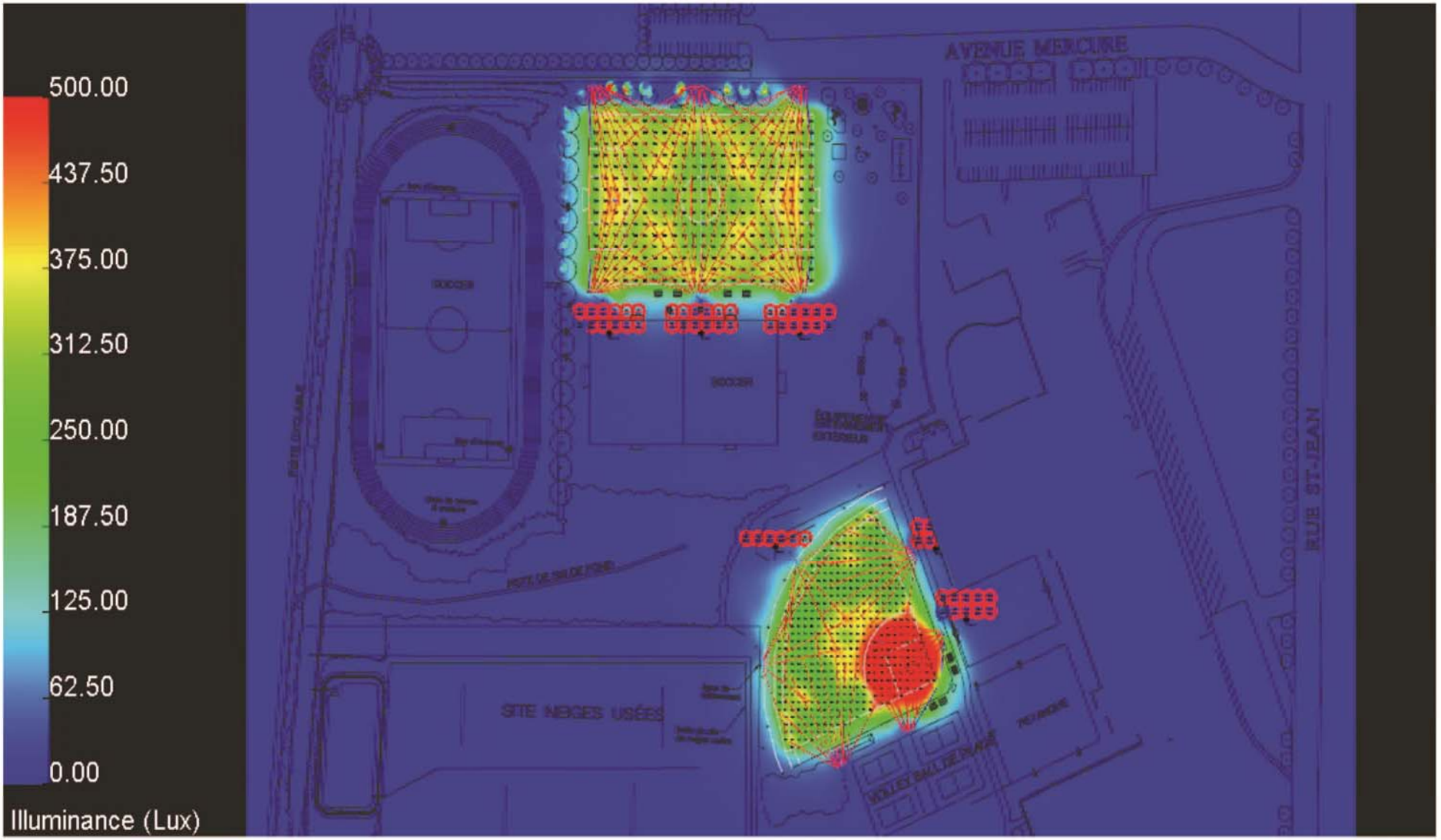

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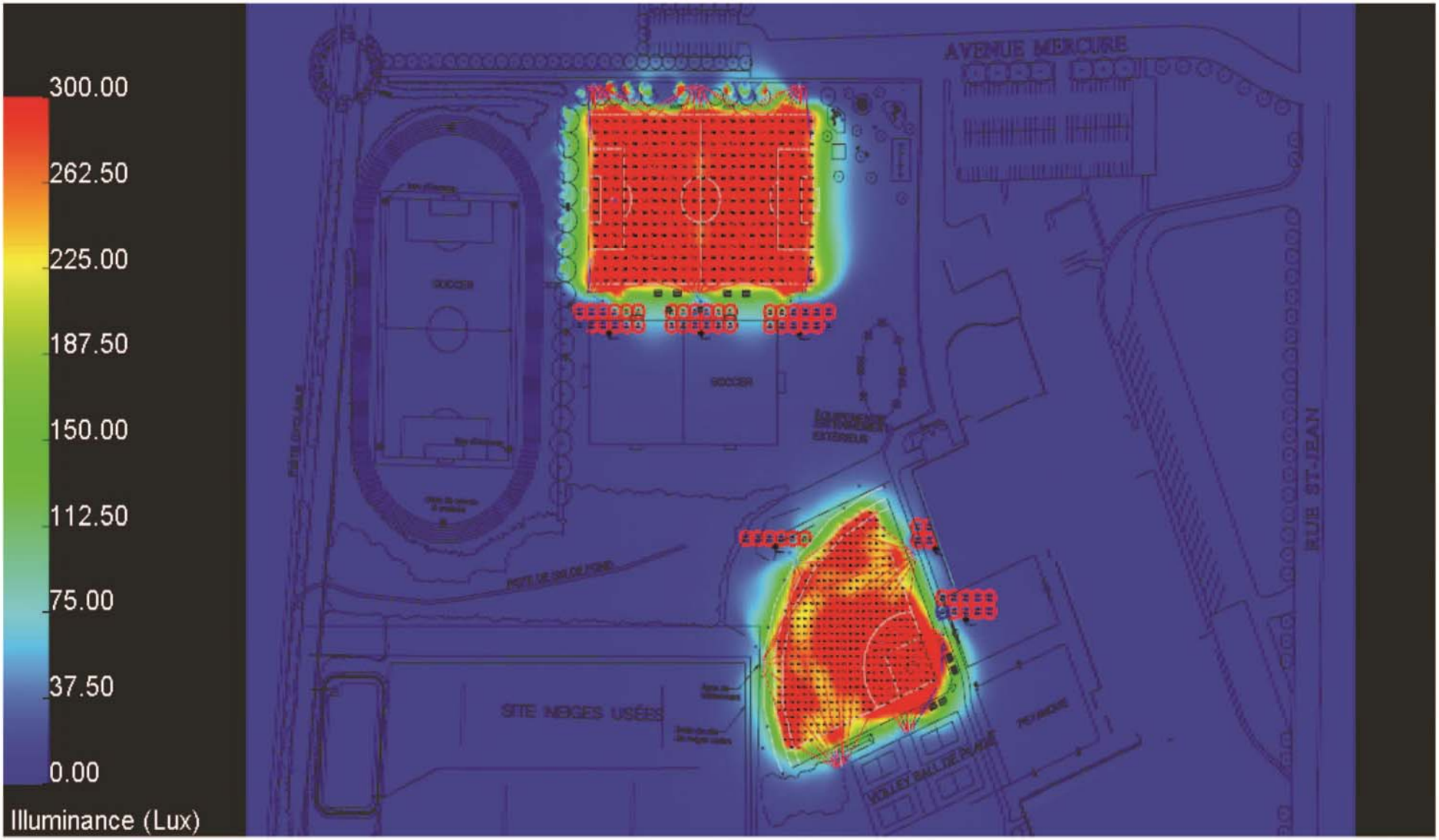

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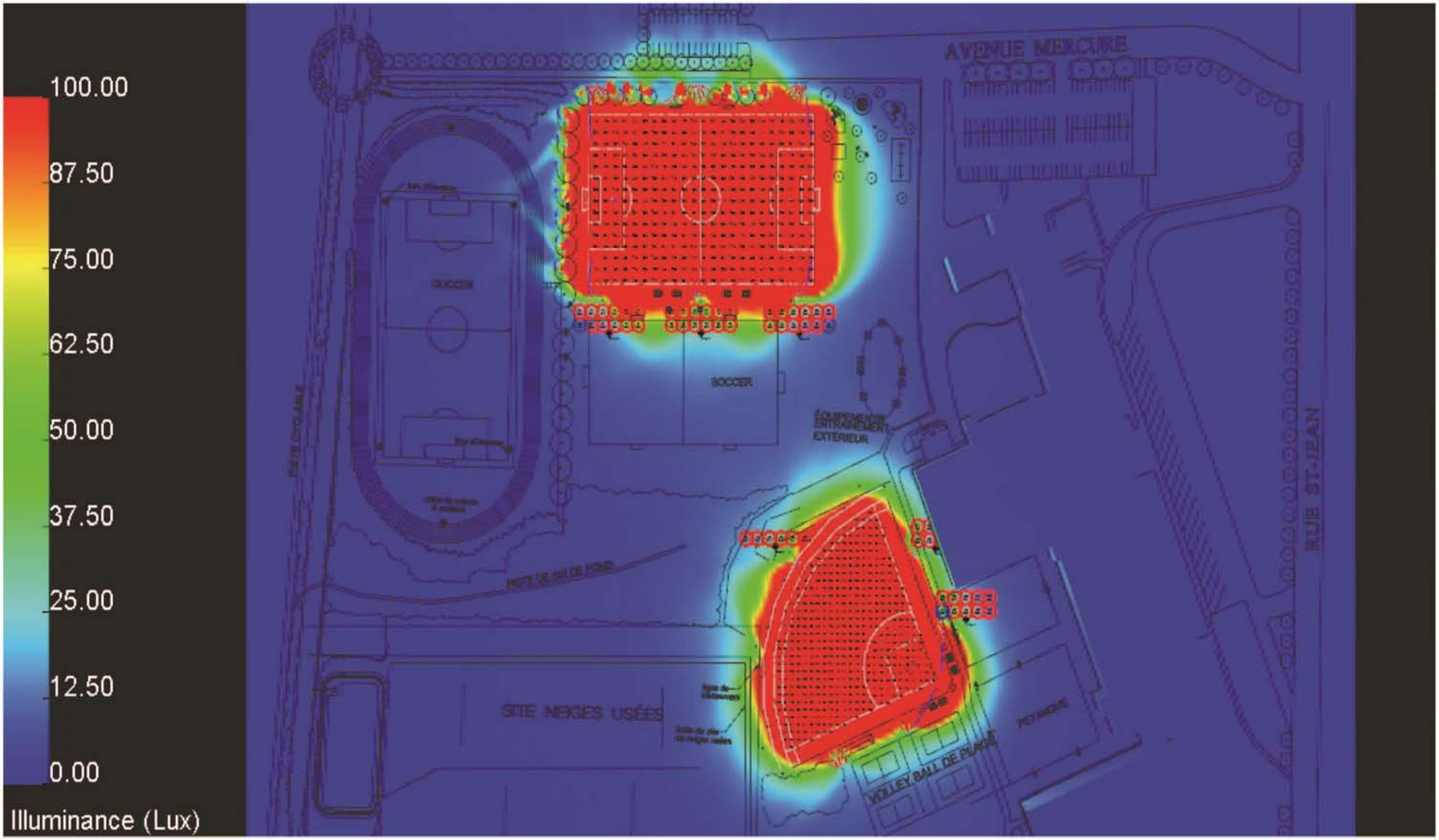

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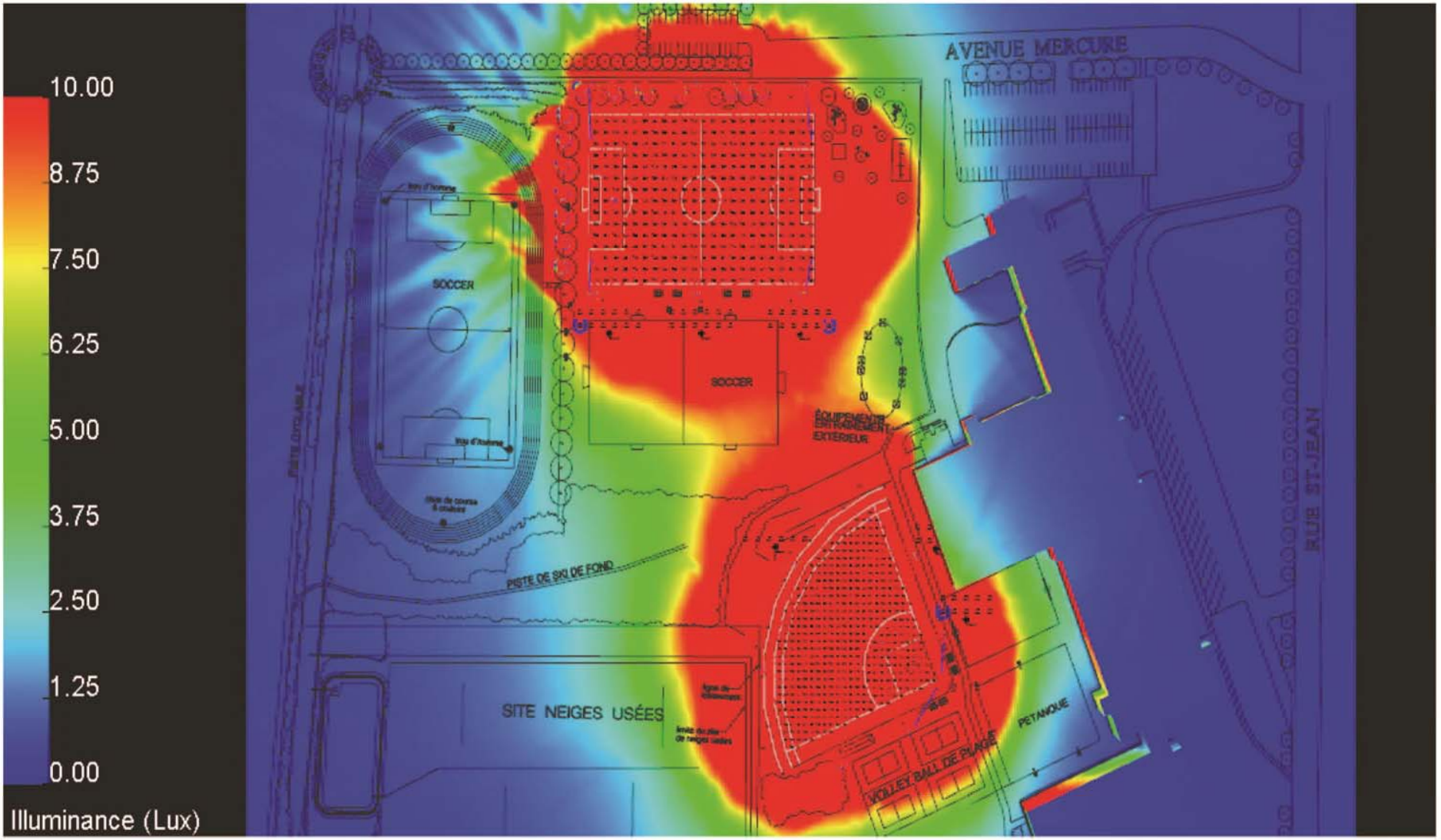

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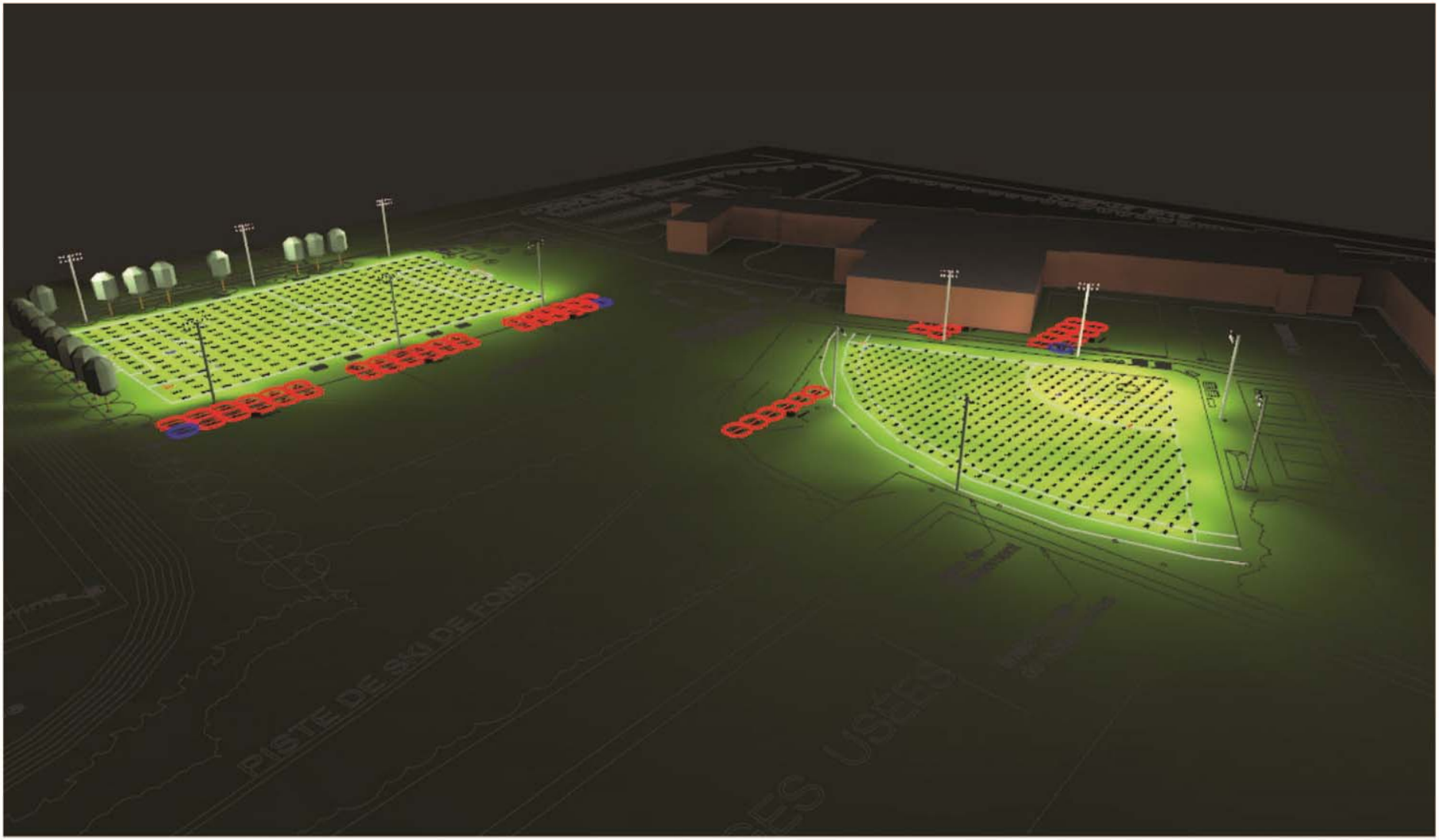

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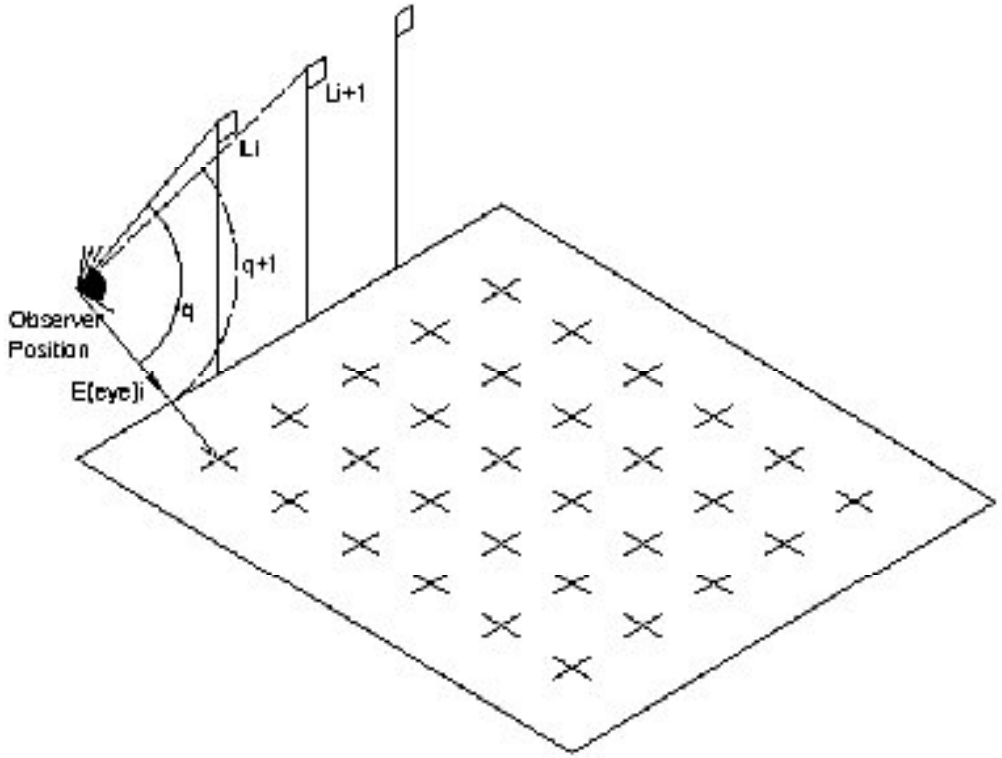
Éblouissement

Glare Rating (éclairage sportif)

(Glare Rating) indique l'évaluation de l'éblouissement dans les sports de plein air. Le GR est basé sur la luminance de voile produite par les luminaires et de l'environnement sur l'œil d'un observateur. Elle est mesurée par l'observateur qui regarde à chaque point d'une grille d'éclairement horizontal. Une petite valeur de (GR) indique un risque moins élevé de l'éblouissement. GR est limitée à des directions au dessous du niveau des yeux.



Pour une analyse complète il faut faire des calculs de plusieurs point de vues ce qui rend la chose complexe.

Éblouissement

Glare Rating (éclairage sportif)

Glare Rating Equations

$$GR = 24 + 27 \lg (L_{VL} / L_{VE}^{0.9})$$

Veiling Luminance Equations considering luminaires and environment

L_{VL} = Veiling luminance on the eye produced by the luminaires for one point.

i = the current luminaire being considered.

n = total number of luminaires in the job file.

$E_{(eye),\,i}$ = the illuminance produced on the observer's eye in a plane perpendicular to the line of sight, produced by the ith source, in lux.

q_i = the angle between the observer's line of sight and the direction of light.

$$L_{VL} = 10 \sum_{i=1}^{n} \frac{E_{(eye)_i}}{(q_i)^2}$$

$$L_{VE} = 0.035 * \left[\frac{E_{hor,av} * \rho}{(\pi * \Omega_0)} \right]$$

L_{VE} = Veiling luminance on the observer's eye produced by the environment.

$E_{hor,av}$ = Average horizontal area illuminance (ground plane).

ρ = the reflectance of the area assuming diffuse reflection.

Ω_0 = the unity solid angle in steradians.

Éblouissement

Glare Rating (éclairage sportif)

When glare rating was first experimented with by CIE researchers, a glare control mark GF was used that relates to the Glare Assessment scale shown below. As the GF marker increases in value, the better glare restriction that is provided by the installation. The glare assessment scale provides meaningful visual information regarding the differences in glare rating values.

Glare rating GR is related to GF by this equation:

$$GR = (10 - GF) * 10$$

Glare Control Mark GF		Glare Rating GR
1	Unbearable	90
2		80
3	Disturbing	70
4		60
5	Just Admissible	50
6		40
7	Noticeable	30
8		20
9	Unnoticeable	10

A variation of +/- 0.5 in Glare Rating is equivalent to an experimental accuracy ratio of +/- 5% in the Luminance ratio.

Éblouissement

Glare Rating (éclairage sportif)

Recommended Glare Rating Limits

To ensure that glare is not excessive in any normal viewing direction at any normally accessible point on the illuminated area, the maximum value of GR should always be less than the recommended value of GRmax.

Area Lighting Applications

Type of Application		GR_{Max}
Safety & Security	Low Risk	55
	Medium Risk	50
	High Risk	45
Movement & Safety	Pedestrians Only	55
	Slow Moving Traffic	50
	Normal Traffic	45
Work*	Very Rough	55
	Rough-Medium	50
	Fine	45

(*) In a work area where viewing tasks are of decisive importance, it is advisable to have a maximum glare rating value five units lower than the specified GRmax.

Éblouissement

Glare Rating (éclairage sportif)

Sports Lighting Applications

Type of Application	GR_{Max}
Lighting for Training Purposes	55
Lighting for Competition Purposes	50

Éclairage Sportifs

Travaux sur OSP (Outdoor Site Performance).
Analyse des débordement de la lumière

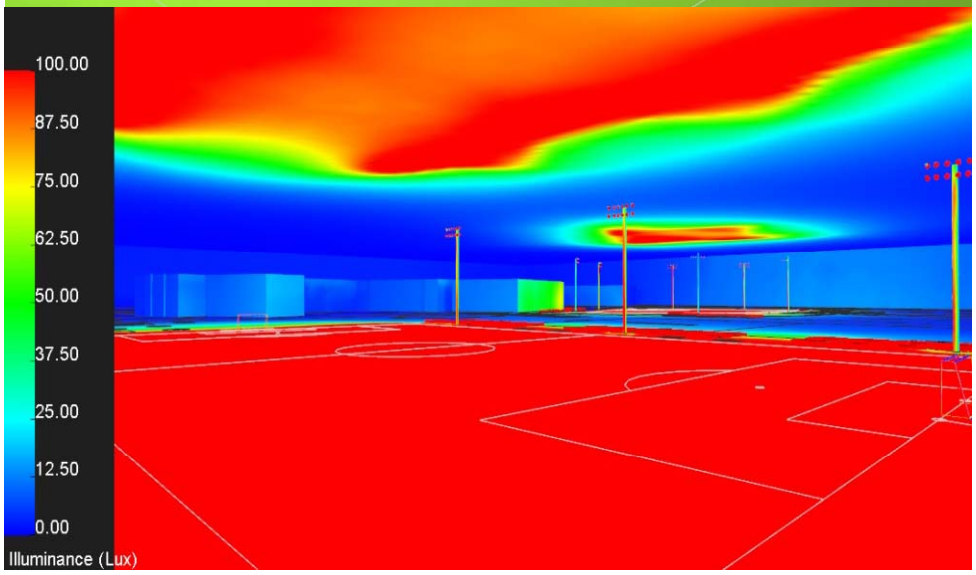
À partir d'une boite noir autour d'un site, il est possible d'analyser les débordements de la lumière et en faire les correctif

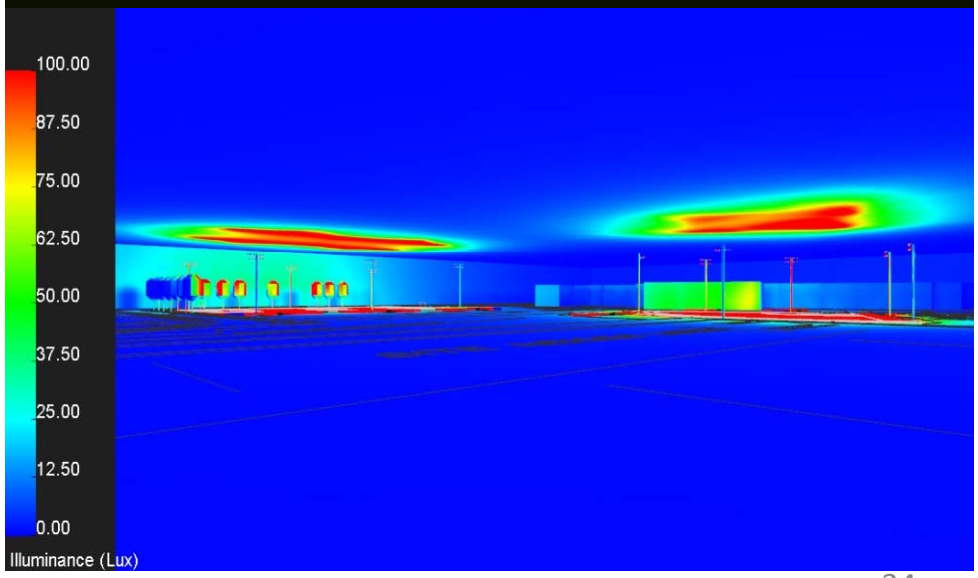
(«OSP») est une technique de calcul conçue pour aider les designer d'éclairage de limité la lumière laissant le site de leur client, tout en offrant la souplesse nécessaire pour répondre à l'éclairage de leurs clients . OSP permettra au prescripteur et à la communauté de comparer les performances du système d'éclairage par rapport aux autres, à l'instar des sites. OSP utilise un calcul hypothétique «boîte» autour d'une installation d'éclairage extérieur afin de prévoir la lumière qui quitte le site.

Lighting Research Center, Rensselaer Polytechnic Institute Troy, New York, USA .

Éclairage Sportifs

Travaux sur OSP (Outdoor Site Performance).
Analyse des débordement de la lumière





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