IMPROVE WAREHOUSE SAFETY WITH PROPER LIGHTING SOLUTION

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WSH COUNCIL (LOGISTICS AND TRANSPORT) COMMITTEE MEMBER

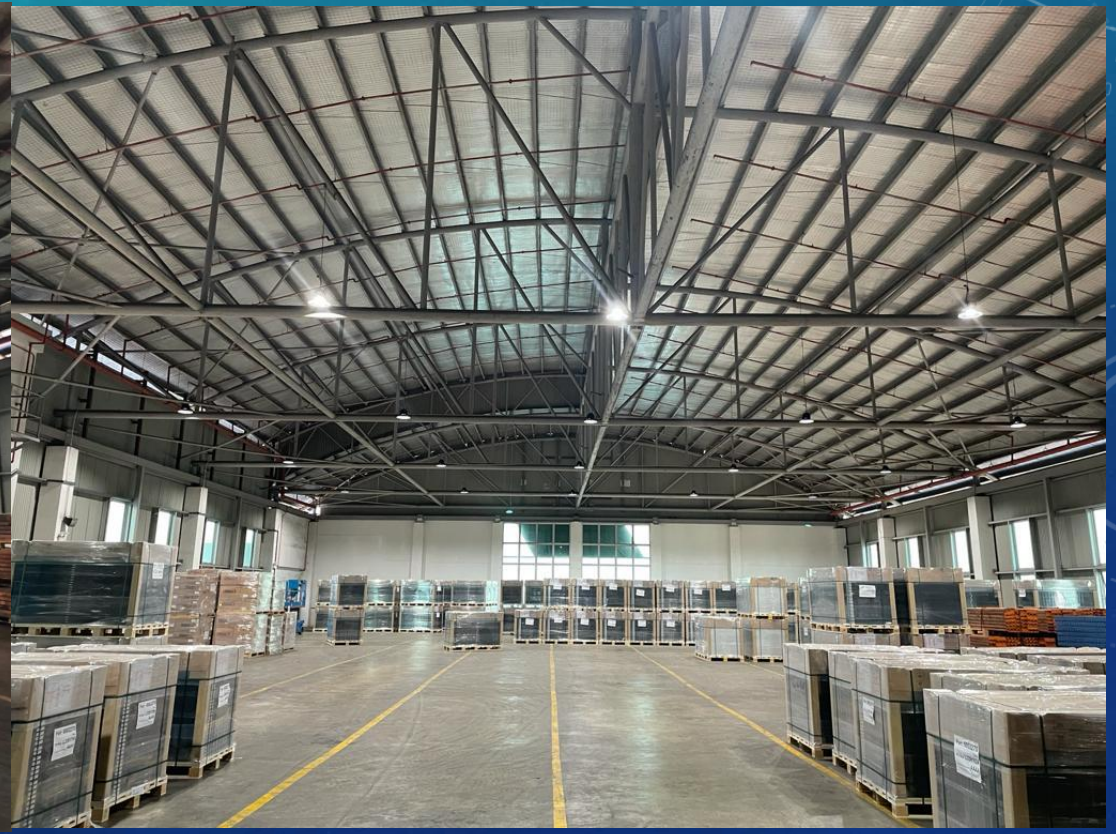
COOLED SINGAPORE

CONTENT

- Why ? Proper lighting in warehouse improves working condition and safety.
- What is required ? Proper planning based on relevant Standards and planning tools.
- How to maintain ? Proper selection and maintenance.

WHY WAREHOUSES NEED PROPER LIGHTING ?

1. Improves working environment : affects worker’s mood and concentration. bright and cool.



WHY WAREHOUSES NEED PROPER LIGHTING ?

2. Improves visibility : reduces work errors due to poor lighting when operating equipment or managing cargo.
3. Reduces operating costs : disruptions due to accidents, absenteeism, improves productivity

WHY WAREHOUSING NEEDS PROPER LIGHTING ?

4. Ultimately, it is the responsibility of ALL stakeholders (management, supervisors & maintenance) to ensure workplaces (including warehouses) are properly lighted up.

WHAT IS REQUIRED TO ACHIEVE PROPER LIGHTING ?

1. Understand the lighting requirement based on the type of work performed (Reference from SS531 : Code of Practice for Lighting of Workplaces)
   A. Illuminance (Lux)
   B. Glare Limitation (UGR)
   C. Min Colour Rendering (CRI)

SS531 ON LIGHTING AT WORKPLACES

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No. 3135 — WORKPLACE SAFETY AND HEALTH (CHAPTER 354A)

WORKPLACE SAFETY AND HEALTH
(APPROVED CODES OF PRACTICE)
NOTIFICATION 2018

In accordance with section 40B(3) of the Workplace Safety and Health Act (Cap. 354A), the Workplace Safety and Health Council hereby notifies that the Council has approved the Codes of Practice set out in the Schedule, with effect from 03 December 2018.

2. The approved Codes of Practice may be inspected at the place and time and on such days as follows:

Place: Workplace Safety and Health Council
1500 Bendemeer Road, #04-01
Ministry of Manpower Services Centre
Singapore 339946

Day: Mondays to Fridays
(public holidays excepted)

Time: 9.00 a.m. to 1.00 p.m.
2.00 p.m. to 5.00 p.m.

	Part 6: System performance tests	(2014)
33.	SS 531: Code of Practice for Lighting of work places Part 1: Indoor	2006 (2013)
34.	SS 531: Code of Practice for Lighting of work places Part 2: Outdoor	2008 (2014)
35.	SS 531: Code of Practice for Lighting of work places Part 3: Lighting requirements for safety and security of outdoor work places	2008 (2014)
36.	SS532: Code of Practice for the storage of flammable liquids Incorporating Corrigendum No. 1, May 2016	2016
37.	SS 536: Code of Practice for the safe use of mobile cranes	2008
38.	SS 537: Code of Practice for safe use of machinery Part 1: General requirements	2008
39.	SS 537: Code of Practice for safe use of machinery Part 2: Woodworking machinery	2009
40.	SS 541: Restraint belts Incorporating Amendment No. 1, April 2012	2008
41.	SS 548: Code of Practice for selection, use and maintenance of respiratory protective devices	2009
42.	SS 549: Code of Practice for selection, use, care and maintenance of hearing protectors	2009

lighting requirements at workplace is a consideration for workplace safety in Singapore

WHAT IS REQUIRED TO ACHIEVE PROPER LIGHTING ?

THE SCHEDULE OF INTERIORS (AREAS) TASKS AND ACTIVITIES WITH SPECIFICATION OF ILLUMINANCE, GLARE LIMITATION AND COLOUR QUALITY

Type of interior, task or activity	$\overline{E}_m$ lux	UGR_L	R_a	Remarks
1. General building areas				
Entrance halls	100	22	60	
Circulation areas and corridors	100	28	40	At exits and entrances provide a transition zone and avoid sudden changes.
Stairs, escalators, travelators	150	25	40	
Loading ramps/bays	150	25	40	
Rest rooms	100	22	80	
Rooms for physical exercise	300	22	80	
Cloakrooms, washrooms, bathrooms, toilets	200	25	80	
Sick bay	500	19	80	
Rooms for medical attention	500	16	90	T_{cp} at least 4000 K
Plant rooms, switch gear rooms	200	25	60	

WHAT IS REQUIRED TO ACHIEVE PROPER LIGHTING ?

Type of interior, task or activity	$\overline{E}_m$ lux	UGR_L	R_a	Remarks
Store, stockrooms, cold store	100	25	60	200 lux if continuously occupied
Dispatch packing handling areas	300	25	60	
2. Agriculture building				

WHAT IS REQUIRED TO ACHIEVE PROPER LIGHTING ?

27. Public car parks (indoor)	Lux	Glare		
In/out ramps (during the day)	300	25	40	Safety colours shall be recognisable.
In/out ramps (at night)	75	25	40	Safety colours shall be recognisable.
Traffic lanes	75	25	40	Safety colours shall be recognisable.
Parking areas	75	28	40	A high vertical illuminance increases recognition of peoples faces and therefore the feeling of safety.
Ticket office	300	19	80	1. Avoid reflections in the windows

COLOUR RENDERING

CRI 80 is the existing standard for lighting CRI

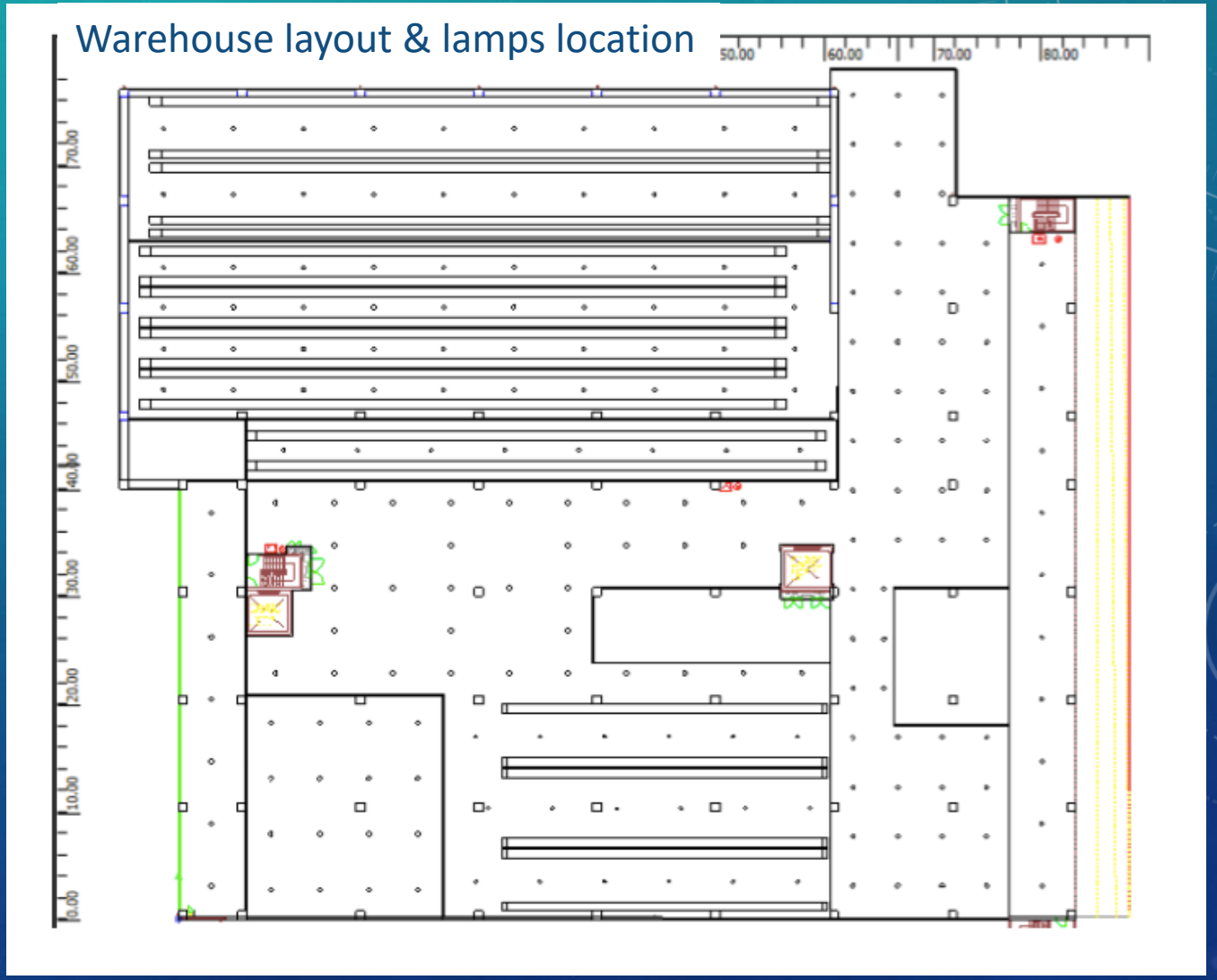
The color rendering index (CRI) is a fairly simple concept characterizing the ability of a light source to restore all the colors of the visible spectrum. The IRC of a light source is expressed in the form of a number ranging from 0 to 100, where 100 indicates a perfect light spectrum, ie encompassing the entire visible spectrum. Therefore, this means that this light source makes all the colors exactly. The lower the number, the lower the amount of color returned.

https://importanceoflighting1122.blogspot.com/2019/04/the-color-rendering-index-cri-or-irc.html

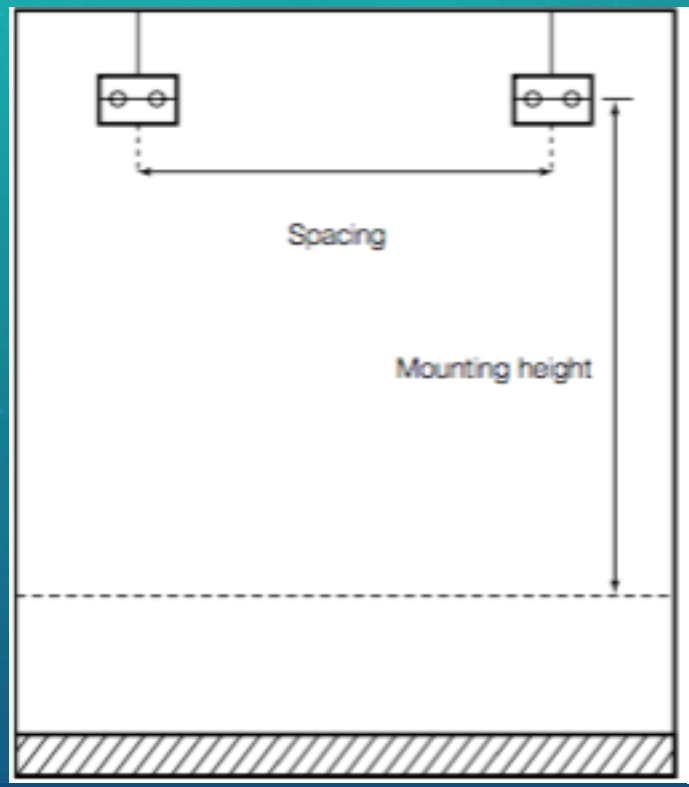
WHAT IS REQUIRED TO ACHIEVE PROPER LIGHTING ?

2. Assessment of current conditions
   A. measurement of brightness (with luxmeter, esp at locations where lighting is essential),
   B. layout of warehouse,
   C. position of lamps, and
   D. condition of lamps

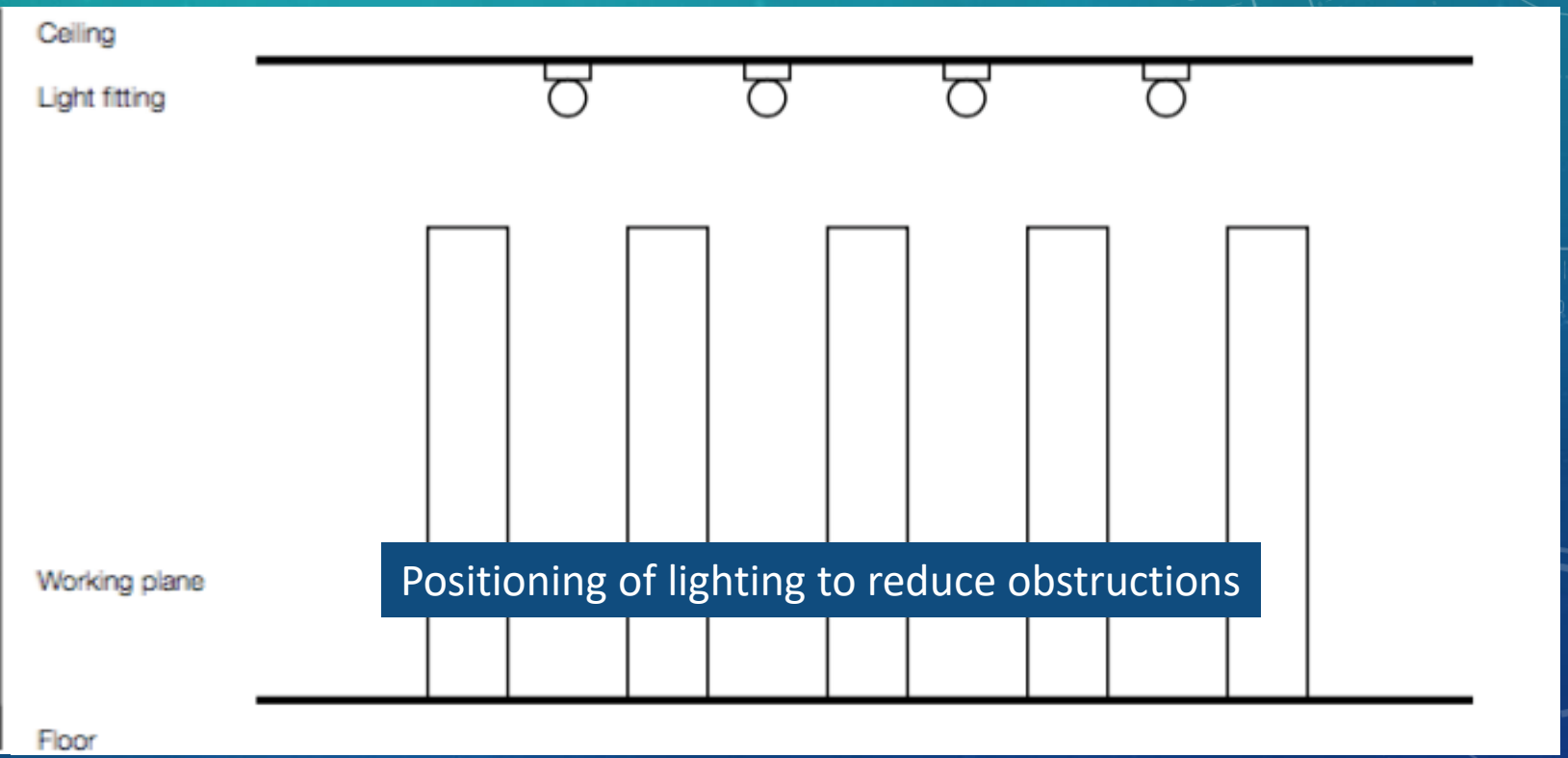
MEASUREMENT OF CURRENT BRIGHTNESS AND WAREOHUSE LAYOUT



POSITION OF LAMPS



Height of lighting and spacing between them are critical factors



Positioning of lighting to reduce obstructions

CONDITION OF LAMPS

- Time to replace conventional metal halide or soldium lamps to LED lamps. Reasons are :
  - Energy savings. Saves up to 70% from conventional lighting
  - Environmentally friendly vs conventional lighting which consists of harmful materials such as mercury.
  - LED has longer lifespan and maintenance free.
  - Conventional lighting deteriorates in brightness up to 30% after only 1000 hours in operations.

Cree currently has published 9576 hours of LM-80 data[4] on the XLamp CXA3050 White where If = 1700mA and Tsp = 85°C. When using the TM-21 method to determine lumen maintenance of the CXA3050 based on a normalized Tsp of 60°C, the reported L70 is > 57,500 hours. This projection is limited by the 6X rule as defined in TM-21. This method also allows lumen maintenance for other L-values to be calculated. In this case, at 57,500 hours the calculated lumen maintenance will be 90 percent.

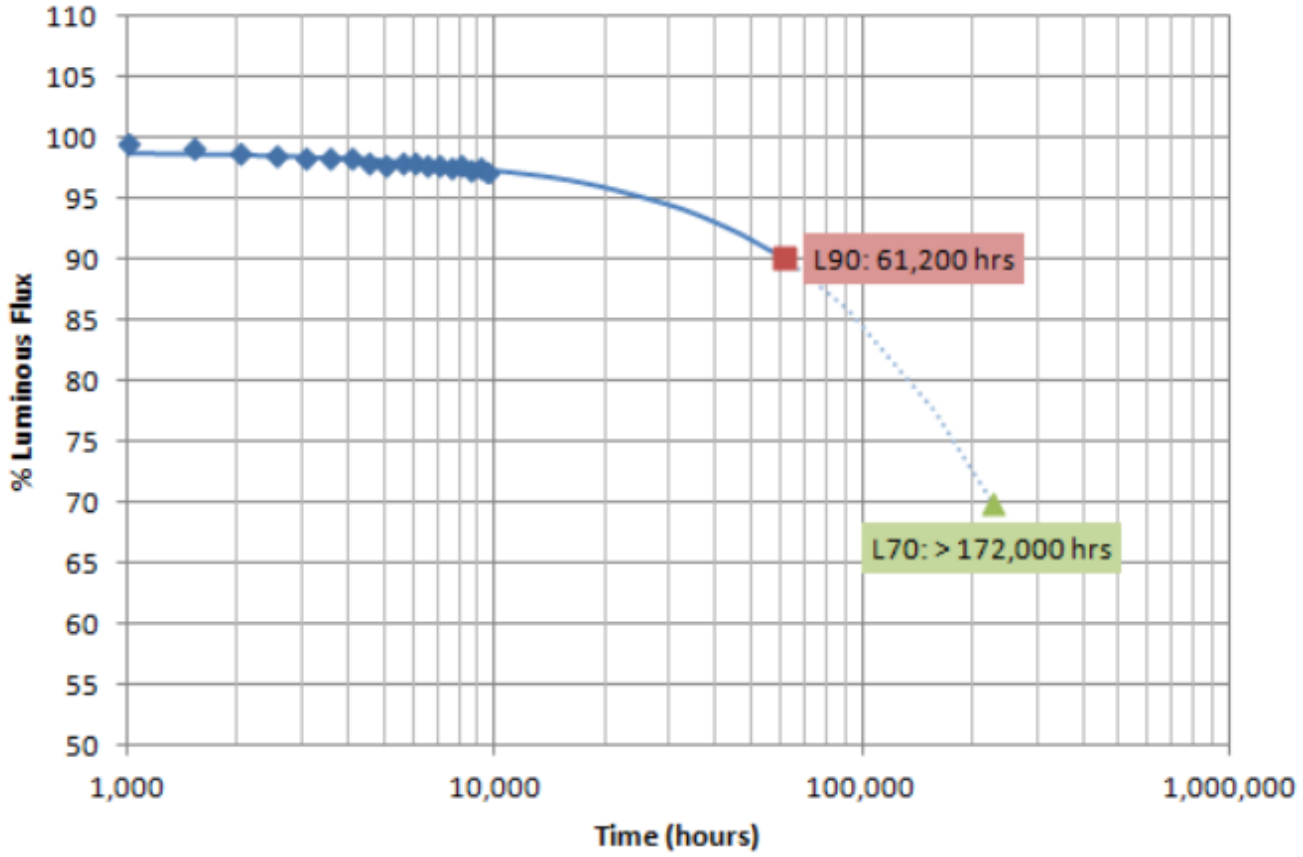
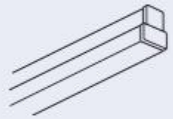
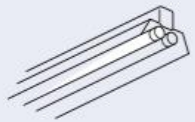


Chart 11: TM-21 projection chart

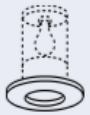
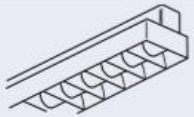
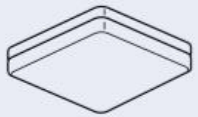
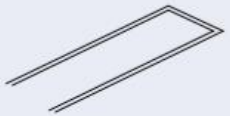
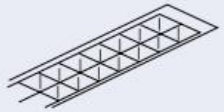
WHAT IS REQUIRED TO ACHIEVE PROPER LIGHTING ?

3. Design suitable lighting solutions for workplace at warehouse.
   A. Decide lighting needs for different locations for office, storage, processing, loading & unloading etc..)
   B. Use of lighting simulations programs to provide suitable models (eg Dialux, Relux, Radiance and AGI32) before installation.

DIFFERENT LAMPS TYPES

Light fitting type	Appearance	Suitable lamp types	Mounting positions	Typical light distribution	Glare control method	Typical application
High bay reflector		MBF, MBI, SON	Surface or pendant	Concentrated downwards	Glare controlled by shielding	High bay industrial premises
Bare batten		MCF	Surface or pendant	In all directions	No control or glare	Offices, industrial premises
Trough reflector		MCF	Surface or pendant	Widespread but downward, some upward light if trough has slots	Glare controlled by shielding	Offices, industrial premises
Linear diffuser		MCF	Surface or pendant	Widespread	Glare controlled by reducing brightness of source	Offices, industrial premises where lamps have to be enclosed
Linear prismatic		MCF	Surface or pendant	Varies widely depending on the characteristics of the prismatic panels	Glare controlled by limiting light distribution	Offices, industrial premises where lamps have to be enclosed
Linear reflector		MCF	Surface or pendant	Directional, exact direction depending on the properties of the reflector	Glare controlled by limiting distribution and by shielding	Offices

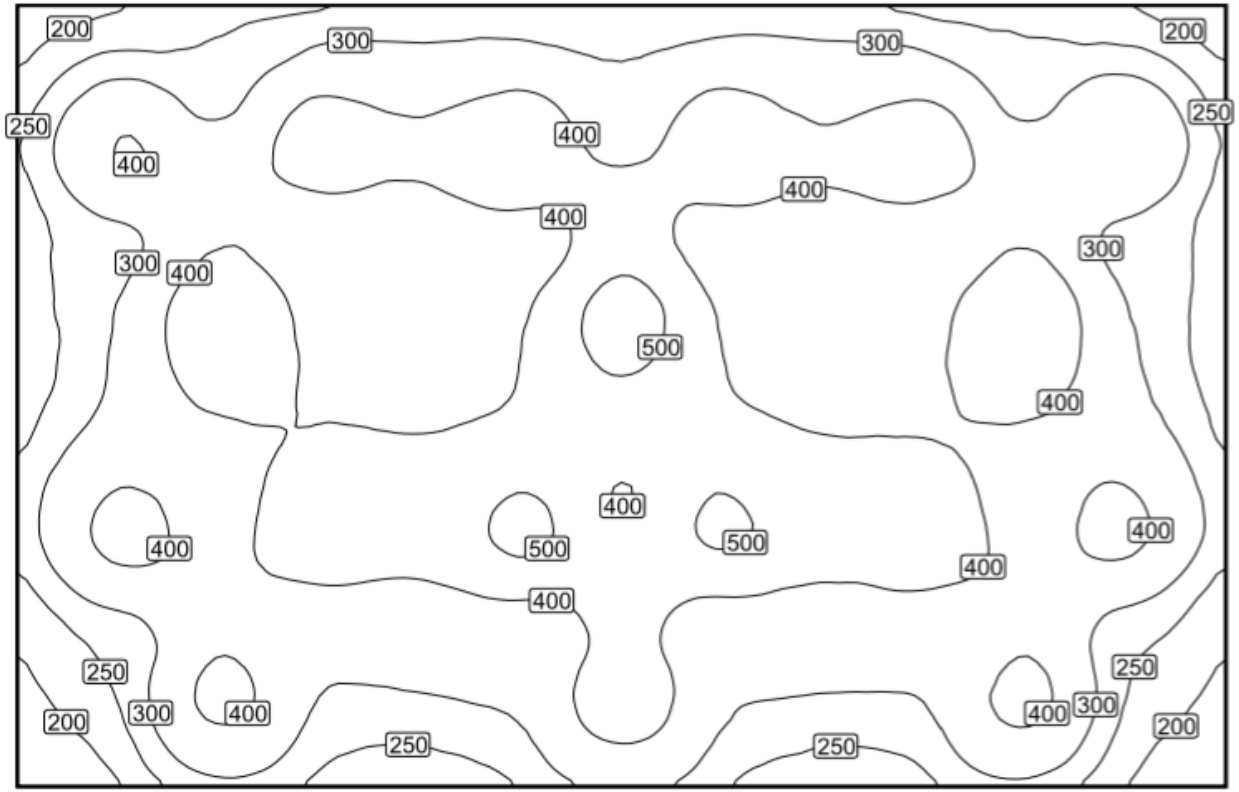
DIFFERENT LAMPS TYPES

Light fitting type	Appearance	Suitable lamp types	Mounting positions	Typical light distribution	Glare control method	Typical application
Downlighters		Tungsten, MBF, Compact MCF	Recessed or surface	Concentrated downwards	Glare controlled by shielding	Office and display areas
Bulkheads		Tungsten, MBF, SON, SOX, MCF	Surface	Widespread	Little glare control but brightness usually low	Industrial premises, exterior areas
Linear louvre		MCF	Surface or recessed	Widespread but downward	Glare controlled by shielding	Offices
Recessed diffuser		MCF, MBF, MBI, SON	Recessed	Widespread but downward	Glare controlled by reducing brightness of light source	Offices
Recessed prismatic		MCF, MBF, MBI, SON	Recessed	Very variable, depending on characteristics of prismatic panel	Glare controlled by limiting light distribution	Offices
Recessed reflector		MCF, MBF, MBI, SON	Recessed	Directional, depending on the properties of the reflector	Glare controlled by limiting distribution and by shielding	Offices
Recessed louvre		MCF, MBF, MBI, SON	Recessed	Widespread but downward	Glare controlled by shielding	Offices

LIGHTING MODELS WITH DIALUX SIMULATIONS

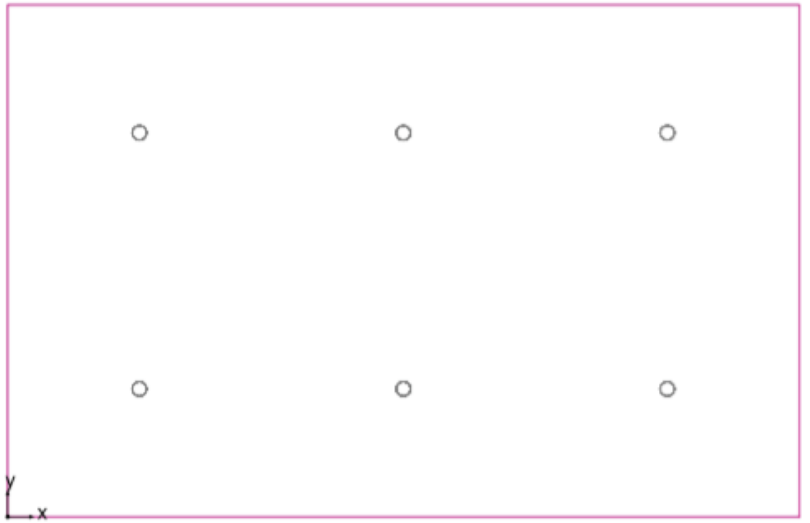
Workplane (Room 1): Perpendicular illuminance (adaptive) (Surface)
Light scene: Light scene 1
Average: 356 lx (Target: ≥ 500 lx), Min: 137 lx, Max: 547 lx, Min/average: 0.38, Min/max: 0.25
Height: 0.800 m, Wall zone: 0.000 m

Isolines [lx]

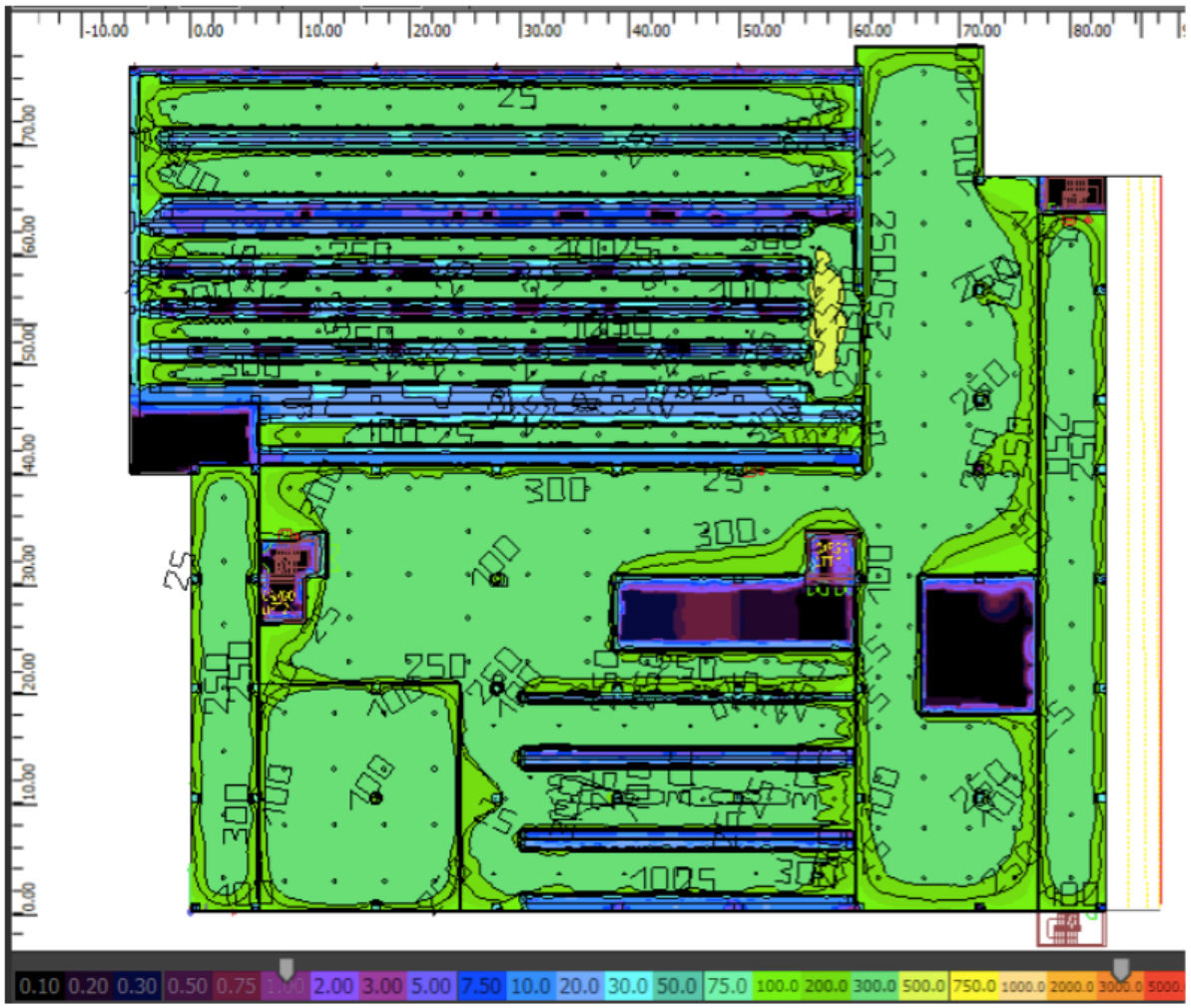


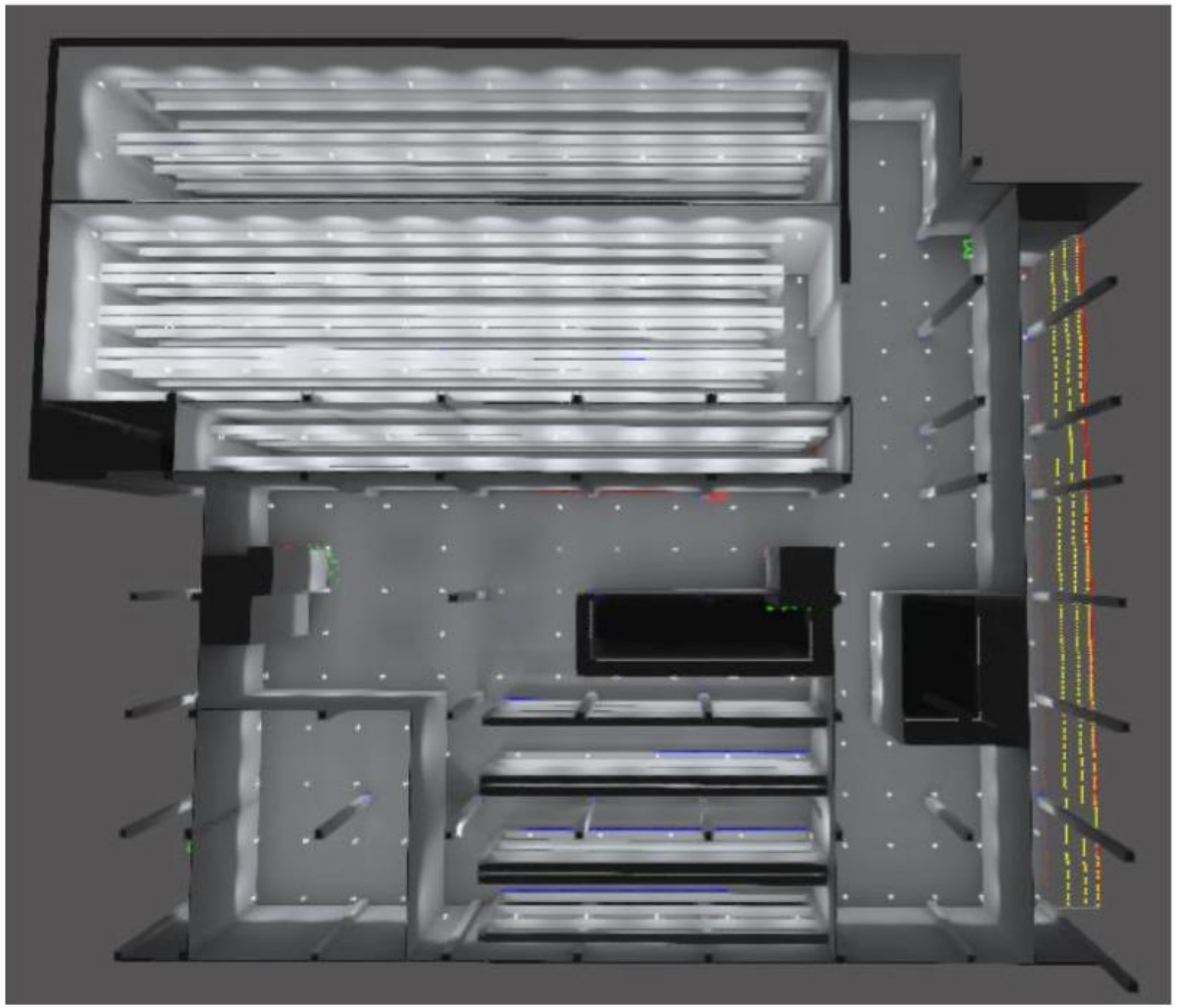
Scale: 1 : 100

Workplane (Room 1) / Perpendicular illuminance (adaptive)



LIGHTING MODELS WITH DIALUX SIMULATIONS





LIGHTING MODELS WITH DIALUX SIMULATIONS

WHAT IS REQUIRED TO ACHIEVE PROPER LIGHTING ?

C. Decide lamp characteristics suitable for different workplaces
   i. light projection,
   ii. light distribution characteristic,
   iii. mounting position,
   iv. glare control method.

DIFFERENT LAMP CHARACTERISTICS

30 deg cap 60 deg cap 110 deg cap

Different lighting projections

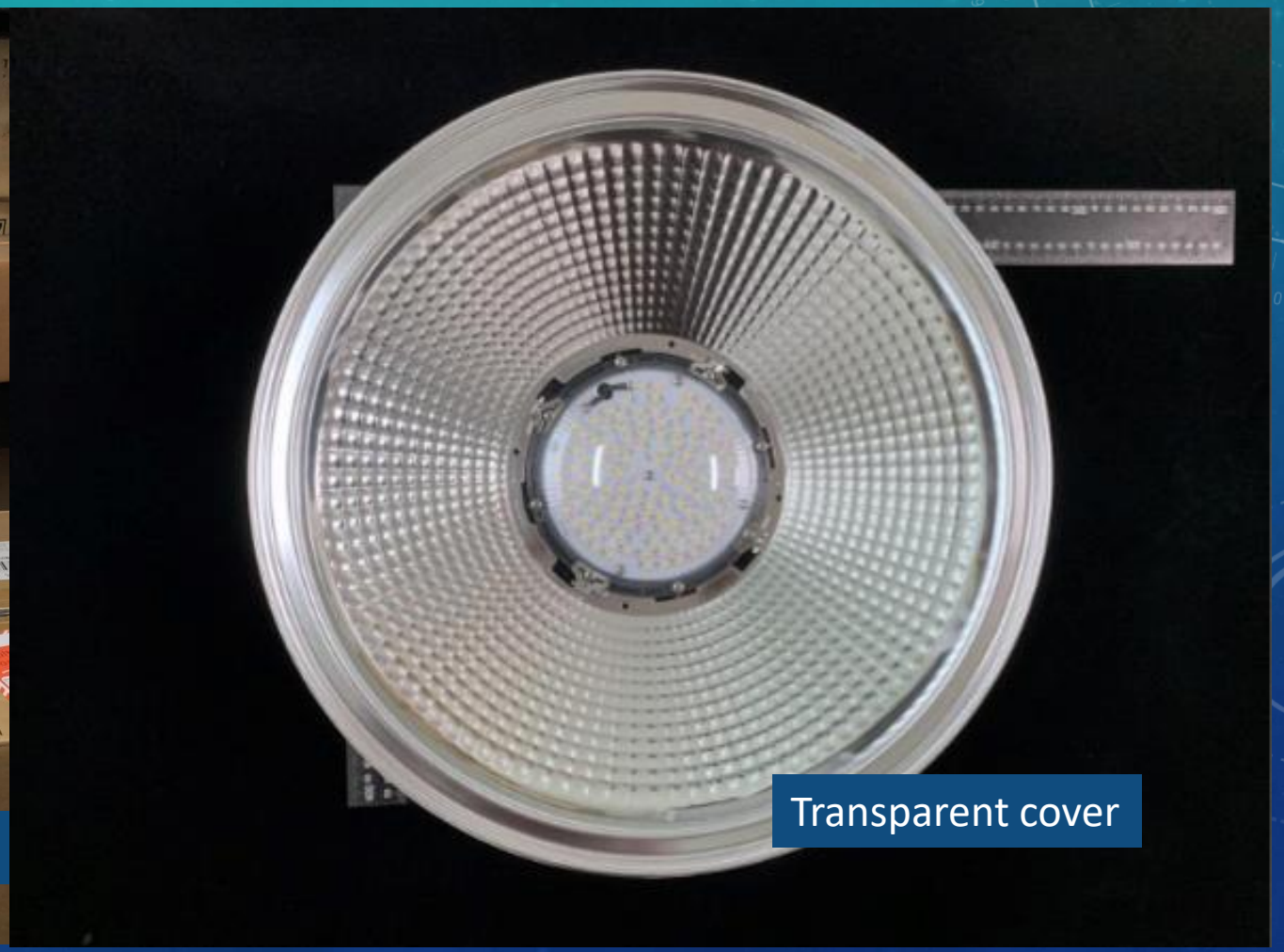
DIFFERENT LAMP CHARACTERISTICS

Lens to direct lighting form LED chip

Without lens

DIFFERENT LAMP CHARACTERISTICS

Frosted cover to reduce glare



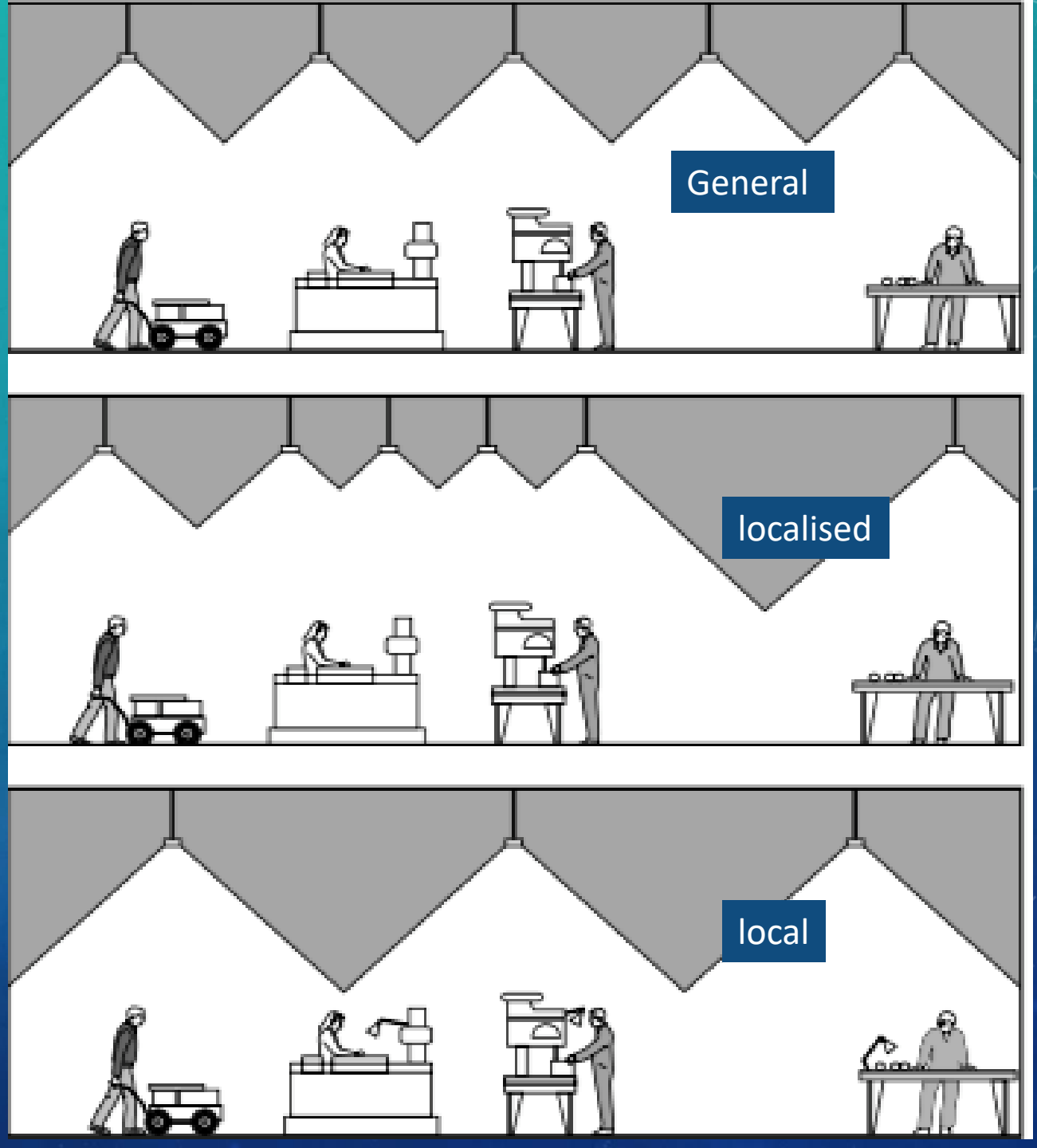
Transparent cover

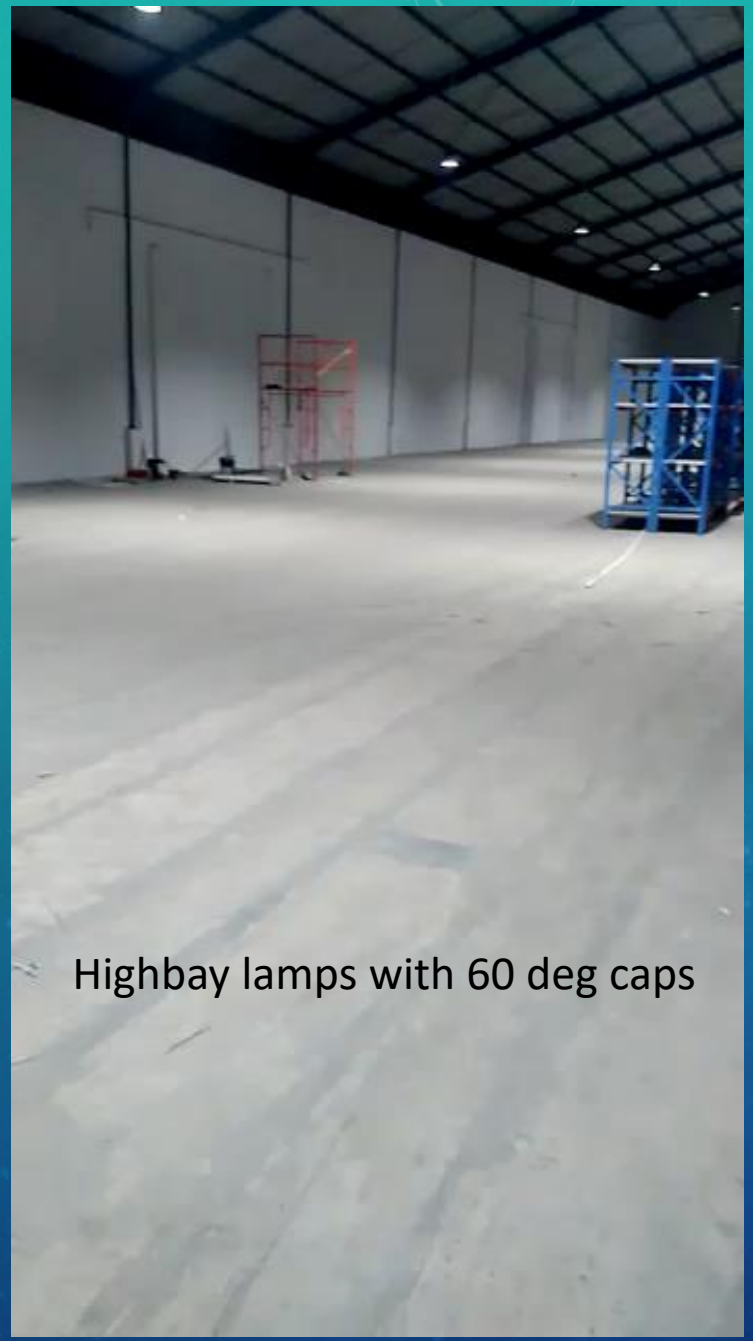
LIGHTING DISTRIBUTION

General lighting : Uniform illumination

Localised lighting : different illumination for different areas. Mainly to cater for different works

Local lighting :Local lighting is usually a combination of background lighting and a luminaire close to the actual work area





Highbay lamps with 60 deg caps

Highbay lamps with 110 deg caps

BEFORE AND AFTER EFFECTS :

- Warehouse before rectifying their lighting in the 12m high warehouse (https://youtu.be/XKR7cmNPacM)
- Warehouse after replacing proper lighting in the 12m high warehouse (https://youtu.be/-aWBYlwroz0)

HOW TO MAINTAIN PROPER LIGHTING ENVIRONMENT?

- To include lighting as one of the important safety risks at workplace and conduct regular risk assessments and controls as like for other workplace hazards.
- Regular brightness checks to ensure sufficient brightness at job sites
- Ensure prompt and proper lighting maintenance, replacement and disposal.
- Ensure suitable emergency lighting are installed and maintained.

REFERENCES

- Lighting at work (1997) HSEBooks https://www.hse.gov.uk/pubns/books/hsg38.htm
- Code of practice for lighting of workplaces, - part 1 : Indoor, SS531 : Part 1 : 2006 (2019)
- https://importanceoflighting1122.blogspot.com/2019/04/the-color-rendering-index-cri-or-irc.html

The End

Thank you for your attention

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