LIGHTING CALCULATION REPORT

Tutorial 3 - Classroom

Classroom

COMPLIANT WITH OBSERVATIONS

13 of 13 assessed criteria met | 0 not met | 2 with a thin margin | 0 not assessed

MAINTAINED ILLUMINANCE	UNIFORMITY UO	WORST-CASE UGR	POWER DENSITY
432 lx	**0.817**	**18.8**	**3.81 W/m2**
task area average	Emin / Eavg	CIE 117	6 luminaires

Client	**Lumina walkthrough**
Designer	**Lumina**
Project reference	**TUT-03**
Space type	**Education - Classrooms and tutorial rooms**
Standard	**EN 12464-1 - Light and lighting: Lighting of work places, Part 1: Indoor work places**
Location	**Berlin**
Revision	**1**
Engine	**Lumina photometric engine 1.0.0**

1. Design inputs

Space

Dimensions	**9.00 x 7.00 x 3.00 m**	length x width x height
Floor area	**63.00 m2**	volume 189.0 m3
Working plane	**0.75 m**	above finished floor
Boundary band excluded	**0.50 m**	task area = room less this band
Reflectances	**80 / 60 / 30 %**	ceiling / walls / floor
Area-weighted mean	**57.2 %**	all six surfaces
Maintenance factor	**0.80**	applied to initial values
Observer eye height	**1.20 m**	for glare and cylindrical illuminance

Calculation grid

Grid	**10 x 8 points**	en12464
Spacing	**0.900 x 0.875 m**	EN 12464-1 maximum 0.929 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.

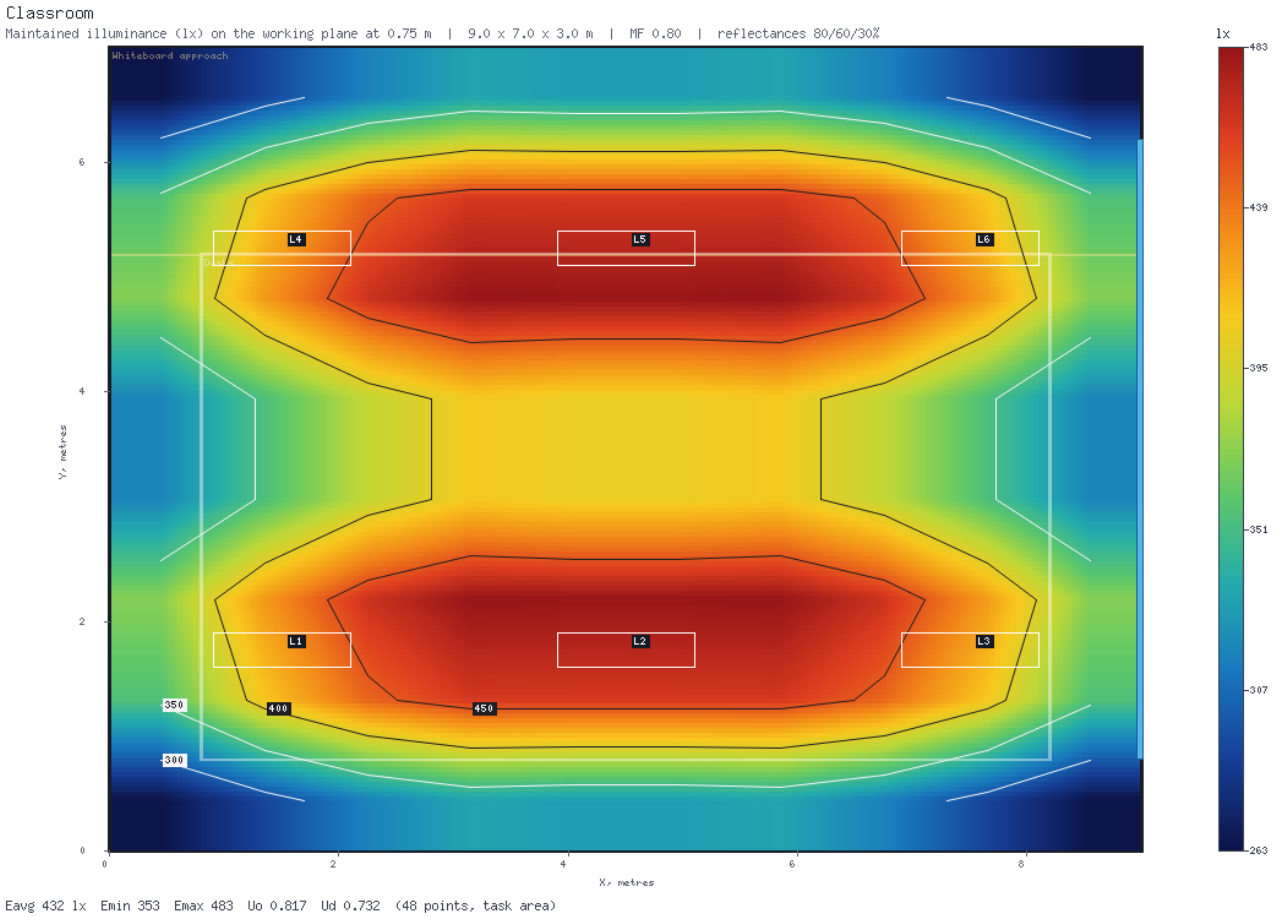
Lumen method cross-check

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	**0.9748**	direct 0.7029 + interreflected 0.2719
CU vs lamp lumens	**not applicable**	LOR absolute photometry
Room cavity ratio	**2.857**	room index K = 1.750
Effective reflectances	**0.800 ceiling / 0.310 floor cavity**	IES zonal cavity
Lumen method Eavg	**386.2 lx**	grid average 387.9 lx
Agreement	**0.43 %**	between independent routes

Numerical quality: 72 enclosure patches, interreflection converged in 13 iterations to a residual of 7.5e-7. Flux accounting closes to 100.32% on direct incidence and 100.31% 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)	48	353	**432**	483	0.817	0.732
Whole room	80	263	388	483	0.677	0.545
Direct component only	48	247	330	383	0.747	0.644
Interreflected component only	80	99	108	121	0.915	0.815

Task zone: Desks	**Eavg 430 lx, Emin 353 lx, Uo 0.822**
Surround zone: Whiteboard approach	**Eavg 366 lx, Emin 263 lx, Uo 0.718**

Room surfaces

Surface	Area m2	Reflect.	Edir lx	Eind lx	Etotal lx	L cd/m2
Ceiling	63.0	80 %	0	115	115	29.4
Floor	63.0	30 %	236	112	348	33.3
Wall X = 0	21.0	60 %	124	106	230	44.0
Wall X = max	21.0	60 %	124	106	230	44.0
Wall Y = 0	27.0	60 %	92	110	202	38.5
Wall Y = max	27.0	60 %	92	110	202	38.5

Vertical and cylindrical illuminance at 1.20 m

Quantity	Min lx	Mean lx	Max lx	Uo
Cylindrical Ez	179	**206**	242	0.870
Vertical Ev, plane facing +X	141	215	321	0.655
Vertical Ev, plane facing -X	141	215	321	0.655
Vertical Ev, plane facing +Y	118	196	282	0.603
Vertical Ev, plane facing -Y	118	196	282	0.603

Glare

Worst-case UGR	**18.80**	looking +X
Observer position	**1.05, 3.50, 1.20 m**	x, y, eye height
Background luminance	**35.0 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	**Education - Classrooms and tutorial rooms**	
Required Em	**300 lx**	Uo >= 0.60, UGR <= 19, Ra >= 80

Criterion	Actual	Required	Unit	Margin	Verdict
Maintained illuminance on the task area	432.2	>= 300	lx	132.2	PASS
Illuminance materially above requirement	432.2	<= 390	lx	132.2	MARGIN
Overall uniformity Uo (Emin/Eavg) on the task area	0.817	>= 0.6		0.217	PASS
Diversity Ud (Emin/Emax) on the task area	0.732	>= 0.2		0.532	PASS
Unified glare rating UGR (worst observer position)	18.8	<= 19		0.2	MARGIN
Mean cylindrical illuminance at 1.2 m	205.7	>= 150	lx	55.7	PASS
Immediate surrounding area maintained illuminance	366.16	>= 200	lx	166.16	PASS
Mean maintained illuminance on the walls	215.9	>= 50	lx	165.9	PASS
Mean maintained illuminance on the ceiling	115.46	>= 30	lx	85.46	PASS
Colour rendering index Ra of the specified luminaires	80	>= 80		0	PASS
Calculation grid spacing	0.9	<= 0.929	m	0.029	PASS
Lighting power density	3.81	<= 4.55	W/m2	0.74	PASS
Average daylight factor	3.21	>= 2	%	1.21	PASS

Thin margin - Illuminance materially above requirement: Design is 44% above the 300 lx requirement. Reducing output would cut energy without losing compliance.

Thin margin - Unified glare rating UGR (worst observer position): Swept over observer positions and the four cardinal viewing directions; the worst case is reported. 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.

5. Recommended corrections

LOW **Trim 31% of output to cut energy**

The design delivers 432 lx where 300 lx is required. Dimming to 69% keeps compliance and saves roughly 66 W.

- Set the constant-light-output level to 69% on the driver or control system.
- Or remove 1 luminaires and re-check uniformity, which will drop.
- Or specify a lower lumen package, which also reduces capital cost.
  Estimated load change -66 W

6. Daylight

Average daylight factor	**3.21 %**	min 0.58 %, max 18.01 %
Uniformity of DF	**0.180**	
BRE closed-form check	**2.79 %**	independent estimator
Glazing to floor area	**14.6 %**	window to wall 9.6 %

Well daylit: electric lighting can be switched or dimmed for much of the day

Window	Wall	Width m	Sill - head m	Area m2	Glass tau	Net tau	Obstr. deg
Window 1	E (E)	5.40	0.90 - 2.60	9.18	0.70	0.504	0

Annual daylight availability

Daylight autonomy	**57.8 %**	at 300 lx, range 20 to 92 %
Spatial daylight autonomy	**58 % of area**	achieving DA >= 50 %
Useful daylight illuminance	**73.2 %**	band 100 to 2 000 lx
Excessive daylight	**12.4 %**	above 2 000 lx: check glare and solar gain
Occupied hours modelled	**2 607**	8:00 to 18:00

Annual figures use 12 representative days x 24 hours, weighted by days per month, with a monthly clearness climate. Switch to the hourly model for a full 8760 step run.

7. Energy, carbon and whole-life cost

Installed load	**240.0 W**	6 luminaires
Power density	**3.810 W/m2**	installed efficacy 130.0 lm/W
Annual energy	**538 kWh**	8.5 kWh/m2
Without controls	**763 kWh**	saving 29.5 %
Full-load equivalent	**2 240 h/yr**	mean output level 0.171
Annual cost	**€139.80**	at 0.260 per kWh, flat
Annual carbon	**204 kg CO2e**	at 0.380 kg/kWh

Control zones

Zone	Circuit	Strategy	Target	Min output	Occupancy
Window row	C1	dimming	300 lx	10 %	100 %
Board lighting	C3	none	500 lx	10 %	100 %

Power density against allowance

Design	**3.810 W/m2**	
Allowance	**4.550 W/m2**	within by 16.3 %

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	€726.00	19.4 %
Energy	€2,050.22	54.8 %

Cost element	Present value	Share
Replacements	€818.17	21.9 %
Cleaning	€149.55	4.0 %
Total present value	**€3,743.94**	**100 %**

Discount rate	**5.0 %**	energy escalation 2.0 %
Equivalent annual cost	**€300.42**	annualised over the study period
Burning hours	**8 760 h/yr**	drives replacement timing

All luminaires carry a unit price.

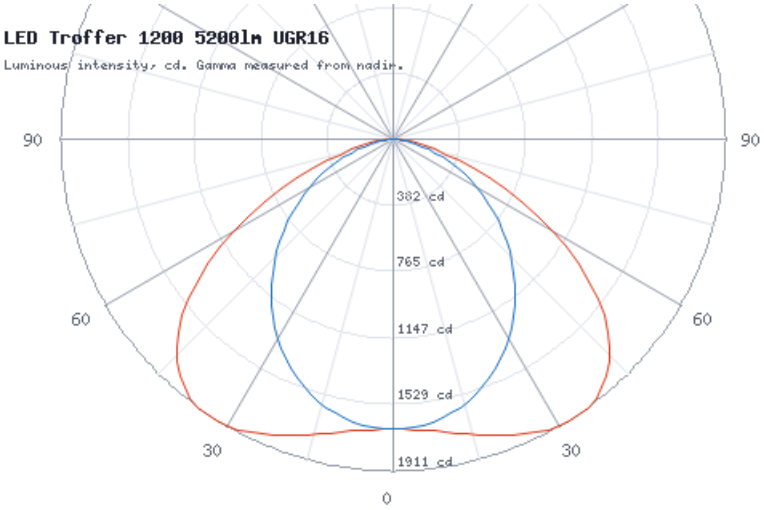
8. Fixture schedule and bill of quantities

Mark	Product	Code	Qty	lm	W	Total W	CCT / Ra	LLF	Cost
T1	Generic LED Troffer 1200 520...	TRF-1200-52...	**6**	5 200	40.0	240	4000K / Ra80	0.847	€576
	Total		**6**			**240**			**€576**

T1 **Generic LED Troffer 1200 5200lm UGR16** Indoor LED, 1200 x 300 x 70 mm, IP20, circuits C1, C2

9. Photometric distributions

Generic LED Troffer 1200 5200lm UGR16



C0 – C180
C90 – C270

5,200 lm | peak 1,912 cd at 33 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: 10 x 8 points at 0.900 x 0.875 m spacing (maximum permitted 0.929 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.