LIGHTING CALCULATION REPORT

Tutorial 2 - Warehouse high bay

Warehouse

COMPLIANT WITH OBSERVATIONS

11 of 11 assessed criteria met | 0 not met | 1 with a thin margin | 0 not assessed

MAINTAINED ILLUMINANCE	UNIFORMITY UO	WORST-CASE UGR	POWER DENSITY
250 lx	**0.852**	**20.7**	**2.50 W/m2**
task area average	Emin / Eavg	CIE 117	15 luminaires

Client	**Lumina walkthrough**
Designer	**Lumina**
Project reference	**TUT-02**
Space type	**Warehouse - Storage racks, continuously occupied**
Standard	**EN 12464-1 - Light and lighting: Lighting of work places, Part 1: Indoor work places**
Location	**Chicago**
Revision	**1**
Engine	**Lumina photometric engine 1.0.0**

1. Design inputs

Space

Dimensions	**30.00 x 20.00 x 9.00 m**	length x width x height
Floor area	**600.00 m2**	volume 5 400.0 m3
Working plane	**0.00 m**	above finished floor
Boundary band excluded	**0.50 m**	task area = room less this band
Reflectances	**50 / 30 / 20 %**	ceiling / walls / floor
Area-weighted mean	**32.9 %**	all six surfaces
Maintenance factor	**0.70**	applied to initial values
Observer eye height	**1.20 m**	for glare and cylindrical illuminance

Calculation grid

Grid	**14 x 10 points**	en12464
Spacing	**2.143 x 2.000 m**	EN 12464-1 maximum 2.155 m

2. Method

Illuminance is computed in two physically separate parts. The direct component is evaluated point by point from each luminaire's measured intensity distribution, combining the inverse square law and the cosine law as E = I(gamma, C) x cos(theta) / r^2 and summing over every luminaire, so overlapping beams add exactly. The interreflected component comes from a radiosity solution of the room enclosure using closed-form configuration factors, which converges on the analytic energy balance rather than relying on a tabulated coefficient of utilisation.

Maintained values are initial values multiplied by the maintenance factor. Standards state their illuminance requirements as maintained values, so compliance is assessed against the maintained figures on the task area only.

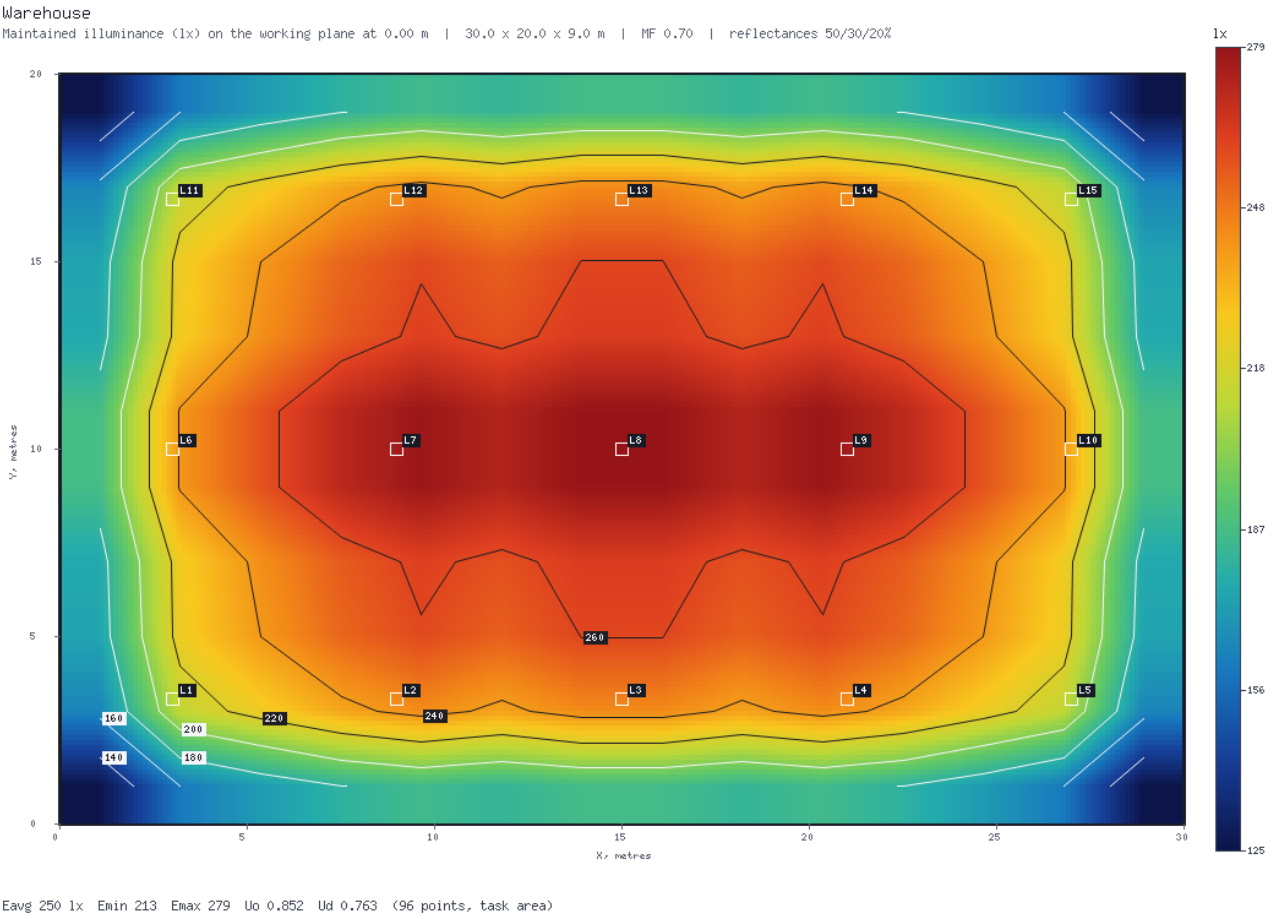
Lumen method cross-check

The lumen method average is derived independently, by integrating each distribution over solid angle and tracing the flux to the surface it lands on. Because it shares no numerical machinery with the point-by-point grid, agreement between the two is a real check on the solution rather than a restatement of it.

Utilance	**0.8530**	direct 0.7825 + interreflected 0.0705
CU vs lamp lumens	**not applicable**	LOR absolute photometry
Room cavity ratio	**3.542**	room index K = 1.412
Effective reflectances	**0.465 ceiling / 0.200 floor cavity**	IES zonal cavity
Lumen method Eavg	**224.0 lx**	grid average 225.2 lx
Agreement	**0.53 %**	between independent routes

Numerical quality: 72 enclosure patches, interreflection converged in 8 iterations to a residual of 2.2e-7. Flux accounting closes to 100.55% on direct incidence and 100.55% on absorption, where 100% is exact energy conservation.

3. Results



Maintained illuminance on the working plane with iso-illuminance contours.

Illuminance summary

Area	Points	Emin lx	Eavg lx	Emax lx	Uo	Ud
Task area (compliance basis)	96	213	**250**	279	0.852	0.763
Whole room	140	125	225	279	0.557	0.450
Direct component only	96	194	232	261	0.836	0.742
Interreflected component only	140	17	19	21	0.922	0.816

Room surfaces

Surface	Area m2	Reflect.	Edir lx	Eind lx	Etotal lx	L cd/m2
Ceiling	600.0	50 %	0	32	32	5.1
Floor	600.0	20 %	207	19	225	14.4
Wall X = 0	180.0	30 %	38	26	64	6.1
Wall X = max	180.0	30 %	38	26	64	6.1
Wall Y = 0	270.0	30 %	38	27	64	6.2
Wall Y = max	270.0	30 %	38	27	64	6.2

Vertical and cylindrical illuminance at 1.20 m

Quantity	Min lx	Mean lx	Max lx	Uo
Cylindrical Ez	48	**67**	82	0.717
Vertical Ev, plane facing +X	27	67	97	0.399
Vertical Ev, plane facing -X	27	67	97	0.399
Vertical Ev, plane facing +Y	26	65	99	0.404
Vertical Ev, plane facing -Y	26	65	99	0.404

Glare

Worst-case UGR	**20.69**	looking +X
Observer position	**1.20, 10.00, 1.20 m**	x, y, eye height
Background luminance	**9.9 cd/m2**	from the interreflected component
Positions assessed	**24**	positions x four viewing directions

4. Standards compliance

Standard	**EN 12464-1 - Light and lighting: Lighting of work places, Part 1: Indoor work places**	
Space type	**Warehouse - Storage racks, continuously occupied**	
Required Em	**200 lx**	Uo >= 0.60, UGR <= 22, Ra >= 60

Criterion	Actual	Required	Unit	Margin	Verdict
Maintained illuminance on the task area	249.74	>= 200	lx	49.74	PASS
Overall uniformity Uo (Emin/Eavg) on the task area	0.852	>= 0.6		0.252	PASS
Diversity Ud (Emin/Emax) on the task area	0.763	>= 0.2		0.563	PASS
Unified glare rating UGR (worst observer position)	20.69	<= 22		1.31	PASS
Mean cylindrical illuminance at 1.2 m	66.57	>= 50	lx	16.57	PASS
Immediate surrounding area maintained illuminance	225.16	>= 150	lx	75.16	PASS
Mean maintained illuminance on the walls	64.2	>= 50	lx	14.2	PASS
Mean maintained illuminance on the ceiling	32.1	>= 30	lx	2.1	PASS
Colour rendering index Ra of the specified luminaires	80	>= 60		20	PASS
Calculation grid spacing	2.143	<= 2.155	m	0.012	MARGIN
Lighting power density	2.5	<= 3.03	W/m2	0.53	PASS

Thin margin - Calculation grid spacing: A grid coarser than the maximum can miss the true minimum. Margin is under 2%: small changes on site could push this out of compliance.

Criteria are reproduced for design guidance. Confirm the governing values against the purchased standard and any local amendments before issuing a design.

7. Energy, carbon and whole-life cost

Installed load	**1 500.0 W**	15 luminaires
Power density	**2.500 W/m2**	installed efficacy 150.0 lm/W
Annual energy	**6 917 kWh**	11.5 kWh/m2
Without controls	**7 905 kWh**	saving 12.5 %
Full-load equivalent	**4 611 h/yr**	mean output level 0.473

Annual cost	**$864.57**	at 0.125 per kWh, flat
Annual carbon	**2 559 kg CO2e**	at 0.370 kg/kWh

Control zones

Zone	Circuit	Strategy	Target	Min output	Occupancy
Aisle occupancy	C1	occupancy	200 lx	10 %	55 %

Power density against allowance

Design	**2.500 W/m2**	
Allowance	**3.030 W/m2**	within by 17.5 %

Compared against the lighting power density allowance for the space type. Control credits, where a code permits them, are not applied automatically.

Whole-life cost, 20 year study

Cost element	Present value	Share
Capital and installation	$2,595.00	14.1 %
Energy	$12,679.27	68.8 %
Replacements	$2,776.69	15.1 %
Cleaning	$373.87	2.0 %
Total present value	**$18,424.82**	**100 %**

Discount rate	**5.0 %**	energy escalation 2.0 %
Equivalent annual cost	**$1,478.46**	annualised over the study period
Burning hours	**8 760 h/yr**	drives replacement timing

All luminaires carry a unit price.

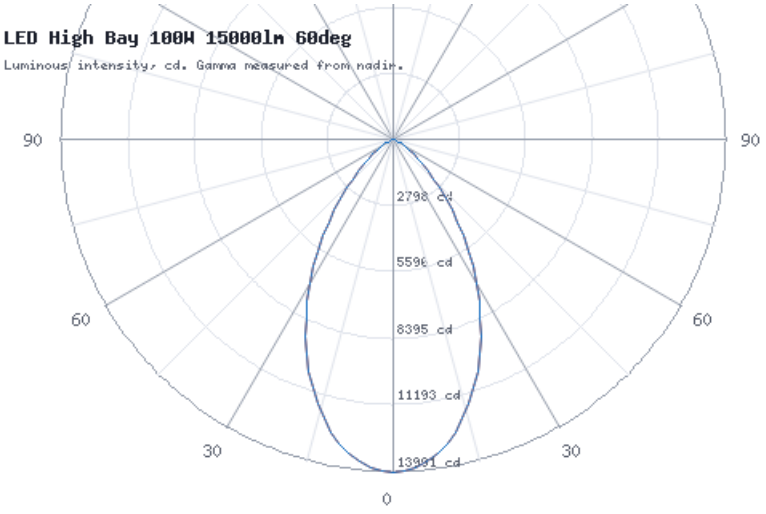
8. Fixture schedule and bill of quantities

Mark	Product	Code	Qty	lm	W	Total W	CCT / Ra	LLF	Cost
T1	Generic LED High Bay 100W ...	HB-100-60	**15**	15 000	100.0	1 500	5000K / Ra80	0.885	$2,220
	Total		**15**			**1 500**			**$2,220**

T1 **Generic LED High Bay 100W 15000lm 60deg** 1 luminaire, 350 x 350 x 140 mm, IP65, circuits C1, C2

9. Photometric distributions

Generic LED High Bay 100W 15000lm 60deg



C0 – C180
C90 – C270

15,000 lm | peak 13,991 cd at 0 deg | DFF 100% | direct

Basis of the calculation

Results are a numerical prediction for the geometry, surface properties and photometric data entered. Real installations differ: construction tolerances, furniture and partitions, surface finishes as built, luminaire orientation on site and lamp or LED batch variation all move the measured result. Room surfaces are modelled as diffuse reflectors, and obstructions inside the space are not included unless drawn as geometry.

Note: Grid per EN 12464-1: 14 x 10 points at 2.143 x 2.000 m spacing (maximum permitted 2.155 m).

Standards criteria, tariffs, grid emission factors and any generic fixture photometry shipped with this software are indicative reference data for design work. Confirm governing values against the purchased standard, the client's tariff and the manufacturer's photometric report before issuing a design for construction.